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PROJECT

REPORT

Ultra-Low Emission Vehicle Taxi Licensing Policy

City of Wolverhampton Council

January 2021

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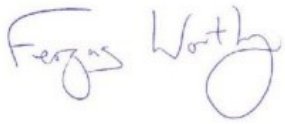

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Document Revisions

No.	Details	Date
1	Initial release	22/01/2021
1.1	Birmingham update	05/02/2021
2	Client feedback	18/02/2021
3	Updated Table 8	01/03/2021

Contents

Abbreviations

BEV	Battery Electric Vehicle
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CAZ	Clean Air Zone
FCEV	Fuel Cell Electric Vehicle
FC REEV	Fuel Cell Range Extended Electric Vehicle
LPG	Liquefied Petroleum Gas
CH_4	Methane
MPV	Multi-Purpose Vehicle
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
N_2O	Nitrous Oxide
NOx	Oxides of Nitrogen
PM	Particulate Matter
PHEV	Plug-in Hybrid Electric Vehicle
REEV	Range Extended Electric Vehicle
SUV	Sports Utility Vehicle
TTW	Tank-to-Wheel
TCO	Total Cost of Ownership
ULEV	Ultra-Low Emission Vehicle
WTW	Well-to-Wheel
WAV	Wheelchair Accessible Vehicle
ZEV	Zero Emission Vehicle

Executive Summary

In 2018, City of Wolverhampton Council commissioned Cenex to undertake a high-level review of their current hackney carriage and private hire vehicle licensing policy, specifically relating to minimum standards for the vehicle age and emissions policy. Several recommendations were made, including the following:

- Review the suitability of ultra-low emission vehicles based on individual vehicle annual mileages, fuel types and fuel economy.
- Determine the most suitable measures to incentivise the transition to ultra-low emission vehicles in support of any proposed vehicle licensing interventions.

Since completion of the previous work, City of Wolverhampton Council has declared a climate emergency with a target to reach net-zero greenhouse gas emissions across its own activities by 2028. Additionally, City of Wolverhampton Council has an aspiration to have a zero-tailpipe emission hackney carriage and private hire vehicle fleet by 2030 or 2035 at the latest (in-line with the UK Government proposal for ending the sale of new petrol, diesel and hybrid passenger vehicles).

In support of these aspirations, City of Wolverhampton Council has commissioned Cenex to undertake a detailed review of the options and feasibility of achieving a zero-tailpipe emission or ultra-low emission hackney carriage and private hire fleet by 2028 or 2035.

This report provides a detailed assessment of the current suitability of ultra-low emission vehicles for all hackney carriage and private hire vehicles licensed by City of Wolverhampton Council (168 and ~11,200 vehicles respectively). This is supported by a recommendation for an ultra-low emission vehicle policy and a high-level summary of the financial, practical and regulatory measures available to City of Wolverhampton Council to accelerate the transition to ultra-low emission vehicles.

To understand the feasibility of these recommendations, Cenex has also undertaken desk-based research into vehicle licensing policy best practice alongside interviews with other local authorities and wheelchair accessible vehicle suppliers / convertors.

Methodology

This review has been delivered in the following stages:

1. **Ultra-Low Emission Vehicle Fleet Review**: a full and detailed review of all vehicles licensed by City of Wolverhampton Council to understand the current fleet composition and emissions (by licence and vehicle type) followed by an assessment of the suitability of each individual vehicle to be replaced by an ultra-low emission vehicle. The number of vehicles currently suitable for replacement by an ultra-low emission vehicle is reported alongside the associated cost and emissions savings. This demonstrates the current feasibility of introducing ultra-low emission vehicles as the minimum emissions standard.
2. **Vehicle Emissions Policy and Measures Review**: assessment of the impact of different dates for the introduction of ultra-low emission vehicles as the minimum emissions standard for newly licensed vehicles followed by all licensed vehicles. This has been supplemented by research into vehicle age and emissions policy as well as financial, practical and regulatory measures delivered through desk-based research and taxi industry interviews.
3. **Trade Engagement and Promotion**: direct engagement with the taxi trade via an online survey, two trade engagement workshops and by trialling personalised ultra-low emission vehicle suitability reports to encourage potential early adopters to transition to ultra-low emission vehicles. Upon completion, a summary of these activities will be provided in Addendum – Trade Engagement and Promotion.

Summary of Current Fleet

The table below provides a summary of the City of Wolverhampton licensed hackney carriage and private hire vehicle fleets (as of August 2020). This gives context for the findings of the report and acts as a baseline for proposed vehicle licensing policy revisions and supporting measures.

	Hackney Carriage Vehicles	Private Hire Vehicles
Number of Vehicles	168	11,372
Vehicle Types	Medium Passenger Van[1] (84%) London Taxi[1] (16%)	Medium Car (45%) Large Car (27%) Multi-Purpose Vehicle (16%) Executive Car (6%) Other (6%)
Vehicle Models	Mercedes-Benz Vito, Citroen Dispatch, Peugeot Expert	Toyota Prius, Skoda Octavia, Toyota Avensis
Average Mileage	28,400 miles per year ~109 miles per day[2]	22,220 miles per year ~85 miles per day[2]
Maximum Mileage[3]	50,000 miles per year, ~190 miles per day	
Total Mileage	4,800,000, miles per year	244,000,000 miles per year
Vehicle Locations[4]	Wolverhampton (100%)	West Midlands[5] (55%) National (35%) Wolverhampton (10%)
Vehicle Operations	Urban with Major Conurbation / City and Town	
Fuel Types	Diesel (100%)	Diesel (64%) Hybrid (22%) Petrol (13%)
Average Fuel Economy	~36 mpg	~48 mpg
Euro Standards	56% Euro 4 or less 8% Euro 6	61% Euro 5 30% Euro 6
Average Air Quality Emissions (Oxides of Nitrogen)	0.91 g / km 42 kg per year	0.38 g / km 14 kg per year
Contribution to Fleet Greenhouse Gas Emissions[6]	2%	98%
Contribution to Fleet Air Quality Emissions[6,7,8]	31% (Wolverhampton) 4% (Total)	69% (Wolverhampton) 96% (Total)

1 all hackney carriage vehicles are wheelchair accessible vehicles.
2 assuming 5 days operation per week and 52 weeks per year.
3 two standard deviations from the average annual mileage. Approximately the top 2.5% of vehicles will cover a greater mileage each year.
4 based on anonymised vehicle proprietor postcode only.
5 excluding Wolverhampton.
6 fleet denotes the combined hackney carriage and private hire vehicles (e.g. all licensed vehicles).
7 air quality emissions are represented as percentage contribution of Oxides of Nitrogen emissions
8 not all fleet air quality emissions occur in the city of Wolverhampton. The Wolverhampton percentage split shows the estimated contribution to air quality in the city of Wolverhampton. The Total percentage split includes the contributions of all private hire vehicles, many of which will emit air quality emissions in other cities.

Conclusions

The City of Wolverhampton Council target of achieving a zero-tailpipe emission or ultra-low emission hackney carriage and private hire vehicle fleet by 2028 is achievable but very challenging with immediate progress requiring a coordinated approach to licensing policy, incentive measures, and chargepoint infrastructure delivered by a dedicated, appropriately funded, programme of work.

Adopting a highly aspirational licensing policy under which all licensed vehicles must be zero emission or ultra-low emission by 2028 and newly licensed vehicles must meet the same standards from 2023 at the earliest (subject to the availability of suitable vehicles) would require the introduction of 1,500 ultra-low emission vehicles each year between 2023 and 2027 followed by 4,700 vehicles in 2028. Between 2020 and 2035, this would reduce cumulative greenhouse gas emissions by 31% and cumulative air quality pollutant emissions by 35%. From 2028 annual greenhouse gas and air quality pollutant emissions would be reduced by at least 54% and 95%, respectively. This would also provide running cost savings of £119m and social damage cost savings of £22.5m.

To support such a policy, direct incentives should only be provided for the introduction of zero emission and ultra-low emission vehicles which meet the latest plug-in grant emissions eligibility criteria[1] (instead of diesel, petrol and hybrid vehicles with improved Euro emission standards). This ensures an earlier transition to ultra-low emission vehicles and crucially reduces both greenhouse gas and air quality pollutant emissions. Any new diesel, petrol or hybrid vehicles introduced will delay significant greenhouse gas emissions reductions by an entire vehicle life cycle.

Interim measures such as trade engagement events, ride and drive opportunities, personalised suitability advice, and increasing the availability of suitable wheelchair accessible vehicles should aim to increase the awareness, knowledge and experience of using ultra-low emission vehicles amongst potential early adopters. At the point of introduction of ultra-low emission as the minimum emissions standard, a targeted package of measures is also required including financial incentives, additional electric vehicle charging infrastructure and ultra-low emission vehicle trial schemes.

Supporting Justification

- Ultra-low emission vehicles are available in key vehicle segments with at least 50 models available in 2020. The number of ultra-low emission vehicle models is expected to increase by 89% before 2025 at which point cost parity with new petrol / diesel vehicles is expected.
- 64% of the combined fleet already meets the suitability criteria to be replaced by a battery electric vehicle, with medium and large cars representing the most immediate opportunities.
    - Battery electric vehicles have real-world electric only ranges of 110-196 miles[2]. 89% of the combined fleet can complete their average daily mileage on one charge only.
    - Except for executive cars, battery electric vehicles provide total cost of ownership savings of £3,000 to £22,000 compared to buying a brand-new Euro 6 vehicle.
    - Battery electric vehicles produce zero tailpipe emissions and provide a 60-75% reduction in fuel lifecycle greenhouse gas emissions.
- The recommended strategy provides clear messaging and certainty to the trade regarding expected minimum emissions standards and replacement vehicle ownership periods. Likewise, a focused package of ultra-low emission vehicle measures can be implemented that provides incentives for vehicle technologies with the largest zero emissions range, thereby improving value for public money.
- Cenex acknowledge that the proposed dates for the aspirational scenario are highly ambitious. These timescales allow for negotiation with the trade and are aligned with other local authorities aiming to have ultra-low emission hackney carriage and private hire fleets by 2030 including Coventry (2024), Cambridge and South Cambridgeshire (2028), and Derby and Nottingham (2030). It should however be noted that City of Wolverhampton Council have far more private hire vehicles (>11,000) and have not yet developed a new licensing policy.

[1] Currently defined as 'CO_2 emissions of less than 50 g/km and can travel at least 70 miles without any emissions at all'.
[2] Based on standard battery capacities, a large car with a 75 kWh battery has an estimated real-world electric range of 267 miles.

Key Risks (shown in descending order of likely risk to implementation)

- **Provision of adequate funding to offer short term incentive measures** to increase confidence in ultra-low emission vehicles and to overcome the increased purchase cost.
  - Recommendation: Develop a full business case to support external funding applications.
- **Limited availability of suitable wheelchair accessible vehicles** (and to a lesser extent 7-seater vehicles and executive cars).
  - There are currently only two models available, the Dynamo Nissan e-NV200 (40 kWh battery electric vehicle) and LEVC TX (31 kWh range extended electric vehicle).
  - Due to a relatively high average daily mileage (109 miles), only 38% of hackney carriage vehicles are able to operate over a day on a single charge of a battery electric vehicle. On average, range extended electric hackney carriage vehicles increase total cost of ownership by £5,000 and reduce greenhouse gas emissions by 37% (compared to a 75% reduction for battery electric vehicles). Currently, both technologies would be heavily reliant on the availability of DC rapid chargepoints for 'top-up' charging during shifts.
  - Recommendation: Support the development of a demonstration fleet of new to market ultra-low emission wheelchair accessible hackney carriage vehicles. Recommended demonstration fleet to include side entry and rear entry wheelchair accessible vehicles based on the latest generation of small and medium van derived passenger vehicles.
  - Recommendation: Ensure that the introduction of ultra-low emission vehicles is conditional on the availability of suitable vehicles across all essential services.
- **Provision of adequate electric vehicle charging infrastructure** to support the wider scale adoption of plug-in ultra-low emission vehicles.
  - The private hire vehicle fleet operates nationally, this may make provision of adequate infrastructure more challenging.
  - Recommendation: Undertake a review of infrastructure requirements to develop a proposal for a regional chargepoint network to support the aspirational licensing policy.
- **Plug-in hybrid electric vehicles are not well suited to City of Wolverhampton Council private hire vehicle operations** but are currently classified as ultra-low emission vehicles.
  - Plug-in hybrid electric vehicles increase total cost of ownership for all vehicle types, additionally plug-in hybrid electric vehicles are no longer eligible for the plug-in grant.
  - If charged once per day, plug-in hybrid electric vehicles increase greenhouse gas emissions for 38% of executive cars and 73% of medium cars. Most plug-in hybrid electric vehicles have an electric only range of 20-30 miles and do not have DC rapid charging capabilities.
  - Recommendation: Do not provide additional incentives (regulatory, financial or otherwise) for current plug-in hybrid electric vehicles or Euro 6 diesel, petrol or hybrid vehicles.
- **The number of City of Wolverhampton Council licensed private hire vehicles has increased from around 650 vehicles in 2013 to over 11,000 vehicles in 2020**. **Only 10% of these vehicles are based in Wolverhampton postcode districts**. Further measures are required to minimise the impact of any future increases in vehicle numbers on emissions and to ensure that incentives are prioritised for vehicles operating locally or in the West Midlands.
  - Recommendation: Introduce ultra-low emission vehicles as the minimum emission standard for new private hire vehicle licence applicants as soon as possible and establish appropriate targets for the number of ultra-low emission vehicles to be licensed by large private hire vehicle operators.
  - Recommendation: Investigate the feasibility of aligning ultra-low low emission vehicle licence policies and incentive measures across the West Midlands. Establish eligibility criteria for preferred incentive measures.

Recommended Ultra-Low Emission Hackney Carriage and Private Hire Vehicle Strategy

Stage 1 (2021)	Gain political support for draft ultra-low emission vehicle policy
Submit draft vehicle emissions policy proposals to the Licensing Committee for approval.	
All licensed vehicles to be zero emission or ultra-low emission by 2028 (subject to review).	
New vehicles to be zero emission or ultra-low emission from 2023 (subject to vehicle suitability).	
Maximum vehicle age limits to be reviewed for diesel, petrol and hybrid vehicles.	
Publish draft proposals including timescales, expected standards, and trade engagement plans.	

Stage 2a (2021)	Review infrastructure and wheelchair accessible vehicle measures
Review infrastructure requirements to support the forecast uptake of plug-in vehicles.	
Undertake a feasibility study for the procurement of a battery electric, 9-seater, passenger van to be converted to a wheelchair accessible hackney carriage vehicle.	
Review the suitability of rear entry wheelchair accessible vehicles as hackney carriage vehicles.	
Publish a list of actions to increase the availability of suitable wheelchair accessible vehicles.	

Stage 2b (2021-2022)	Introduce interim measures to support potential early adopters
Identify and engage with potential early adopters.	
Increase awareness, knowledge and experience of using ultra-low emission vehicles: • Publish a provisional list of approved vehicles with revised vehicle conditions of licensing to maximise ultra-low emission vehicle availability. • Facilitate trade engagement events with ride and drive opportunities. • Provide personalised advice and suitability assessments. • Develop pilot scheme for an ultra-low emission vehicle trial scheme.	
Engage with the trade to establish the type and level of financial support required. Implement a non-repayable grant scheme covering direct licensing costs for select early adopters.	

Stage 3 (2021-2023)	Develop then approve final proposals and targeted measures
Assign a dedicated programme manager responsible the delivery of multiyear projects covering vehicle licensing policy, ultra-low emission vehicle measures and infrastructure.	
Determine objectives and key performance indicators to be monitored during the programme.	
Determine the specifics of the recommended strategy including, but not limited to, the following: • Definition of an ultra-low emission vehicle e.g. 'CO_2 emissions of less than 50 g/km and can travel at least 70 miles without any emissions at all'. • Maximum vehicle age limits for different emissions standards. • Conditions on the availability of suitable ultra-low emission vehicles. • Emissions policy introduction dates.	
Develop a full business case to support external funding applications for measures that are major projects such as an interest free loan scheme, a non-repayable grant scheme, electric vehicle charging infrastructure, and an ultra-low emission vehicle trial scheme.	
Undertake a public consultation regarding final proposals and measures.	

Stage 4 (2023-2025)	Implement final ultra-low emission vehicle policy and measures
Undertake a final review of ultra-low emission vehicle suitability.	
Launch final package of measures six months prior to the new licensing policy, measures to be reviewed annually and made available for at least two years.	
Implement ultra-low emission vehicle policy for newly licensed vehicles.	

1 Introduction

In 2018, City of Wolverhampton Council commissioned Cenex to undertake a high-level review of their current hackney carriage and private hire vehicle licensing policy, specifically relating to minimum standards for the vehicle age and emissions policy. Several recommendations were made, including the following:

- Review the suitability of ultra-low emission vehicles (ULEVs) based on individual vehicle annual mileages, fuel types and fuel economy.
- Determine the most suitable measures to incentivise the transition to ULEVs in support of any proposed vehicle licensing interventions.

Since completion of the previous work, City of Wolverhampton Council has declared a climate emergency with a target to reach net-zero greenhouse gas emissions across its own activities by 2028. To address the joint environmental challenges of achieving zero greenhouse gas emissions by 2050 and ensuring compliance with legal limits for air quality pollutant emissions, City of Wolverhampton Council has an aspiration to have a zero-tailpipe emission vehicle (ZEV) hackney carriage and private hire fleet by 2030 or 2035 at the latest (in-line with the UK Government proposal for ending the sale of new petrol, diesel and hybrid passenger vehicles[3]).

City of Wolverhampton Council has commissioned Cenex to undertake a detailed review of the options and feasibility of achieving a ZEV (or ULEV) hackney carriage and private hire fleet by 2028 or 2035.

1.1 Scope

This report provides a detailed assessment of the current suitability of ULEVs for all hackney carriage and private hire vehicles licensed by City of Wolverhampton Council as of 21st August 2020 (168 and ~11,200 vehicles respectively). All private hire vehicles are included regardless of location.

An ULEV has been defined using the Office for Zero Emission Vehicles and the Vehicle Certification Agency definition as any car or van that emits less than 75 g/km of carbon dioxide (CO_2) from the tailpipe. Technologies currently meeting this definition have been included in this report and include fuel cell electric vehicles (FCEV), fuel cell range extended electric vehicles (FC REEV), battery electric vehicles (BEV), range extended electric vehicles (REEV) and plug-in hybrid electric vehicles (PHEVs). Due to advances in technology, it is expected that from 2021 an ULEV will be defined as a car or van that emits less than 50 g/km with a minimum required zero emission range.

ULEV suitability has been assessed for each vehicle using average daily mileage, calculated real-world operating range, total cost of ownership (TCO) and emissions with consideration for which vehicle models are most likely to be fit for purpose as taxi vehicles. The vehicle cost modelling presented in this report is based on the outright purchase and subsequent ownership of an ULEV compared to purchasing a brand-new diesel or petrol vehicle. It is acknowledged that, where allowed, many operators prefer to purchase used vehicles outright. Indicative cost differences for ULEVs compared to used diesel vehicles have been included where relevant.

1.1.1 Out of Scope

- Operational suitability has been assessed using annual mileage data from MOT records and an assumed number of days used per week to calculate average daily mileage. It is the responsibility of vehicle proprietors, with the support of City of Wolverhampton Council (and partners), to confirm overall and day to day operational suitability. The main exception to this is the vehicles that will be fitted with telematics devices and assessed in 2021.
- Electric vehicle charging infrastructure requirements are out of scope and have not been assessed as part of this report.
- This report provides a summary of measures to increase the uptake of ULEVs but is not intended as an outline or full business case assessment of such measures.

[3] https://www.gov.uk/government/news/government-takes-historic-step-towards-net-zero-with-end-of-sale-of-new-petrol-and-diesel-cars-by-2030

1.2 Methodology

This review has been delivered in the following stages:

1. **Ultra-Low Emission Vehicle Fleet Review**: a full and detailed review of all vehicles licensed by City of Wolverhampton Council to understand the current fleet composition and emissions (by licence and vehicle type) followed by an assessment of the suitability of each individual vehicle to be replaced by an ULEV. The number of vehicles currently suitable for replacement by an ULEV is reported alongside the associated cost and emissions savings. This demonstrates the current feasibility of introducing ULEV as the minimum emissions standard.
2. **Vehicle Emissions Policy and Measures Review**: assessment of the impact of different dates for the introduction of ULEV as the minimum emissions standard for newly licensed vehicles followed by all licensed vehicles. This has been supplemented by research into vehicle age and emissions policy as well as financial, practical and regulatory measures delivered through desk-based research and taxi industry interviews.
3. **Trade Engagement and Promotion**: direct engagement with the taxi trade via an online survey, two trade engagement workshops and by trialling personalised ULEV suitability reports to encourage potential early adopters to transition to ULEVs. Upon completion, a summary of these activities will be provided in Addendum – Trade Engagement and Promotion.

For reference, the term 'taxi' has been used interchangeably throughout this report to describe the entire taxi trade (taxi drivers, taxi vehicles). It therefore covers hackney carriage and private hire vehicles. 'Hackney carriage vehicle' and 'private hire vehicle' have been used to differentiate between licence types. These terms do not refer to specific vehicle specifications.

The following formatting has been applied to the main body text throughout the report:

- **Key assumptions** are shown in bold and are underlined.
- **Key findings** are shown in bold only and are summarised in Section 7 Conclusions.
- **Implementation Recommendations** are shown in light green text boxes and represent individual recommendations that address specific considerations.
- **Strategy Recommendations** are shown in light gold text boxes and represent recommendations which collectively achieve the overall objectives of the project. Strategy recommendations have been consolidated in Section 8 Recommended Ultra-Low Emission Hackney Carriage and Private Hire Vehicle Strategy.

Figure 1 provides a summary of the overall methodology used to produce this report.

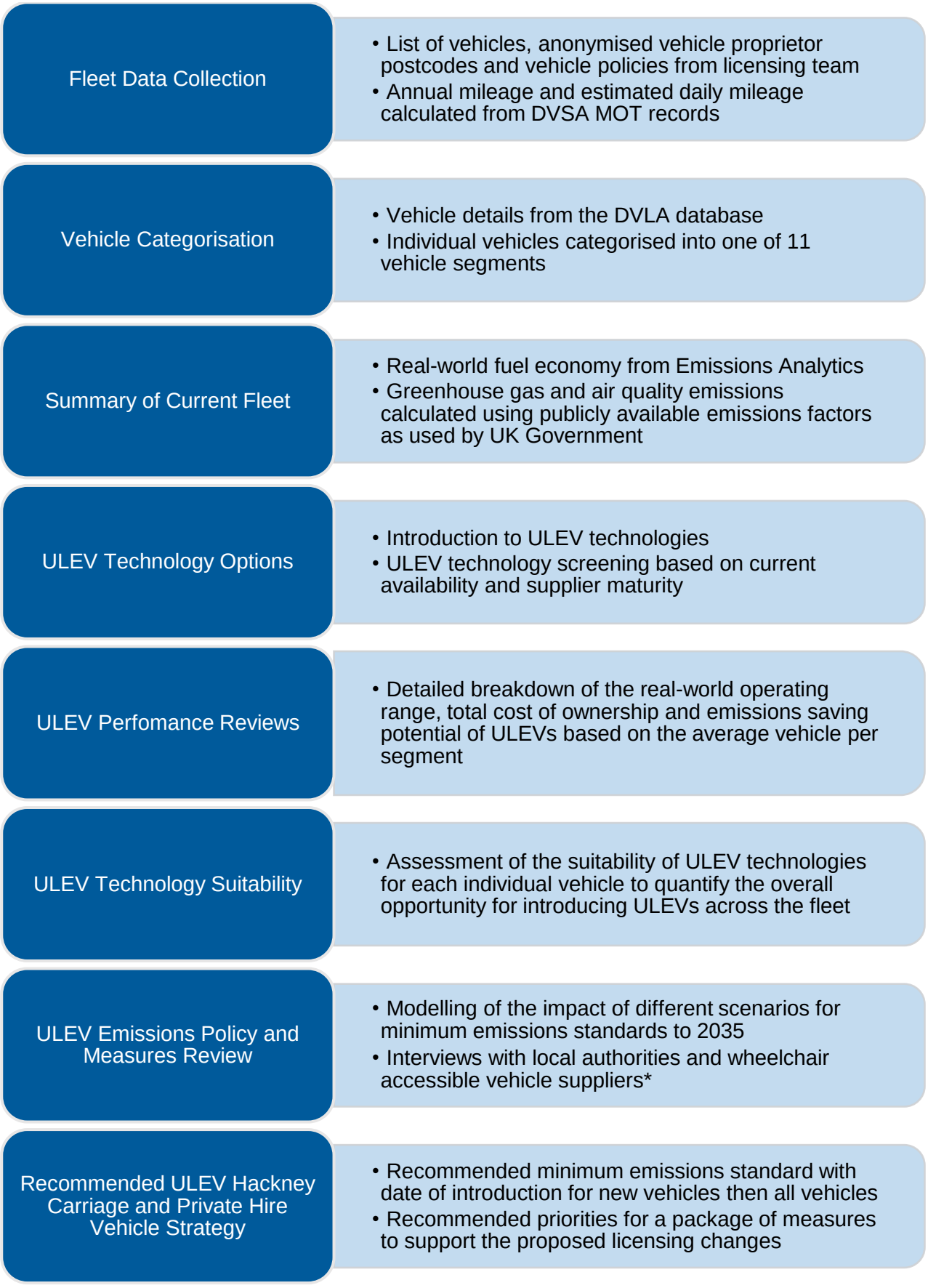


Figure 1 - Summary of Methodology

* Brotherwood (brief call with Sales Consultant), Cardiff County Council (brief call with licensing team), Coventry City Council, Dynamo Motor Company and Paul Rigby Group.

2 Summary of Current Fleet

This section studies the provided fleet data to understand and baseline the current fleet size, vehicle types, operational patterns and emissions. The purpose of this section is to provide context for the report and to provide a baseline for proposed vehicle emissions policies.

City of Wolverhampton Council provided Cenex with a list of 168 hackney carriage and 11,204 private hire vehicle registrations, correct as of August 2020. Additionally, the following information was also supplied:

- Total mileage at the most recent compliance test for each vehicle.
- An identification of wheelchair accessible vehicles (WAV).
- Operator licence number for each private hire vehicle.
- Separate and anonymised list of vehicle proprietor postcodes (district code only e.g. WV1).

2.1 Review of Current Vehicle Licensing Policy

The vehicle licensing policy determines the fleet composition and emissions profile through accepted vehicle types, maximum vehicle age limits and minimum emissions standards.

Table 1 shows the current City of Wolverhampton Council vehicle age and emissions policy. City of Wolverhampton Council use a vehicle age based policy and do not directly specify any minimum emissions standards.

Table 1 – Vehicle Age and Emissions Policy; City of Wolverhampton Council

	Maximum Age Limit (Newly Licensed Vehicles)	Maximum Age Limit (Renewal)
Hackney Carriage Vehicle	Brand New	16 years
Private Hire Vehicle	12 years	12 years

Hackney carriage vehicles must be brand new when first licensed and can be renewed up to the age of 16 years, subject to vehicle inspections which occur annually up to the age of 10 years then every 6 months up to the age of 16 years.

Private hire vehicles will not be licensed over the age of 12 years. City of Wolverhampton Council do not have an 'exceptional condition' policy, such policies waive age limits for vehicles in exceptional condition which can often lead to increased fleet emissions.

2.1.1 West Midlands Licensing Policy

For context, the licensing policies of the other local authorities in the West Midlands have also been reviewed. This information is used to highlight any important differences, particularly those which may make establishing minimum emissions standards more challenging.

Table 2 and Table 3 show the maximum age limits for hackney carriage and private hire vehicles licensed across the seven local authorities that constitute the West Midlands Combined Authority.

Table 2 – Hackney Carriage Vehicle Age and Emissions Policy; West Midlands Local Authorities

Local Authority	Maximum Age Limit (Newly Licensed Vehicles)	Maximum Age Limit (Renewal)
Birmingham	15 years	15 years
Coventry	15 years	15 years
Dudley	None	None
Sandwell	None	None
Solihull	None	None
Walsall	Brand New	18 years
Wolverhampton	Brand New	16 years

Table 3 – Private Hire Vehicle Age and Emissions Policy; West Midlands Local Authorities

Local Authority	Maximum Age Limit (Newly Licensed Vehicles)	Maximum Age Limit (Renewal)
Birmingham	12 years	12 years
Coventry	15 years	15 years
Dudley	None	None
Sandwell	None	None
Solihull	None	None
Walsall	5 years	15 years
Wolverhampton	12 years	12 years

Except for the requirement for newly licensed hackney carriage vehicles to be brand new (like Walsall Council), the City of Wolverhampton Council age limits are well aligned with other local authorities across the West Midlands. Both Birmingham City Council and Coventry City Council have recently introduced ULEV emissions policies. Details of these policies are discussed further in Section 6.3 Vehicle Age and Emissions Policy Best Practice.

All 2,515 hackney carriage vehicles[4] licensed by the West Midlands local authorities are required to be purpose-built WAVs. This covers vehicles meeting the London Taxi Condition of Fitness and medium van derived passenger vehicles meeting the 'national' hackney carriage vehicle specification (e.g. standard turning circle). Such vehicles are side entry WAVs with a fully partitioned driver compartment. 1% (148 vehicles) of the private hire vehicles are also WAVs with a wider variety of vehicle specifications allowed including small van derived passenger vehicles.

Cenex advocate a regional approach to the introduction of minimum emissions standards and approved vehicle types. This provides a level of standardisation and emissions reduction potential over a wider geographical area. Environmentally conscious local authorities should consider the environmental impact of their licensed taxi vehicles as a key responsibility regardless of whether vehicles are operating outside of their district.

2.2 Fleet Composition and Operations

Of the 11,372 vehicles licensed by City of Wolverhampton Council, 168 vehicles are licensed as hackney carriage vehicles and 11,204 vehicles are licensed as private hire vehicles.

Figure 2 shows the number of private hire vehicles licensed between 2013 and 2020.

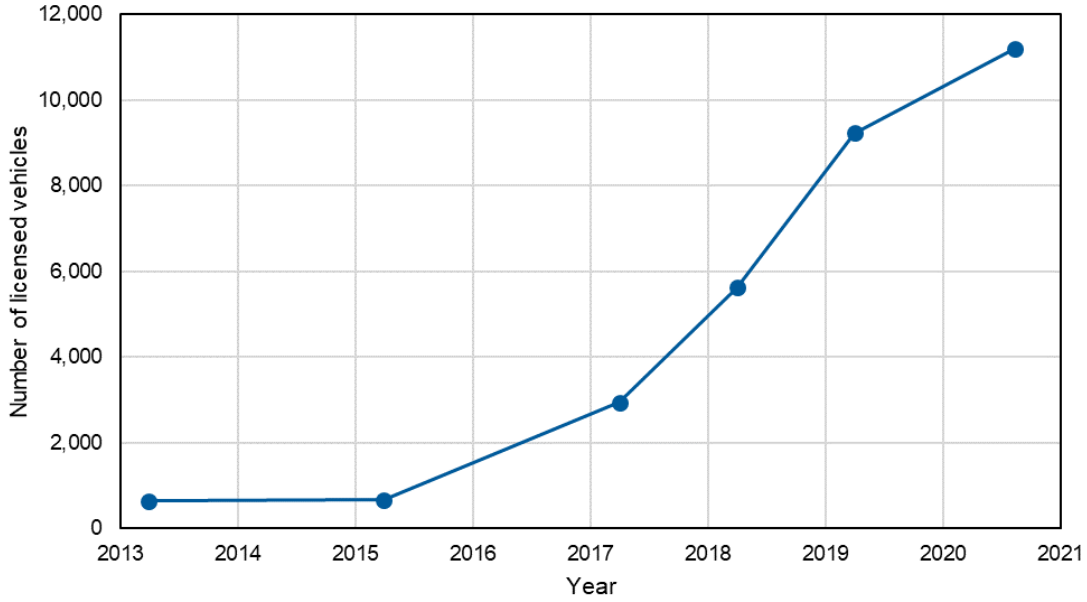


Figure 2 – Number of Private Hire Vehicles Licensed by City of Wolverhampton Council by Year

[4] https://www.gov.uk/government/statistical-data-sets/taxi01-taxis-private-hire-vehilces-and-their-drivers

Section 55A of The Deregulation Act 2015[5] introduced new legislation in relation to the sub-contracting of bookings from one private hire vehicle operator to another including to an operator licensed and located in a different local authority district.

The number of City of Wolverhampton Council licensed private hire vehicles has increased from around 650 vehicles in 2013 to over 11,000 vehicles in 2020. **For modelling purposes and the remainder of this report the number of private hire vehicles has been fixed at 11,204 vehicles**.

The number of licensed private hire vehicles will have a large impact on annual fleet emissions, as such introducing minimum emissions standards that guarantee or encourage sustainable changes in vehicle numbers should be considered a priority.

Implementation Recommendation: Investigate options to introduce ULEV as the minimum emissions standard for new vehicle licence applicants / new entrants as soon possible (e.g. proprietors that do not currently hold a City of Wolverhampton Council vehicle licence).

A limit on the number of licensed private hire vehicles would achieve similar results but requires new legislation in England. On 17th April 2019, Glasgow City Council became the first city in Scotland to introduce an overprovision policy for private hire vehicles[6].

2.2.1 Number and Type of Vehicles

Table 4 shows a breakdown of the top three vehicle models currently used within the hackney carriage vehicle fleet.

Table 4 – Hackney Carriage Vehicle Fleet Composition

	Top Three Vehicle Models	Number of Vehicles by Model	Total Number of Vehicles by Segment	Percentage of Vehicles
Medium Van	Mercedes-Benz Vito Citroen Dispatch Peugeot Expert	51 33 32	141	84%
London Taxi	LTI TX II LTI TX4 LTI TX1	12 8 6	27	16%
Total	**-**	**-**	**168**	**100%**

84% of the hackney carriage vehicles are medium van derived vehicles such as the Mercedes-Benz Vito and Citroen Dispatch. The remaining 16% of the hackney carriage fleet (27 vehicles) are 'London Taxi' vehicles.

Table 5 shows a breakdown of the top three vehicle models in each vehicle segment within the private hire vehicle fleet.

[5] https://www.legislation.gov.uk/ukpga/2015/20/introduction/enacted
[6] https://www.glasgow.gov.uk/article/17616/Licence-for-a-Private-Hire-Car

Table 5 – Private Hire Vehicle Fleet Composition

	Top Three Vehicle Models	Number of Vehicles by Model	Total Number of Vehicles by Segment	Percentage of Vehicles
Medium Car	Toyota Prius Skoda Octavia Toyota Auris	1,494 1,072 728	5,131	45%
Large Car	Toyota Avensis Volkswagen Passat Vauxhall Insignia	756 643 379	3,084	27%
Medium Multi-Purpose Vehicle (MPV)*	Vauxhall Zafira Volkswagen Touran Toyota Verso	525 301 285	1,367	12%
Executive Car	Mercedes-Benz E-Class BMW 5-Series Audi A6	351 139 113	639	6%
Large MPV*	Ford Galaxy Volkswagen Sharan Seat Alhambra	138 122 93	424	4%
Medium Van	Mercedes-Benz Vito Vauxhall Vivaro Renault Trafic	85 21 15	228	2%
Small MPV	Kia Carens Seat Altea Vauxhall Meriva	31 23 11	75	1%
Midsized Sports Utility Vehicle (SUV)	Peugeot 5008 Mitsubishi Outlander Nissan X-Trail	38 15 10	75	1%
Small Car	Skoda Fabia Seat Ibiza Dacia Sandero	31 7 6	66	1%
Small Van	Peugeot Partner Volkswagen Caddy Nissan NV200	27 13 10	57	0%
Other	-	-	35	0%
Total**	**-**	**-**	**11,181**	**100%**

* MPVs in 5-seater and 7-seater variants, ** 23 vehicles have been excluded as no vehicle data was returned from the MOT database.

Private hire vehicles are predominantly medium cars (45%) and large cars (27%); these segments make up 72% of the private hire vehicle fleet. The remainder of the fleet includes MPVs with up to 7 seats (16%), executive cars (6%), and niche vehicle segments accounting for less than 2% of the fleet each.

Most vehicle segments are dominated by the top three vehicle models, these models typically account for over 50% of their respective vehicle segments. The executive car segment is the clearest example of this where the Mercedes-Benz E-Class alone accounts for 55% of the vehicle segment with the top three models accounting for 94% of the vehicle segment. In the short term, vehicle proprietors wanting to transition to an ULEV may have to consider using either a different make and model, or a different vehicle type altogether.

2.2.2 Annual Mileage and Estimated Average Daily Mileage

Annual mileage and average daily mileage are critical in determining the economic suitability (ownership and running costs) and operational suitability (electric only range vs. daily mileage) of ULEVs. As it is difficult to gather this information in a consistent manner via local authority in-house test records or trade surveys, **Cenex has calculated the annual mileage on a per vehicle basis using the mileage recorded during MOTs**. A further 128 vehicles were excluded from the analysis, these vehicles are all less than three years old and therefore do not have MOT mileage data. More information on the method for gathering and processing annual mileage data can be found in Appendix A – Detailed Methodology.

Figure 3 shows the distribution of annual mileage for the hackney carriage vehicles only. Figure 4 shows the distribution of annual milage for the combined hackney carriage and private hire vehicle fleet (heavily weighted towards private hire vehicles due to the prevalence of such vehicles).

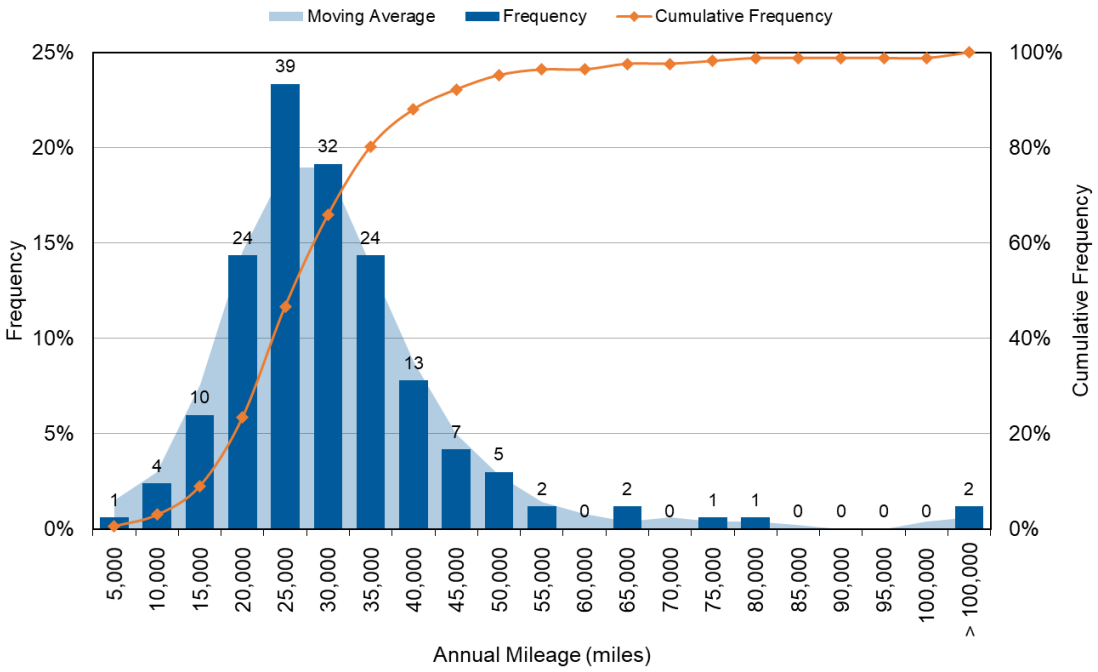


Figure 3 - Distribution of Annual Mileage; Hackney Carriage Vehicles

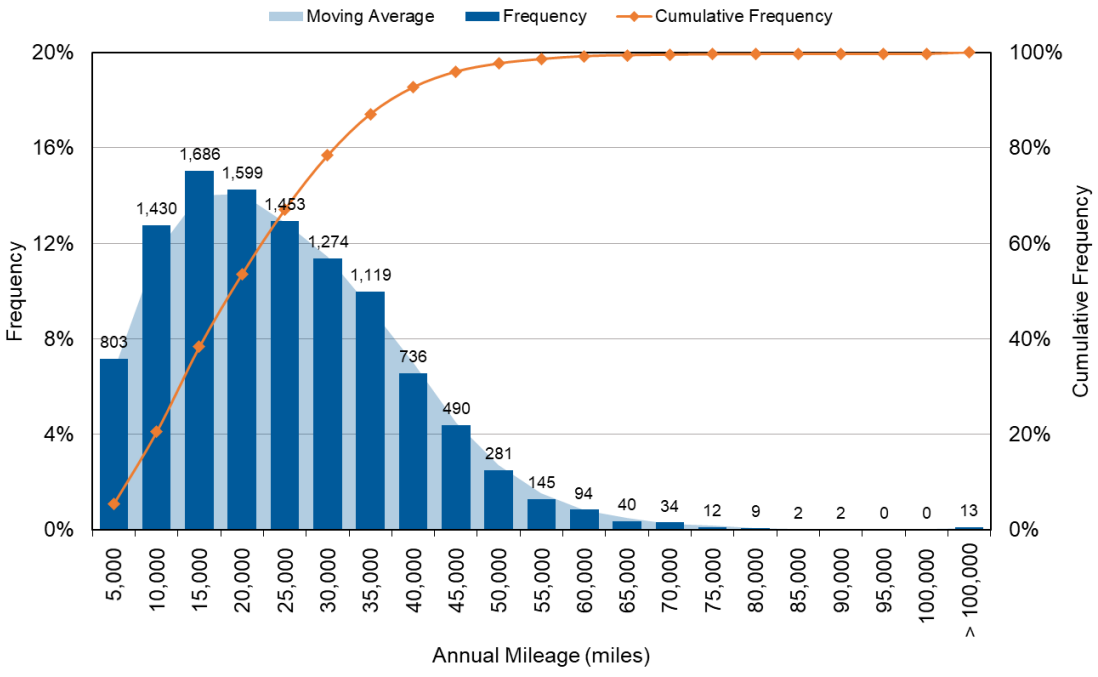


Figure 4 – Distribution of Annual Mileage; Hackney Carriage and Private Hire Vehicles

The average annual mileage of the hackney carriage vehicle fleet and combined vehicle fleet is 28,400 miles and 22,220 miles respectively (including private hire vehicles). Both mileages are comparable to other taxi fleets that Cenex has assessed such as Cardiff Capital Region (~5,700 vehicles with an average annual mileage of 24,700 miles). Higher annual mileages improve the economic suitability of ULEVs by providing larger running cost savings. Conversely, higher annual mileages are typically a result of higher daily mileages which can be operationally challenging for ULEV replacement as vehicles may be more range constrained.

Relatively few vehicles cover very high mileages but in absolute terms there is still a significant proportion of the fleet that may be more operationally challenging to switch to ULEVs. 20% of the fleet (>2,000 vehicles) average more than 30,000 miles a year.

The Office for National Statistics 2019 Labour Force Survey shows that **82% of taxi drivers work at least five days per week**[7].

To assess the operational suitability of each individual vehicle, **it has been assumed that vehicles are used for five days a week and 52 weeks a year**. As an example, an annual mileage of 30,000 miles equates to an average daily mileage of 115 miles. As licensing standards are independent of usage pattern or duty cycle there is a risk that the use of ULEVs could adversely impact a proportion of the fleet which covers relatively high mileages.

Implementation Recommendation: Ensure that participants selected for vehicle telematics trials cover an appropriate range of mileages including both low and high mileage users.

Use vehicle telematics trial results to better understand the relationship between annual mileage, number of days used, average daily mileage and daily mileage for typical taxi vehicle operations.

2.2.3 Estimated Driving Environment

City of Wolverhampton Council provided Cenex with a separate and anonymised list of vehicle proprietor postcode districts (covering 98% of the fleet with valid postcode formats). This information has been used to provide context regarding vehicle locations and to inform typical driving environments, **it has been assumed that vehicles operate in or around the vehicle proprietor postcode district**.

Figure 5 shows the number of City of Wolverhampton Council licensed vehicles by postcode district.

7 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/833569/taxi-and-phv-england-2019.pdf

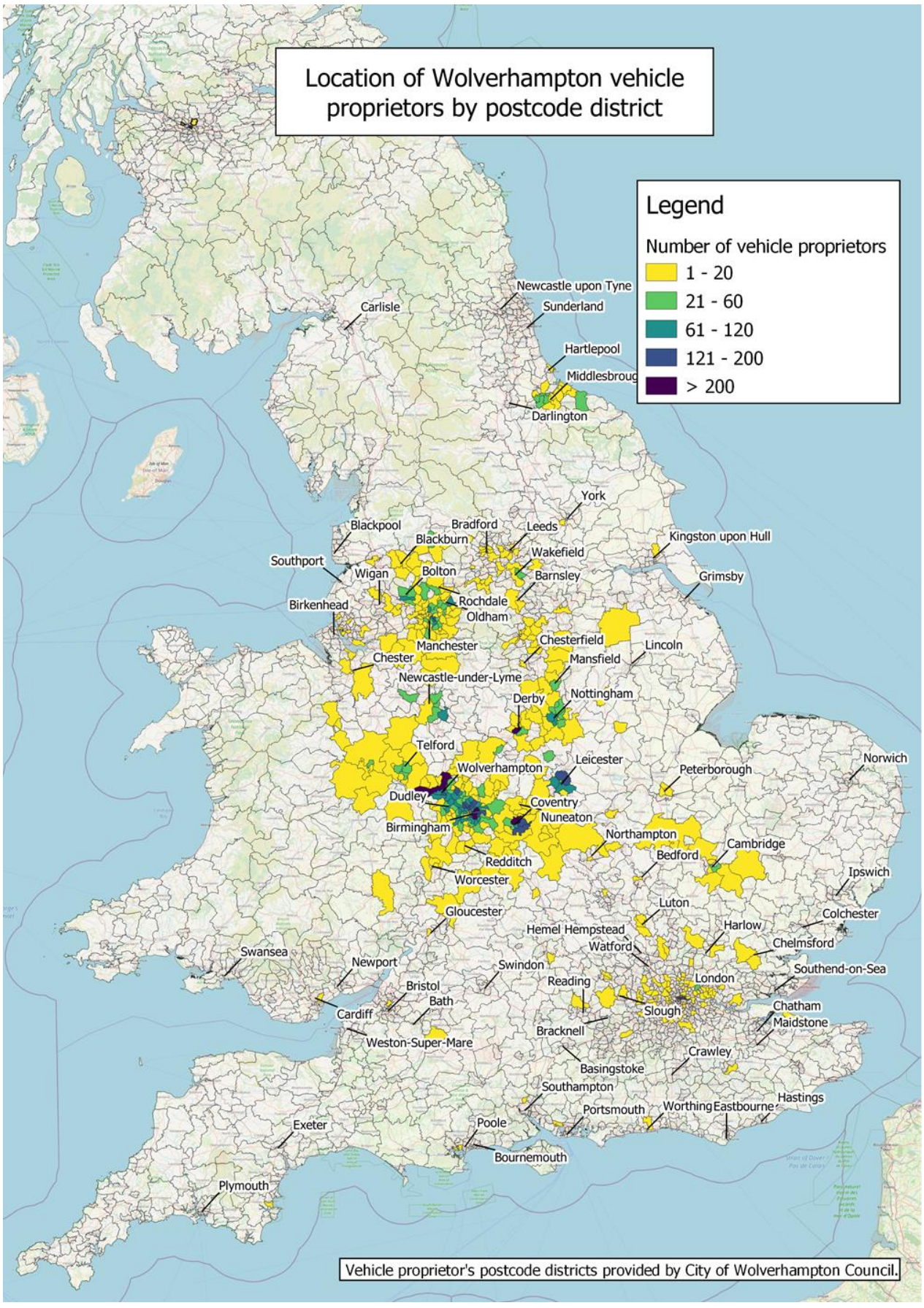


Figure 5 - Map of Vehicle Proprietor Postcodes by District

65% of the fleet have vehicle proprietor postcodes in the West Midlands. Wolverhampton postcode districts only account for 10% of the total number of licensed vehicles. The regional / national operation of the fleet will make installation of adequate infrastructure more challenging.

The relative energy consumption of ULEVs compared to internal combustion engine vehicles is largely determined by the typical driving environment / drive cycle (e.g. vehicle speed vs. time). The difference in energy consumption when driving is one of the main factors in determining the relative total cost of ownership (due to differences in running costs) and emissions of different vehicle technologies. Without vehicle telematics data it is not possible to accurately determine the driving environment for each individual vehicle. Instead, **an average estimated driving environment was assigned to the entire fleet based on the rural-urban classification of vehicle proprietor postcode districts**[8].

Table 6 shows the number of vehicles in each rural-urban classification in order of most urban to most rural descending.

Table 6 – Rural-Urban Classification from Vehicle Proprietor Postcode

Rural-urban classification	Number of vehicles
London	246
Urban with Major Conurbation	7,564
Urban with Minor Conurbation	474
Urban with City and Town	2,331
Urban with Significant Rural	340
Largely Rural	87
Mainly Rural	47

94% of vehicles are licensed to a vehicle proprietor located in a predominantly urban local authority district (urban with major conurbation, with minor conurbation, or with city and town). The definition of the predominantly urban classification is ≥74% of the population living in urban areas[9]. **It has been assumed that 75% of miles are driven in urban environments and the remaining 25% are rural / motorway**. A more detailed breakdown of rural-urban classification by local authority distract can be found in Appendix B – Additional Tables and Charts.

2.3 Fuel Economy and Fleet Emissions

Table 7 shows the percentage of each fuel type compared to the 2019 UK passenger car fleet.

Table 7 - Summary of Fuel Types Compared to UK Car Fleet[10]

Fuel Type	Licensed Taxi Vehicles (City of Wolverhampton Council)	Licensed Cars (UK, 2019)
Diesel	64.1%	39.1%
Hybrid Electric	21.7%	1.6%
Petrol	12.8%	58.5%
LPG	0.7%	0.0%
Battery Electric	0.5%	0.3%
Plug-in Hybrid Electric	0.1%	0.4%

Diesel vehicles account for 64% of the vehicles licensed by City of Wolverhampton Council, this compares to only 39% of all cars licensed in the UK. **100% of the hackney carriage vehicles are diesel**.

Hybrid electric vehicles account for 22% of the fleet and petrol vehicles account for the remaining 13%. For context, Cenex has previously undertaken the same analysis on two large regional taxi fleets (~9,500 taxi vehicles across 22 local authorities). This analysis showed a share of 92% diesel, 4% petrol and 4% hybrid electric. This suggests **a relatively high proportion of hybrid electric vehicles compared to other local authorities and compared to the wider passenger car market**.

8 https://www.gov.uk/government/statistical-data-sets/taxi01-taxis-private-hire-vehilces-and-their-drivers
9 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/591464/RUCLAD_leaflet_Jan2017.pdf
10 https://www.gov.uk/government/statistical-data-sets/veh02-licensed-cars

Table 8 shows the number of ULEVs and hybrid electric vehicles for private hire vehicle operators with more than 100 licensed vehicles each. Operators shown in green already use some ULEVs or have a higher than average proportion of hybrid electric vehicles (e.g. >22%).

Table 8 - Number of Ultra-Low Emission and Hybrid Electric Vehicles by Private Hire Operator

Private Hire Operator	Total Vehicles	Percentage of Private Hire Vehicles	Battery Electric Vehicles	Plug-in Hybrid Electric Vehicles	Hybrid Electric Vehicles	Hybrid Electric Vehicles as percentage of each fleet
PHOP94	4,604	42.1%	57	10	1,337	29%
PHOP279	712	6.5%			73	10%
PHOP194	478	4.4%			100	21%
PHOP140	287	2.6%		1	67	23%
PHOP91	256	2.3%			97	38%
PHOP126	242	2.2%			62	26%
PHOP200	176	1.6%		1	55	31%
PHOP44	157	1.4%			20	13%
PHOP210	152	1.4%			12	8%
PHOP179	148	1.4%			2	15%
PHOP206	147	1.3%			21	1%
PHOP178	145	1.3%			21	14%
PHOP220	141	1.3%			22	15%
PHOP141	130	1.2%			20	10%
PHOP134	130	1.2%			13	15%
PHOP54	128	1.2%			32	25%
PHOP128	124	1.1%	2		16	13%
PHOP168	110	1.0%			8	7%
Total	**8,267**	**76%**	**-**	**-**	**-**	**-**

18 of the 159 private hire vehicle operators (11%) have at least 100 vehicles, collectively these 18 operators account for 8,267 vehicles (75% of the private hire vehicle fleet).

Five operators are already using some ULEVs (PHOP94, 140, 200, 128 and 235[11]). It is suggested that City of Wolverhampton Council should engage directly with private hire vehicle operators already using ULEVs to identify potential opportunities to further increase the uptake of ULEVs.

Two operators are using a higher proportion of hybrid electric vehicles (>30% for PHOP91 and 200). Petrol hybrid electric vehicles emit lower levels of air quality pollutant emissions relative to diesel vehicles. In addition, hybrid electric vehicles can reduce greenhouse gas emissions under specific, but not all, drive cycles. It is suggested that City of Wolverhampton Council should engage with hybrid electric vehicle proprietors to understand their procurement decision and how this might impact the uptake of ULEVs.

Implementation Recommendation: Establish appropriate targets for the number of licensed ULEVs to be introduced by private hire vehicle operators.

Cenex suggest that private hire vehicle operators should be expected to at least match the percentage of new ULEV registrations in the passenger car market (7.7% of all new vehicle registrations in 2020 Q3 and 3.0% in 2019 Q3[12]).

As a minimum this could be an optional target discussed during licence applications. Alternatively, this could be a requirement in private hire vehicle operator conditions of licensing. A more stringent condition could be the proportion of zero emission miles driven in each period. This would require evidencing of use as a taxi vehicle and of any zero emission miles driven.

46% of private hire vehicle operators have fewer than 10 vehicles, additional consideration should be made for smaller operators who may require alternative incentives.

[11] Not shown, one battery electric vehicle out of seven licensed vehicles.
[12] https://www.gov.uk/government/statistics/vehicle-licensing-statistics-july-to-september-2020

Table 9 shows a summary of the annual mileage and fuel economy by vehicle segment. To simplify reporting, similar vehicle segments have now been combined (e.g. medium and large MPVs). The medium van (WAV) category effectively represents the hackney carriage vehicle fleet.

Table 9 - Summary of Annual Mileages and Fuel Economy

	Average Annual Mileage (miles)	Average Fuel Consumption (MPG)	Number of Vehicles	% of Total vehicles
Small Car	18,700	46.0	164	1%
Medium Car	21,900	45.2	4,961	45%
Large Car	22,200	44.6	3,024	27%
Executive Car	23,000	44.3	635	6%
Medium MPV	21,300	43.4	1,762	16%
Midsized SUV	20,700	38.8	63	1%
Large 4x4 / SUV	17,800	30.3	4	0%
Small Van	21,700	43.6	57	1%
Medium Van	30,000	35.9	208	2%
Medium Van (WAV)	28,400	35.9	166	1%
Large Van*	20,500	28.9	6	0%
Total	**22,189**	**44.1**	**11,070****	**100%**

* large van derived WAV conversions with a maximum seating capacity of eight passengers.

** Liquefied petroleum gas (LPG) vehicles (89 vehicles), known PHEVs (12 vehicles – additional Toyota Prius vehicles could be PHEV, but these are not identified by the MOT database) and BEVs (50 vehicles) have been excluded from the fleet emissions baselining.

Fuel economy has been taken from independent, real-world, testing of petrol, diesel and hybrid vehicles undertaken by Emissions Analytics[13] based on a 75% / 25% split of urban and extra-urban driving. A full list of the fuel economy values used during this report can be found in Appendix A – Detailed Methodology.

Combustion of fossil fuels used for road transport produces three main greenhouse gas emissions that contribute directly to climate change. These are CO_2, methane (CH_4) and nitrous oxide (N_2O). For reporting purposes, greenhouse gas emissions are standardised to CO_2 equivalents (CO_2e) based on their global warming potential compared to CO_2.

Tank to Wheel (TTW) or Scope 1 emissions represent the amount of CO_2 (derived from fossil fuels) which is released from a vehicle's tailpipe.

Well to Wheel (WTW) or All Scope emissions are a more complete method of looking at CO_2 emissions and represent the amount of CO_2 emitted during the fuel's life cycle. This includes the upstream emissions associated with fuel extraction, processing, transportation, and dispensing, as well as the emissions from final fuel combustion. **The greenhouse gas emissions in the main body of the report are presented as WTW CO_2e**.

In addition to greenhouse gas emissions, high temperature combustion of fuels used for road transport also produces two main air quality pollutant emissions that at high concentrations or sustained low concentrations contribute directly to several health issues including respiratory and cardiovascular conditions as well as reduced life expectancy. These are nitrogen dioxide (NO_2) and particulate matter (PM). **The National Atmospheric Emissions Inventory provide average speed related emissions factors for oxides of nitrogen (NOx) and PM** for different vehicle types, euro emissions standards and fuel types. NOx is a collective term that includes NO_2 as well as nitric oxide (NO). Although NO is not considered hazardous to human health it can lead to the formation of NO_2, as such the collective NOx emission factors are still relevant as evidenced by their use in the Emission Factor Toolkit published by Defra.

[13] https://www.emissionsanalytics.com/real-world-test-database

Table 10 shows the emissions profile of the fleet in terms of percentage contribution to annual WTW CO_2e, NOx and PM emissions. Absolute emissions values and a more detailed breakdown of the emission profile can be found in Appendix B – Additional Tables and Charts.

Table 10 – Summary of Hackney Carriage and Private Hire Vehicle Fleet Emissions

	% of Total Vehicles	% of PM Emissions	% of NOx Emissions	% of WTW CO_2e Emissions
Small Car	1%	2%	1%	1%
Medium Car	45%	34%	30%	42%
Large Car	27%	32%	32%	28%
Executive Car	6%	5%	7%	6%
Medium MPV	16%	17%	17%	16%
Midsized SUV	1%	0%	1%	1%
Large 4x4 / SUV	0%	0%	0%	0%
Small Van	1%	0%	1%	1%
Medium Van	2%	2%	6%	4%
Medium Van (WAV)	1%	8%	4%	2%
Large Van	0%	0%	0%	0%
Total	**100%**	**1,400 kg**	**162,000 kg**	**78,000 t**

Medium cars, large cars and MPVs account for 42%, 28% and 16% of the WTW CO_2e emissions, respectively. This is proportional to the number of vehicles and a combined total of 86% of fleet WTW CO_2e emissions. **Medium vans (including WAVs) account for 3% of the overall fleet but 6% to 10% of the fleet greenhouse gas and air quality pollutant emissions**.

Table 11 shows the estimated air quality emissions in Wolverhampton postcode districts. Locally, medium vans account for an estimated 15% of vehicles (168 / 1,100 vehicles).

Table 11 – Estimated Air Quality Emissions in Wolverhampton by Licence Type

	% of PM Emissions in Wolverhampton	% of NOx Emissions in Wolverhampton
Hackney Carriage Vehicles	47%	31%
Private Hire Vehicles	53%	69%

The hackney carriage vehicle fleet accounts for 47% of PM emissions and 31% of NOx emissions in Wolverhampton postcodes.

Table 12 shows the vehicle age and euro emissions standard of each vehicle segment, the distribution column shows a histogram of vehicle age from less than one year (leftmost column) to over ten years old (rightmost column).

Table 12 – Vehicle Age and Euro Emissions Standard Profile.

	Vehicle Age (years)		Engine Euro Standard		
	Distribution	Average	Euro 4 or less	Euro 5	Euro 6
Small Car		7.3	8%	68%	24%
Medium Car		6.7	8%	58%	34%
Large Car		7.6	10%	66%	24%
Executive Car		5.7	3%	47%	50%
Medium MPV		7.3	9%	66%	25%
Midsized SUV		6.3	0%	59%	41%
Large 4x4 / SUV		5.3	0%	50%	50%
Small Van		7.3	0%	84%	16%
Medium Van		5.3	3%	46%	50%
Medium Van (WAV)		10.6	56%	36%	8%
Large Van		6.2	0%	67%	33%
Total		**7.0**	**9%**	**61%**	**30%**

Only 30% of the combined fleet meets the latest Euro 6 emissions standard, introduced for all new car registrations from 1st September 2015. This is reflected in the vehicle age distribution which suggests that relatively few brand-new vehicles are procured.

The medium van (WAV) vehicle segment, which includes all hackney carriage vehicles, has by far the lowest level of compliance with the latest emissions standards. **56% of medium vans (WAV) are Euro 4 or lower with an average vehicle age of ~11 years**. These vehicles also have higher annual mileages, low fuel economy (relative to other vehicles) and poor air quality emissions standards. These factors result in a disproportionate contribution to fleet emissions compared to the relatively small number of vehicles, additionally air quality issues might be exacerbated by vehicles operating from city centre taxi ranks.

Table 13 shows a comparison between a Euro 6 medium car (representative of a private hire vehicle) and medium van (WAV).

Table 13 – Fuel Economy and Air Quality Emission Comparison between Medium Car and Medium Van

	Medium Car (Euro 6)	Medium Van (WAV) (Euro 6)	Medium Van (WAV) (Euro 4)
MPG	50.2	35.9	35.9
NOx (g/km)	0.366	0.480	0.762
PM (g/km)	0.002	0.001	0.024

Medium vans return lower fuel economy compared to medium cars, achieving ~36 mpg compared to ~50 mpg for a medium car. Additionally, the normalised air quality emissions are higher, particularly for Euro 4 vehicles. The average annual mileage of the medium van (WAV) segment is also 6,500 miles higher which further increases the relative emissions per vehicle.

3 Ultra-Low Emission Vehicle Technology Options

This section introduces the main ULEV technologies discussed in this report by providing basic definitions and technology descriptions alongside an initial, high level screening of ULEV technologies based on current UK vehicle availability and supplier / market maturity. A summary of current and near-term vehicle availability is also presented alongside example vehicle model specifications. The purpose of this information is to enable City of Wolverhampton Council to have informed discussions with the trade regarding potential replacement vehicle technologies.

3.1 Zero Tailpipe Emission Vehicle Technologies

A zero-tailpipe emission vehicle or ZEV is a vehicle which does not emit greenhouse gas or air quality pollutant emissions from the vehicle exhaust / tailpipe. ZEVs do not have an internal combustion engine and instead are driven by an electric motor which is powered by electricity generated by a battery and / or a hydrogen fuel cell which both convert stored chemical energy into electrical energy.

Table 14 provides a description of ZEV technologies.

Table 14 - Zero Emission Vehicle Technologies

Technology	Example	Description
Battery Electric Vehicle (BEV)		A BEV stores energy in a battery and delivers its power to the wheels through an electric motor. The motor can also act as a generator to recover energy normally lost when decelerating (known as regenerative braking).
Fuel Cell Range Extended Electric Vehicle (FC REEV)		A BEV which also has an onboard hydrogen fuel cell to recharge the battery on the go. The wheels are always powered by the electric motor. The battery can also be recharged by plugging the vehicle into a mains power source. **At the time of writing, FC REEVs are not available in the UK.**
Fuel Cell Electric Vehicle (FCEV)		Compressed hydrogen can be used to power an electric motor by generating electricity through a fuel cell. A small battery is often used for peak power requirements and for regenerative braking only. Hydrogen is taking its first steps to becoming commercially available as a road transport fuel in the UK.

3.2 Ultra-Low Emission Vehicle Technologies

An ULEV is currently defined as any car or van that emits less than 75 g/km of CO_2 from the tailpipe. All ZEVs are guaranteed to meet this definition, additionally technologies that incorporate an internal combustion engine and electric motor can also meet this definition depending on the proportion of zero emission miles. Due to advances in technology, it is expected that from 2021 an ULEV will be defined as a car or van that emits less than 50 g/km with a minimum required zero emission range.

To be eligible for the plug-in grant[14], an ULEV must have CO_2 emissions of less than 50 g/km and can travel 70 miles with zero tailpipe emissions. This grant offers up to £3,000 off the price of a brand-new car and up to £7,500 off the price of a brand-new purpose-built taxi.

Table 15 provides a description of additional technologies that meet the current definition of an ULEV, these include range extended and plug-in hybrid electric vehicles which incorporate an internal combustion engine.

[14] https://www.gov.uk/plug-in-car-van-grants

Table 15 - Ultra-Low Emission Vehicle Technologies

Technology	Example	Description
Range Extended Electric Vehicle (REEV)		A BEV which also has an onboard generator (powered by an internal combustion engine) to recharge the battery on the go. The wheels are always powered by the electric motor. The battery can also be recharged by plugging the vehicle into a mains power source.
Plug-in Hybrid Electric Vehicle (PHEV)		A PHEV has an internal combustion engine as well as a battery and electric motor. The wheels can be driven by either the combustion engine or the electric motor. The battery can be recharged by plugging the vehicle into a mains power source.

3.3 Ultra-Low Emission Vehicle Technology Screening

Cenex has undertaken a high-level assessment of ULEV options to highlight technologies that have the potential to deliver emissions savings across entire vehicle segments at an equivalent, or lower, total cost of ownership based on current UK availability and supplier maturity.

Table 16 and Table 17 show the ULEV technology screening criteria and associated results. **All green technologies have been taken forward for a detailed suitability assessment.**

Table 16 – Ultra-Low Emission Technology Screening Criteria

Green	High market maturity.
Amber	Low market maturity – known to be uneconomical, inadequate infrastructure.
Red	Not demonstrated or not available in the UK.

Table 17 - Ultra-Low Emission Vehicle Technology Screening

Vehicle Type	Vehicle Segment (Rank of WTW CO_2e Emissions Contribution)	PHEV	REEV	BEV	FCEV
Cars	Medium (1)				Hyundai Nexo
	Large (2)				Toyota Mirai
	Executive (5)			**SUVs only**	
	MPV (3)	*		**Nissan only**	
Van Derived Vehicles (4)	Medium Passenger Van		Ford only		
	WAV		**LEVC only**	**Dynamo only****	

* The only PHEVs available are the BMW 225xe and Mercedes-Benz B250e, both of which are premium models with a maximum of five seats. They are therefore unlikely to be suitable replacements for current vehicle models.

** Although there are numerous battery electric small and medium vans available (from Peugeot / Citroen / Vauxhall, Nissan, and Renault) there are few examples of type approved wheelchair conversions for these vehicles (see Brotherwood and Vic Young).

BEVs are available in all segments although in the MPV and medium van (WAV) segments there is currently only one model available. REEVs are available in the medium van segment only and PHEVs are available as potential replacements in the medium, large and executive car segments.

Hydrogen FCEVs are available from Hyundai and Toyota in the medium and large car segments. **FCEVs are currently uneconomical (due to the cost of vehicles and hydrogen fuel), additionally there is also a lack of viable hydrogen refuelling stations.** The relative performance of FCEVs can be found in Appendix B – Additional Tables and Charts.

To date, most deployments of FCEVs and hydrogen refuelling stations have been undertaken as part of publicly funded research and development projects.

As an example, as part of the Fuel Cells and Hydrogen Joint Undertaking funded Zero Emission Fleet Vehicles for European Rollout (or ZEFER) project, Green Tomato Cars has deployed 50 Toyota Mirai FCEVs as private hire vehicles in London[15].

3.3.1 Examples of Available Vehicle Models and Specifications

Cenex has reviewed available ULEV models and highlighted those which may be alternatives for popular taxi vehicle models. The vehicles are categorised into the relevant vehicle segments excluding minicars, small cars, luxury cars and sports cars as well as models costing more than £65,000 after the plug-in grant. SUVs have been included in the medium to executive car segments as many of the newly released ULEVs have a crossover SUV body style.

Figure 6 shows the estimated number of ULEV models available in the UK in 2020 (correct at the time of writing).

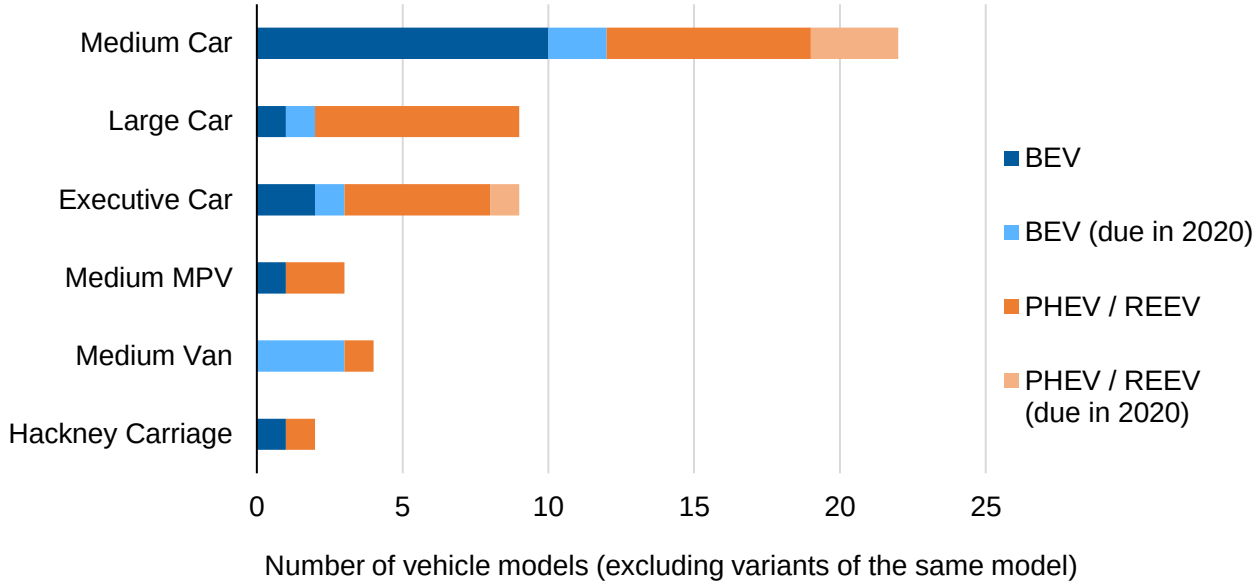


Figure 6 – Estimate Number of ULEV Models, UK 2020

Cenex estimate that by the end of 2020 there are at least 50 ULEV models available to purchase in the UK that could potentially be used as taxi vehicles. This excludes variants of the same model with different battery capacities. Except for the large and executive car segments, there is an approximately equal split between BEVs and PHEVs. A full list of the vehicle models included in this table can be found in Appendix B – Additional Tables and Charts.

The number of available ULEV models is also expected to increase by 89% before 2025[16].

Table 18 shows example vehicle specifications for relevant models, this is for information only and is representative of currently available ULEVs. Prices include VAT and the plug-in grant where applicable (£3,000 for BEVs and £7,500 for purpose-built hackney carriage vehicles).

[15] https://zefer.eu/
[16] https://www.transportenvironment.org/publications/electric-surge-carmakers-electric-car-plans-across-europe-2019-2025

Table 18 – Example ULEV Specifications

Vehicle Segment	ULEV Type	Licensed vehicles in the UK	Example Model (battery/engine capacity)	Price	Electric Only Range (miles)	Standard Charge Time (7 kW)	Rapid Charge Time (max)
Medium Car	BEV	42,000	Nissan Leaf (40 kWh)	£26,345	168	7h 30m	1h 00m
			Hyundai Kona (64 kWh)	£32,845	279	9h 35m	1h 15m
	PHEV	16,000	Toyota Prius PHEV (1.8L petrol, 8.8 kWh)	£31,695	23	2h 00m	NA
Large Car	BEV	16,000	Tesla Model 3 Standard (55 kWh)	£38,900	258	8h 00m	30m
	PHEV	24,000	Volkswagen Passat GTE (1.4L petrol, 13 kWh)	~£36,000	~34	~2h 00m	NA
Executive Car	BEV	16,000	Jaguar I-Pace (90kWh)	£60,995	292	13h 00m	1h 30m
	PHEV	17,000	Mercedes-Benz E-Class (2L petrol/diesel, 13.5 kWh)	£47,700	31	1h 15m	NA
Medium MPV	BEV	500	Nissan eNV200 (40 kWh)	£29,255	124	7h 30m	45m
	PHEV	5,000	BMW 225xe (1.5L petrol, 7.6 kWh)	£35,125	22	2h 00m	NA
Medium Van (8-seater)	BEV	-	Peugeot e-Traveller (50kWh)	~£46,000	143	~7h 30m	30m
	REEV	10	Ford Tourneo Custom PHEV (1.0L petrol, 13.6 kWh)	£48,500	33	2h 00m	NA
Hackney Carriage Vehicle	BEV	-	Dynamo Nissan eNV200 (40 kWh)	£45,500	124	7h 30m	45m
	REEV	4,000	LEVC TX (1.5L petrol, 31 kWh)	£55,599	62	3h 45m	30m

There are several website databases available that could be used by vehicle proprietors to review and compare the specifications of potential ULEVs. Notable examples include Electric Vehicle Database[17], Go Ultra Low[18] (select suppliers only) and Next Green Car[19]. Current conditions of licensing and a lack of awareness of approved vehicles are potential barriers to the adoption of ULEV taxi vehicles.

Implementation Recommendation: Publish and maintain a provisional list of approved ULEV hackney carriage and private hire vehicles.

Review the technical specifications of all currently available ULEVs (including those not currently licensed as taxi vehicles), review and revise vehicle conditions of licensing to maximise the availability of suitable ULEVs (window tints, minimum engine capacity, internal dimensions, body style etc.), develop and publish a provisional list of approved ULEVs, update to approved status as vehicles are presented for licensing for the first time, promote to trade as new vehicles are approved.

[17] https://ev-database.uk/
[18] https://www.goultralow.com/car-selector/
[19] https://www.nextgreencar.com/new-car-search/

4 Ultra-Low Emission Vehicle Performance Reviews

This section shows the relative performance of ULEVs that have been selected for further analysis during the technology screening process. Cenex uses an in-house spreadsheet model to provide a detailed breakdown of the estimated real-world operating range, TCO and emissions of each **ULEV technology compared to the outright purchase of a brand-new Euro 6 vehicle**.

The 'Ultra-Low Emission Vehicle Performance Reviews' reported in this section are **based on the average vehicle for each segment** as calculated during the fleet baselining and are reported for selected vehicle segments only. Conversely, the 'Ultra-Low Emission Vehicle Technology Suitability' reported in Section 5 includes an assessment of each individual vehicle. In both cases, the following parameters are used as the main inputs to the spreadsheet model:

- Annual mileage from MOT records with vehicles used for five days per week
- Fuel economy from Emissions Analytics independent test data, driving environment of 75% urban / 25% rural[20]
- Ownership period = 10 years (hackney carriage vehicles) and 7 years (private hire vehicles).
- Diesel = £1.23 / litre, Petrol = £1.18 / litre (average fuel prices for last 12 months, AA)
- Electricity = £0.17 / kWh (average domestic price for 2019, UK Government)

Table 19 summarises the key assumptions held within the calculation engine of the spreadsheet model. A table of references can also be found in Appendix C – Fleet Review References.

Table 19 - Key Modelling Assumptions

Assumption	Description
Estimated real-world operating range	The electric only range stated is based on the estimated vehicle fuel / energy consumption assuming one charge per day. Actual operating range on any given day will vary by driving style, payload (passengers and luggage), use of air conditioning / cabin heating or other external factors (e.g. ambient temperature). Actual electric only range can vary by up to 50% based on these variables.
Predicted residual values	Where possible predicted residual values are based on independent data. Despite this, predicted residual values are uncertain and vary significantly based on market factors such as supply vs. demand and policy measures. Additionally, they are forecast over the life of the vehicle.
Infrastructure costs	Ultra-low emission vehicle infrastructure costs are not included in the model.

Table 20 shows the annual mileage and emissions contribution for the six vehicle segments that have been assessed. Results are reported by vehicle segment in order of WTW CO_2e emissions contribution descending. **Detailed results are shown for the medium car and medium van (WAV) segments, all remaining segments are summarised separately.**

Table 20 – Scope of Ultra-Low Emission Vehicle Performance Reviews

	Average annual mileage (miles)	Average daily mileage (miles)	% of total vehicles	% of total WTW CO_2e emissions
Medium Car	21,900	84	45%	42%
Large Car	22,200	85	27%	28%
Medium MPV	21,300	82	16%	16%
Executive Car	23,000	88	6%	6%
Medium Van	30,000	115	2%	4%
Medium Van (WAV)	28,400	108	1%	2%

All costs include VAT (relevant to most owner drivers who are typically not VAT registered). Performance reviews are presented over two pages with charts for operating range, TCO and emissions followed by a summary of the key findings of each technology. Positive values represent savings to a new Euro 6 vehicle.

[20] Results for a mostly rural scenario (25% urban, 75% rural / motorway) can be found in Appendix B – Additional Tables and Charts

4.1 Ultra-Low Emission Vehicle Performance Review – Medium Car

Figure 7 to Figure 9 show the relative performance of ULEV technologies for medium cars.

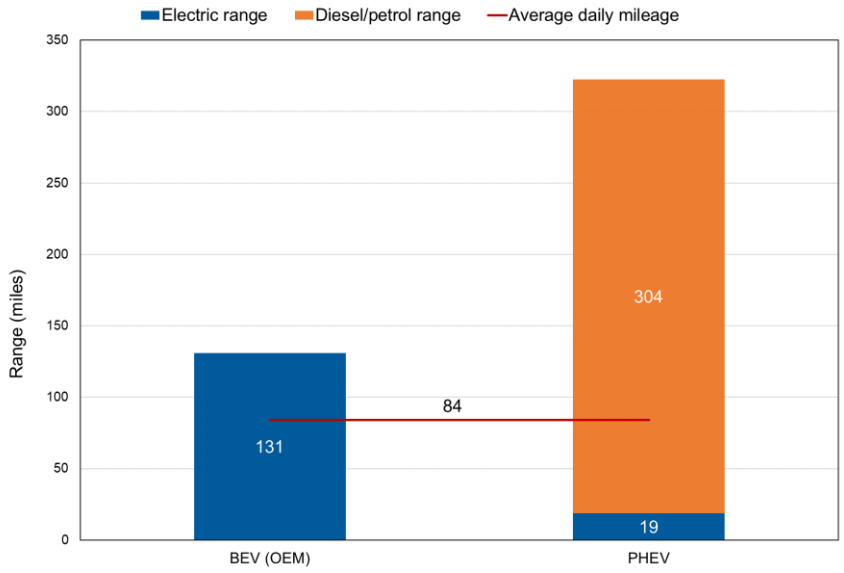


Figure 7 – Operating Range; Medium Car

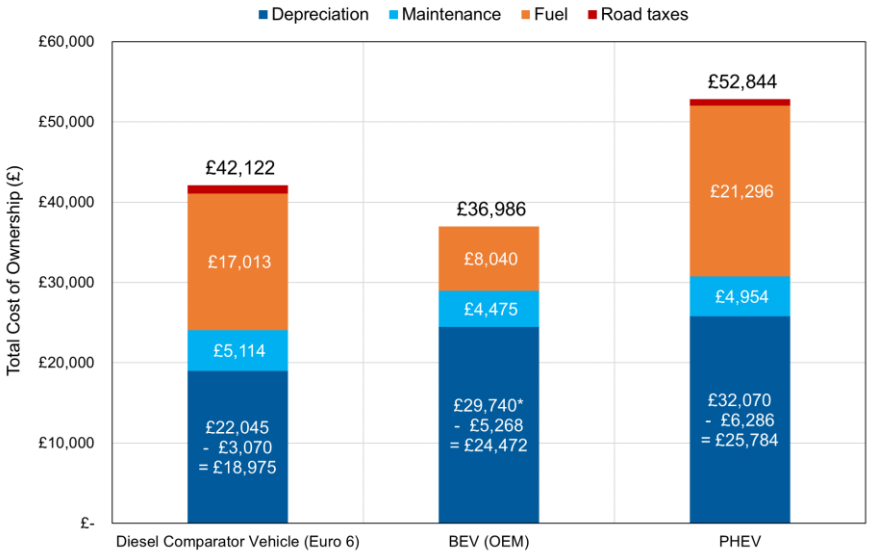


Figure 8 - Total Cost of Ownership; Medium Car

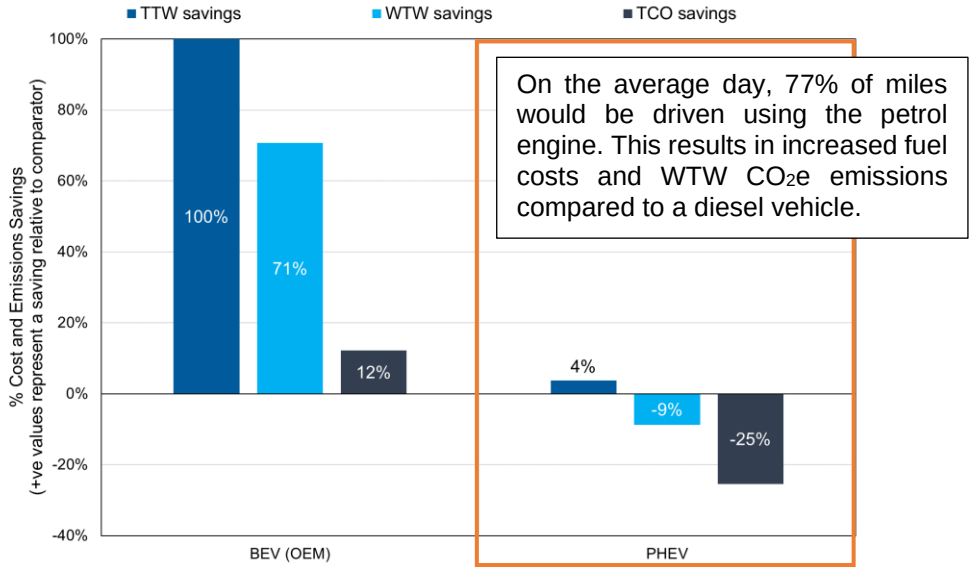


Figure 9 – CO_2e Emissions Savings vs. Cost savings; Medium Car

BEV

Criteria	Performance
Operational	• **Estimated real-world range of 131 miles (40 kWh battery) results in 64% of the battery capacity being used on the average day.** • 7kW AC on-board charger as standard = 8h charging time at 7kW+ chargepoint. • 1 hour to DC charge to 80% capacity using a 50 kW rapid charger. • 62 kWh battery variants available for higher mileage vehicles.
TCO	• **£7,000 increase in purchase cost** (including £3,000 plug-in grant) • Purchase cost of £30,000 including the plug-in grant and an expected residual value of £5,000 after 7 years ownership. The residual values are competitive compared to the diesel vehicle but still result in a **depreciation cost increase of £5,500**. • **Running cost savings of £12,000** through reduced fuel and maintenance costs. • **TCO reduction of £5,000 (12% saving)**. Plug-in grant is not required to achieve TCO parity with diesel but instead reduces the amount of capital funding required.
Emissions	• **Zero tailpipe emissions.** • **71% reduction in WTW CO_2e emissions** based on the current UK grid energy mix. This will reduce further as the UK grid decarbonises.

PHEV

Criteria	Performance
Operational	• Estimated real-world electric only range of 19 miles (12 kWh battery) results in 100% of the battery capacity being used on the average day. 77% of average daily mileage would be completed using petrol engine. • 7kW AC on-board charger as standard = 2h charging time at 7kW+ chargepoint. • Most PHEVs cannot DC rapid charge currently.
TCO	• Purchase cost increase of £10,000 leads to a depreciation cost increase of £7,000. PHEV cars do not receive the plug-in grant as they do not meet the emissions eligibility criteria. • **Fuel costs increase as the vehicle drives 77% of its mileage powered by petrol.** A petrol engine is less efficient than an equivalent diesel engine and so it consumes more fuel which increases costs if driven extensively with the internal combustion engine. • **TCO increase of £11,000 (25% increase).**
Emissions	• Zero tailpipe emissions when in electric only mode. • Due to sustained use of the petrol engine, the PHEV makes a small reduction in TTW CO_2 but makes a **9% increase in WTW CO_2e**. • **94% reduction in NOx emissions compared to a Euro 6 diesel vehicle**.

4.2 Ultra-Low Emission Vehicle Performance Review – Medium Van (WAV)

Figure 10 to Figure 12 show the performance of ULEVs for wheelchair accessible medium vans.

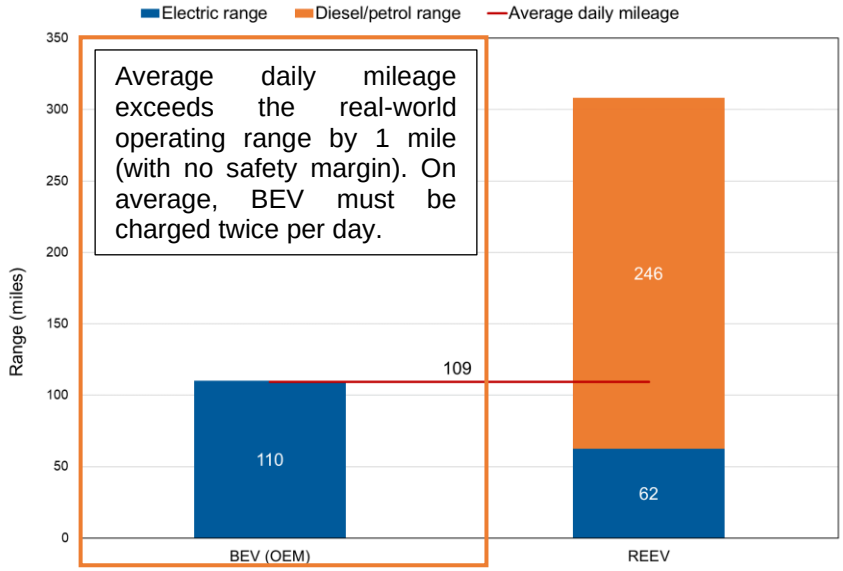


Figure 10 – Operating Range; Medium Van (WAV)

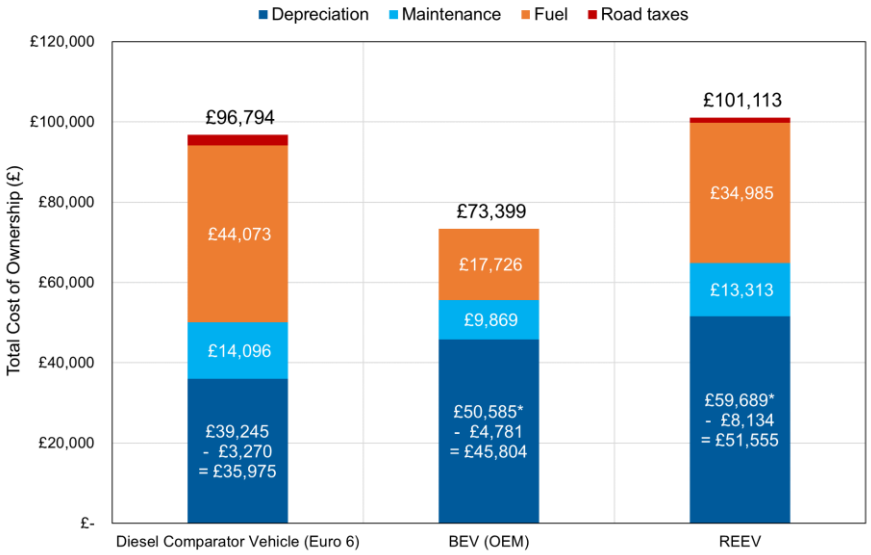


Figure 11 - Total Cost of Ownership; Medium Van (WAV)

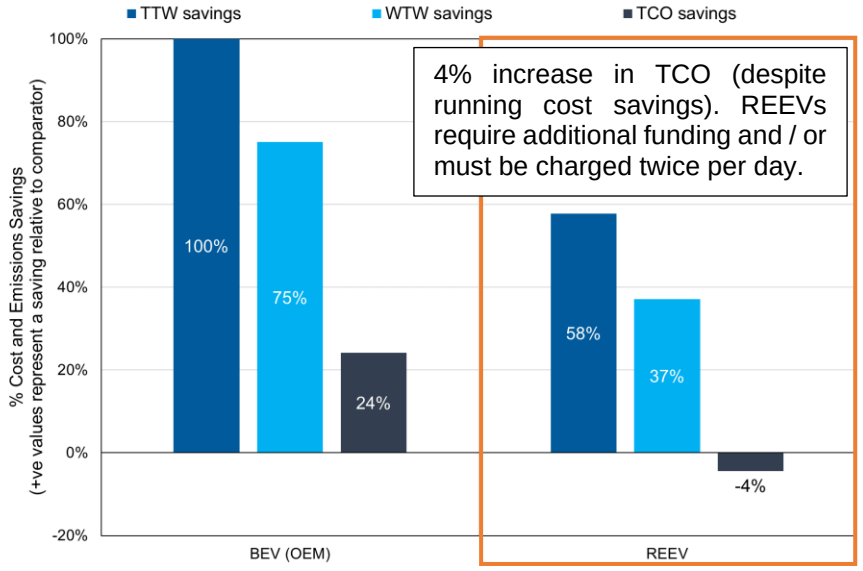


Figure 12 - CO_2e Emissions Savings vs. Cost Savings; Medium Van (WAV)

BEV (OEM)

Criteria	Performance
Operational	• **Estimated real-world range of 110 miles (40 kWh battery) results in >100% of the battery capacity being used on the average day.** • The average daily mileage is equal to the range of the vehicle and so it is expected that on over half of the days of operation the vehicle would have to be recharged during the shift. • 7kW AC on-board charger as standard = 8h charging time at 7kW+ chargepoint. • 1 hour to DC charge to 80% capacity using a 50 kW rapid charger.
TCO	• **Purchase cost increase of £10,000**. • **Running cost savings of £30,000** through reduced fuel and maintenance costs over the ten-year ownership. • **TCO reduction of £23,000 (24% saving)**.
Emissions	• **Zero tailpipe emissions.** • **75% reduction in WTW CO_2e emissions** based on the current UK grid energy mix. This will reduce further as the UK grid decarbonises.

REEV

Criteria	Performance
Operational	• **Estimated real-world electric only range of 62 miles** (32 kWh battery) results in 100% of the battery capacity being used on the average day. • **Once the battery capacity has run out, the REEV can use the petrol engine to complete the daily mileage.** • 22kW AC on-board charger as standard = 1h charging time at 22kW chargepoint. This will be longer at a lower power chargepoint. • 30 minutes to DC charge to 80% capacity using a 50 kW rapid charger.
TCO	• **Purchase cost increase of £20,000** leads to a depreciation cost increase of £15,500. • **Running cost savings of £10,000** through reduced fuel and maintenance costs over the ten-year ownership. • **TCO increase of £5,000 (4% increase)**. Charging the vehicle during the shift would reduce this TCO increase.
Emissions	• Zero tailpipe emissions when in electric only mode. • **37% reduction in WTW CO_2e emissions** based on the current UK grid energy mix. This can be reduced further by charging twice per day. • **94% reduction in NOx emissions compared to a Euro 6 diesel vehicle**.

The impact of two battery charges on both the BEV and the REEV can be found in Appendix B – Additional Tables and Charts. This analysis provides the following conclusions:

- If charged twice per day, BEVs and REEVs can both complete the average daily mileage using electricity only. The REEV maintains an additional ~250 mile range from the petrol range extender.
- REEVs make a 2% TCO saving due to a substantial increase in electric running. The electricity cost in this assessment was at a home charging cost and the impact of higher cost public charging was not assessed.
- Due to running on electric power only, the REEV increases its WTW CO_2e savings from 37% to 66%.

Several of the measures and recommendations discussed in Section 6.4 are focused on addressing the three main challenges associated with the wheelchair accessible hackney carriage vehicle segment (operating range for BEVs, total cost of ownership for REEVs and a lack of alternative vehicle / technology options).

<u>Strategy Recommendation</u>: Clearly define and document minimum emissions standards in vehicle age and emissions policy documents (particularly for ULEVs).

Cenex suggest that at the point of introduction of ULEVs for newly licensed vehicles, City of Wolverhampton Council should adopt the most recent plug-in grant emissions eligibility criteria (currently defined as '**CO_2 emissions of less than 50 g/km and can travel at least 70 miles without any emissions at all**'). Based on current vehicle capabilities, this would exclude PHEVs.

Consideration should also be paid to the following:

- The impact of the introduction of new emissions standards (e.g. Euro 7) or the revision of current ULEV definitions. In this case, City of Wolverhampton Council should provide provisional definitions for future vehicle age and emissions policy changes.
- Providing the trade with a clear roadmap, and robust transition process, from current internal combustion engine only vehicles (of differing euro standards) to ZEVs.
- The ongoing impact of plug-in grant eligibility on any required financial support measures.

4.3 Ultra-Low Emission Vehicle Performance Review – Other Vehicle Segments

Table 21 details the key differences in the performance reviews of the remaining vehicle segments compared to the medium car and medium van (WAV) segments previously reported.

Table 21 – Summary of Remaining Vehicle Segments (compared to Medium Car and Medium Van (WAV))

Segment	Differences to Medium Car and Medium Van performance
Large Car	• Only one BEV is currently available (Tesla Model 3). • This vehicle has increased range compared to the medium car and only uses 44% of the 55 kWh battery capacity to complete the average daily mileage. • Maintenance costs are higher than equivalent medium cars. • **Operationally suitable with WTW CO_2e emission savings of 75% and TCO savings of £3,000.**
Medium MPV	• Only one BEV is currently available (Nissan eNV200). • The average daily mileage uses 75% of the battery capacity. • No PHEVs are available in this segment. • **Operationally challenging with WTW CO_2e emission savings of 70% and TCO savings of £7,000.**
Executive Car	• **Only premium SUV BEVs are currently available.** • These vehicles have a high purchase cost and do not receive the plug-in grant as they cost over £50,000. The depreciation costs are also significantly higher as a result. • Fuel cost savings are less than other BEVs as the large SUV form factor is less efficient than a saloon vehicle. • **Operationally suitable with WTW CO_2e emissions savings of 60% but a TCO increase of £6,000.**
Medium Van (8-seater)	• BEVs are at the range limit to complete the average daily mileage. • Only one REEV is available (Ford Tourneo Custom PHEV). • The vehicle is relatively expensive as it does not receive the plug-in grant. • The battery is much smaller than the equivalent REEV and the vehicle completes over 70% of its miles on petrol power. As such fuel costs increase from the diesel comparator. • **Not operationally suitable but 71% WTW CO_2e emission savings and TCO saving of £10,000.**

5 Overall Ultra-Low Emission Vehicle Technology Suitability

In this section the suitability of ULEV technologies has been assessed for each individual vehicle on the fleet. The purpose of this assessment is to highlight the overall opportunity for each technology to replace diesel / petrol vehicles within each vehicle segment and therefore across the entire fleet. This analysis uses the same approach described during the 'Ultra-Low Emission Vehicle Performance Reviews' but individual vehicle input parameters are used instead of the vehicle segment averages. The following 'suitability criteria' have been applied to individual vehicles for all assessed ULEV technologies:

- Operating range suitability criteria (driver criteria) – **ULEVs must be able to complete the average daily mileage on less than one full charge or tank with at least 20 miles range remaining** (including any secondary fuels).
    - It has been assumed that all vehicles with have access to adequate infrastructure to charge vehicles between shifts and that drivers will be unwilling to routinely charge their vehicle during shifts.
- Greenhouse gas emissions suitability criteria (local authority criteria) – **ULEVs must provide WTW CO_2e emissions savings** on less than one full charge per day.
    - Use of vehicles that cannot guarantee a reduction in greenhouse gas emissions (particularly PHEVs) represents a significant risk to the environmental aspirations of City of Wolverhampton Council.
- Total cost of ownership suitability criteria (vehicle proprietor criteria) – **ULEVs must provide TCO savings** on less than one full charge per day.
    - It has been assumed that vehicle proprietors will not accept any increase in TCO regardless of potential emissions savings.

The purpose of this assessment is to provide a quantitative assessment of the overall ULEV suitability based on current vehicle availability and performance, this provides a measure for the feasibility of any proposed vehicle age and emissions policy changes. Results are presented in four tables, one for the introduction of each of the suitability criteria (where % suitability reduces with the introduction of each criteria) followed by a summary table. A green, yellow, red colour scale has been applied across all tables where green represents a suitability of 100% and red represents a suitability of 0%.

Table 22 shows the percentage of vehicles that meet the operating range suitability criteria by vehicle segment. This is the most important criteria for drivers as first and foremost ULEVs must be able to complete the required daily duties. BEVs are categorised as BEV (S) for standard battery capacities and BEV (L) for large battery capacities.

Table 22 - Operating Range Suitability

% of vehicle segment	BEV (S)	BEV (L)	PHEV / REEV
Medium Car	71%	96%	100%
Large Car	95%	99%	100%
Medium MPV	61%	NA	NA
Executive Car	89%	NA	100%
Medium Van	46%	NA	100%
Medium Van (WAV)	40%	NA	100%
Total Fleet	**76%**	**72%**	**84%**

This shows that **76% of the fleet could complete the average daily mileages on less than one charge if using BEV (S)**. This increases to **89% when including large battery variants** of medium and large cars (72% of the fleet has a suitable large battery variant). Crucially **only 40% to 60% of the medium vans and MPVs meet the operating range suitability criteria**. The operating range of REEVs and PHEVs is inherently suitable due to the ability to operate using the internal combustion engine once the battery is depleted.

Table 23 shows the percentage of vehicles that meet the greenhouse gas emissions suitability criteria in addition to the operating range criteria.

Table 23 - Operating Range and Greenhouse Gas Emissions Suitability

% of vehicle segment	BEV (S)	BEV (L)	PHEV / REEV
Medium Car	71%	96%	27%
Large Car	95%	99%	50%
Medium MPV	61%	NA	NA
Executive Car	89%	NA	62%
Medium Van	46%	NA	49%
Medium Van (WAV)	40%	NA	100%
Total Fleet	**76%**	**72%**	**32%**

The number of suitable BEVs and REEVs remains unchanged but the total percentage of PHEVs reduces significantly. **Only 32% of the fleet would provide WTW CO_2e emissions savings if using PHEV / REEVs**. This is due to relatively low electric only range of most PHEVs (30 miles maximum) and the relatively high average daily mileage of the fleet (85 miles).

Table 24 shows the percentage of vehicles that meet all suitability criteria including the total cost of ownership suitability criteria. This represents a realistic best-case scenario for the uptake of ULEVs based on current vehicle capabilities and economics.

Table 24 - Operating Range, Greenhouse Gas Emissions and Total Cost of Ownership Suitability

% of vehicle segment	BEV (S)	BEV (L)	PHEV / REEV
Medium Car	49%	34%	0%
Large Car	79%	29%	0%
Medium MPV	37%	NA	NA
Executive Car	1%	NA	0%
Medium Van	32%	NA	0%
Medium Van (WAV)	38%	NA	0%
Total Fleet	**52%**	**24%**	**0%**

Assessed individually and without financial incentives, **52% of the fleet could provide TCO savings for BEV (S), 24% for BEV (L) and 0% for PHEV / REEV**. The introduction of the TCO suitability criteria has had the largest impact on REEV medium vans (WAV), reducing from 100% to 0%, and BEV executive cars, reducing from 89% to 1%.

Finally, Table 25 shows the most suitable ULEV technology for each individual vehicle. In each case the ULEV technology that meets all suitability criteria and provides the largest TCO savings has been selected. This rationalises the BEVs by selecting the most appropriate battery capacity.

Table 25 - ULEV Technology Selection

% of vehicle segment	BEV (S)	BEV (L)	ULEV Suitable	ULEV Not Suitable
Medium Car	49%	23%	72%	28%
Large Car	79%	4%	83%	17%
Medium MPV	37%	-	37%	63%
Executive Car	1%	-	1%	99%
Medium Van	32%	-	32%	68%
Medium Van (WAV)	39%	-	39%	61%
Total Fleet	**52%**	**12%**	**64%**	**36%**

The overall suitability assessment shows that **64% of the fleet is currently suitable for replacement by a BEV with an appropriately sized battery**, 70 to 80% of the medium and large cars meet the suitability criteria and represent the best opportunities for early adoption of ULEVs. A fleet with the composition shown above would provide a 48% reduction in annual WTW CO_2e emissions and a 90% reduction in NOx emissions (if the remaining 36% of the fleet is Euro 6).

At least 60% of the MPVs, executive cars and medium vans are not currently suitable for replacement by ULEV. These vehicle segments account for ~30% of the fleet greenhouse gas emissions.

5.1.1 Impact of Average Daily Mileage and Annual Mileage on Suitability

To better understand the results of the 'Ultra-Low Emission Vehicle Technology Suitability' assessment, TCO savings have been plotted against calculated average daily mileage for representative vehicle segments and ULEV technologies. As all vehicles have been assigned the same driving environment, ownership period and fuel economy (within each vehicle segment) the suitability is determined by the average daily mileage and annual mileage, these values are directly related as **all vehicles have been assumed to be used for 260 days a year** (5 days a week).

Figure 13 and Figure 14 show the TCO savings against the average daily mileage for the medium car and medium van (WAV) segments, respectively. The area of the line highlighted in bold with a green text box represents vehicles which meet the operating range and TCO suitability criteria.

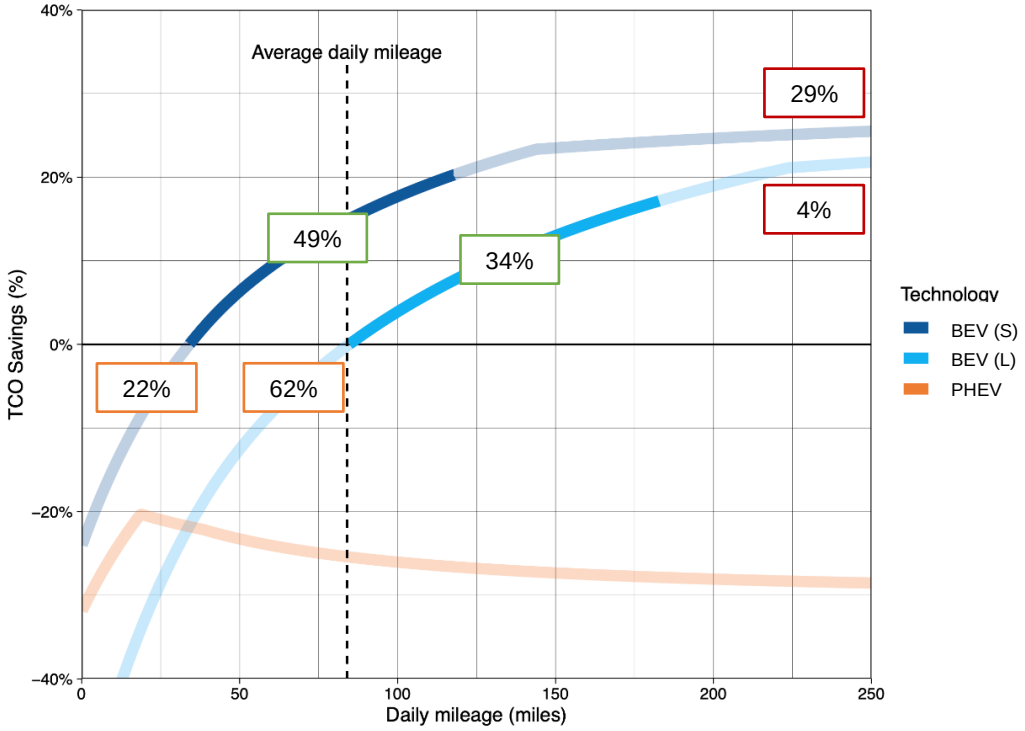


Figure 13 - Total Cost of Ownership Savings vs. Average Daily Mileage; Medium Car

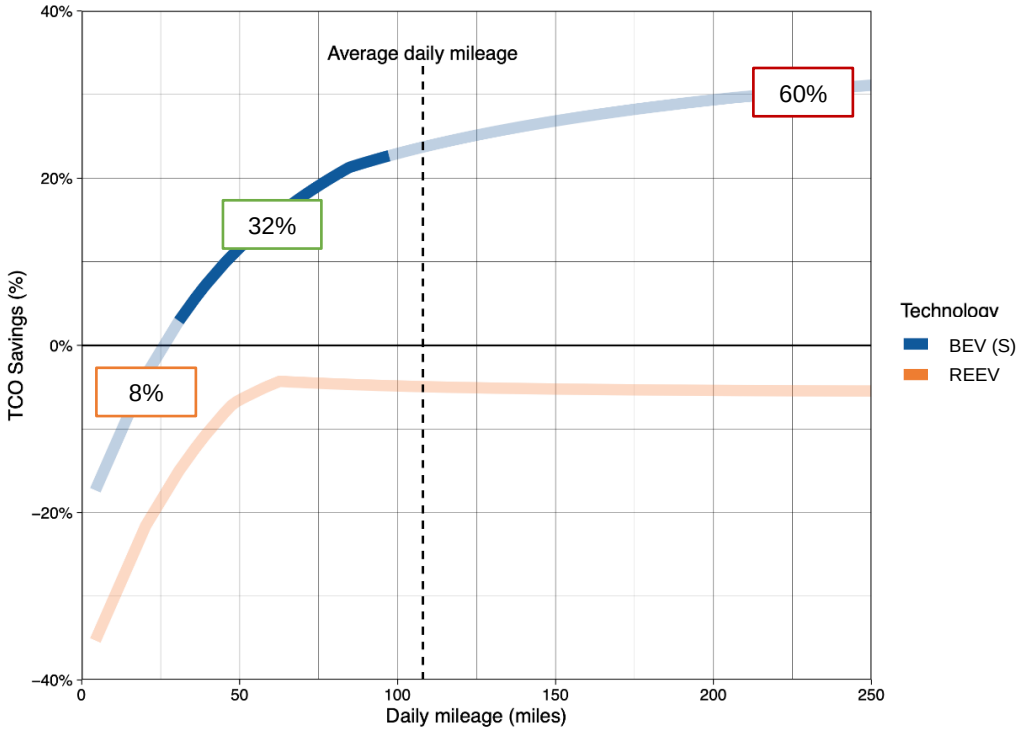


Figure 14 - Total Cost of Ownership Savings vs. Average Daily Mileage; Medium Van (WAV)

The mileage sensitivity analysis provides the following insight:

- BEVs have a minimum annual mileage that is required to achieve TCO parity. Above these annual mileages BEVs provide increasing TCO savings up to a maximum of 20% to 30%.
    - These minimum mileages are ~6,500 miles / ~25 miles a day for medium vans (WAV), 9,000 miles / ~35 miles a day for BEV (S) medium cars and 22,000 miles / 85 miles a day for BEV (L) medium cars.
    - Vehicles below these thresholds account for 8%, 22% and 62% of the relevant vehicle segments, respectively.
- Without relying heavily on public charging infrastructure, BEVs have a maximum daily mileage limit.
    - These maximum mileages are ~100 miles for medium vans (WAV), ~110 miles for BEV (S) medium cars and ~180 miles for BEV (L) medium cars.
    - Vehicles above these thresholds account for 60%, 29% and 4% of the relevant segments, respectively.
- When operating in electric only mode, REEVs and PHEVs follow the same trends as BEVs (increasing running cost savings with increasing daily and annual mileages). Beyond this mileage both vehicles are primarily powered by an internal combustion engine, at this point TCO savings are minimised.
    - PHEV medium cars provide the smallest difference in TCO to a Euro 6 diesel vehicle at ~6,500 miles / 25 miles a day. Even at this point there is a TCO increase of 20%.
    - REEV medium vans (WAV) have a larger, 31 kWh battery, and can achieve ~60 miles of electric only range. At this point the TCO increase is 5%. If charged once per day only this point represents the most economic mileage (15,600 miles a year).

Figure 15 provides a detailed breakdown of the suitability of BEVs with standard battery capacities, this example is intended to highlight the different constraints that can apply across vehicle segments using the same ULEV technology. Green bars represent the percentage of vehicles that meet the operating range and TCO suitability criteria (all BEVs inherently provide CO_2 emissions savings), amber bars represent vehicles which provide an increase in TCO (require additional funding in the short term but could be suitable as costs reduce in the future) and red bars represent vehicles which need more than one charge per day (require a larger battery, could be suitable if charged during shifts, or require future ULEV technologies such as next generation BEVs or even FCEVs).

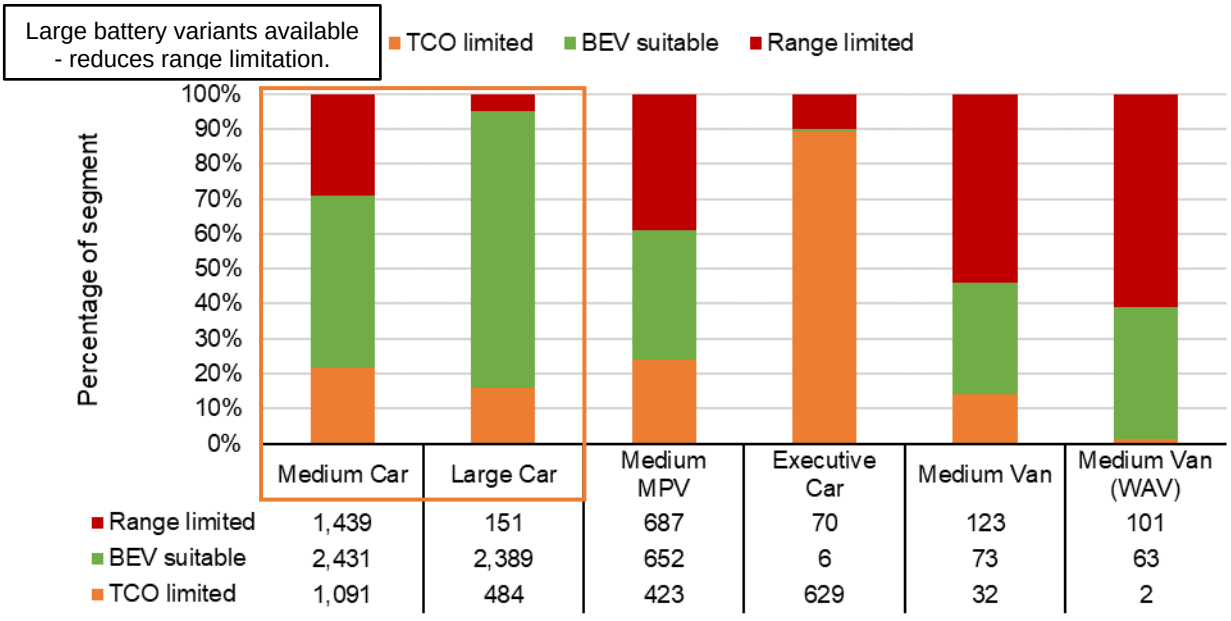


Figure 15 - Detailed Breakdown of BEV Suitability by Vehicle Segment (Standard Battery Capacity)

This highlights the relative challenges in each vehicle segment as follows:

- **BEVs with 40-50 kWh batteries currently do not provide adequate operating range for most MPVs, Medium Vans and Medium Vans (WAV)**. These vehicles are essential for carrying larger numbers of passengers and wheelchair users.
- **BEV executive cars are currently only available as premium SUVs** with a large purchase cost premium (~£25k). ~90% of the executive car fleet do not meet the TCO suitability criteria.
- In most vehicle segments, **BEVs could increase the TCO for up to 20% of the lowest mileage vehicles**. These vehicles do not provide adequate opportunity for running cost savings to offset the increased purchase cost.

Strategy Recommendation: Ensure that the introduction of ULEV as the minimum emissions standard is conditional on the availability of an appropriate number of suitable vehicle models, and technologies, to cover all essential services.

Undertake a periodic and quantifiable review of ULEV suitability including a formal review 6-12 months before the planned introduction of new vehicle emissions policies.

Cenex suggest that at least three suitable models should be available to fulfil each essential service and that like for like vehicle replacement should be considered as desirable only.

Suitability could be as simple as meeting the preferred definition of an ULEV or being eligible for the plug-in grant (or similar). Alternatively, City of Wolverhampton Council could determine additional conditions such as maximum purchase costs, minimum electric only ranges (official or independently verified through real-world testing) or a more thorough vehicle approval / first time inspection process. The required level of suitability should reflect the percentage of the fleet that is expected to be an ULEV at any given time.

6 Ultra-Low Emission Vehicle Emissions Policy and Measures Review

This section provides a recommendation for an ULEV focused vehicle emissions policy supported by a summary of the measures available to City of Wolverhampton Council to accelerate the transition to ULEVs. To understand the feasibility of these recommendations, Cenex has undertaken desk-based research into vehicle licensing policy best practice alongside interviews with other local authorities and WAV suppliers / convertors.

6.1 Licensing Policy Scenarios

To understand the potential impact of the introduction of an ULEV emissions policy, Cenex has developed three licensing scenarios based on the operational suitability of currently available ULEVs and vehicle emissions policy best practice research, as reported in Section 6.3.

The analysis reported in this section uses an in-house taxi licensing and replacement model which is used to calculate the number of replacement vehicles, capital and revenue costs, and emissions based on different scenarios for the introduction of ULEV as the minimum emissions standard.

The modelling period is 2020 to 2035 but the introduction of ULEV as a minimum emissions standard has been modelled from 2023 to 2030 using the current maximum vehicle age limits. This reflects the minimum timescale for the introduction of new policies and the aspirations of City of Wolverhampton Council. The modelling only adds vehicles at the minimum emission standards and as such does not reflect the likely natural increase in ULEVs that the UK market will experience in the modelling period. Three licensing scenarios have been modelled as described below.

1. **Baseline** – new vehicles are required to meet the latest euro emissions standards (Euro 6) followed by the UK Government proposal for ending the sale of new diesel, petrol and hybrid passenger vehicles in 2030.
2. **Improved** – all vehicles are required to meet the latest euro emissions standards (Euro 6), followed by the phased introduction of ULEV as the minimum emissions standard from 2025 (new vehicles) to 2030 (all vehicles). Typical policy used to achieve short term compliance with clean air zone requirements.
3. **Aspirational** – removal of the interim regulatory requirement for improved euro emissions standards (Euro 6) in favour of an early phased introduction of ULEV as the minimum emissions standard from 2023 (new vehicles) to 2028 (all vehicles). Considered best practice for achieving long term reductions in greenhouse gas and air quality pollutant emissions.

Figure 16 shows the minimum emissions standard and date of introduction for new vehicles and all vehicles in each scenario.

Scenario	2023	2024	2025	2026	2027	2028	2029	2030
Baseline	Euro 6 (New)							ULEV (New)
Improved	Euro 6 (All)		ULEV (New)					ULEV (All)
Aspirational	ULEV (New)					ULEV (All)		

Figure 16 - Minimum Emissions Standard by Licensing Scenario

For modelling purposes, 'New Vehicles' refers to a vehicle that is introduced to the fleet to replace an existing licensed vehicle that has reached the maximum age limit. In practice, this standard should also apply to newly licensed vehicles that do not replace a vehicle on an existing licence (e.g. a vehicle licence application from a new vehicle proprietor). To simplify the analysis, **the number of licensed vehicles has been assumed to be fixed over the modelling period**. 'All Vehicles' provides an additional requirement for vehicles to meet the minimum emissions standard at the point of renewing a vehicle licence.

The following assumptions have been applied across all licensing scenarios:

- Maximum vehicle age limit of 16 years for hackney carriage vehicles and 12 years for private hire vehicles, once a vehicle reaches the maximum age limit it is replaced by the specified minimum emissions standard. The introduction of new emissions standards for all vehicles results in vehicle replacement regardless of current vehicle age.
- Replacement vehicles are brand-new, and vehicles are replaced on a like for like basis (same vehicle type and fuel unless replaced by an ULEV). This is for modelling purposes only, Cenex advocate licensing used ULEVs that meet the licensing criteria.
- Any vehicle replaced before 2023 is assumed to meet Euro 6 emissions standards.
- Dates of introduction and minimum emissions standards are the same for hackney carriage and private hire vehicles.
- Replacement ULEV technologies have been determined by operating range and average daily mileage only. TCO and WTW CO_2e emissions savings criteria have not been applied.
    - All high market maturity ULEV technologies have been included in the modelling including BEV, REEV and PHEVs. This represents a scenario based on the minimum definition of an ULEV (less than 75 g/km of CO_2 from the tailpipe). As previously discussed, Cenex strongly recommend defining a more stringent ULEV definition.
    - ULEVs have been assessed against the operating range suitability criteria (vehicle must be able to complete the average daily mileage on less than one full charge or tank with at least 20 miles range remaining) in order of electric only range descending.
        - BEV > REEV > PHEV > Euro 6 (where no suitable ULEV currently exists)

These scenarios represent the minimum possible emissions savings based on current vehicle performance and the assumption that City of Wolverhampton can provide adequate financial support to enable all vehicle proprietors to transition to an ULEV with adequate operating range to complete their average daily mileage.

6.2 Impact of Revised Vehicle Age and Emissions Policy

Each scenario is assessed against four main criteria: the number of required replacement vehicles each year, cumulative WTW CO_2e emissions, annual and cumulative air quality pollutant emissions.

Savings in social damage costs have also been calculated by applying WebTAG environmental impact appraisal guidance[21]. This methodology monetises harmful emissions of CO_2, NOx and PM according to their potency. The values are adjusted slightly by the year they apply and are taken from the WebTAG Data Book[22]. For reference the 2017 baseline figures for each pollutant are £60.27 per tonne for CO_2, £10,699 per tonne for NOx, and £203,331 per tonne for PM. The net present value of the damage cost saving is calculated in 2020 prices using a discount rate of 3.5% in line with the DEFRA methodology.

[21] https://www.gov.uk/government/publications/assess-the-impact-of-air-quality
[22] https://www.gov.uk/government/publications/tag-data-book

6.2.1 Impact of ULEV Emissions Policy on Hackney Carriage Vehicle Fleet

This sub-section shows the impact of the three licensing scenarios on the hackney carriage vehicle fleet with the information presented in several parts, namely: the number and type of replacement vehicles, a detailed breakdown of the WTW CO_2e emissions by scenario with key dates overlaid, a summary of the WTW CO_2e and NOx emissions, and a summary of the associated costs (additional capital cost, running cost savings and social damage cost savings). PM emissions can be found in Appendix B – Additional Tables and Charts.

Table 26 shows the percentage of the hackney carriage vehicles due for replacement in each scenario. It should be noted that the baseline scenario represents the normal turnover rate, assuming that vehicles are replaced at the maximum age limit (some vehicles will be replaced prior to this).

Table 26 - Percentage of Fleet Replaced Each Year; Hackney Carriage Vehicle Fleet

	Baseline	Improved	Aspirational
2020	5%	5%	5%
2021	4%	4%	4%
2022	12%	12%	12%
2023	10%	70%	10%
2024	4%	0%	4%
2025	17%	0%	17%
2026	17%	0%	17%
2027	6%	0%	6%
2028	6%	0%	46%
2029	8%	0%	0%
2030	2%	100%	0%
2031	2%	0%	0%
2032	2%	0%	0%
2033	1%	0%	0%
2034	1%	0%	0%
2035	3%	0%	0%

- **Baseline** – on average, only 16 vehicles (6% of the fleet) are replaced each year with a peak of 28 vehicles (17% of the fleet) in 2025 and 2026.
- **Improved** – 116 vehicles (70% of the fleet) are replaced by Euro 6 diesel vehicles in 2023 and the entire fleet is replaced by ULEVs in 2030 (resulting in an effective seven-year ownership period for new diesel vehicles). No vehicles are replaced between 2024 and 2029 due to the maximum age limit of 16 years.
- **Aspirational** – until 2028 the aspirational scenario requires the same number of replacement vehicles as the baseline scenario but in this scenario ULEVs are required instead of Euro 6 vehicles. As such 90 vehicles (54% of the fleet) are replaced on the current maximum age limit between 2023 and 2027, **with the peak of 28 ULEVs (17% of the fleet) occurring in 2025 and 2026**. The remaining 76 vehicles (46% of the fleet) are replaced by ULEVs in 2028.

Figure 17 shows the corresponding hackney carriage fleet composition where euro emissions standards are denoted by number and ULEVs are denoted by the relevant technology types.

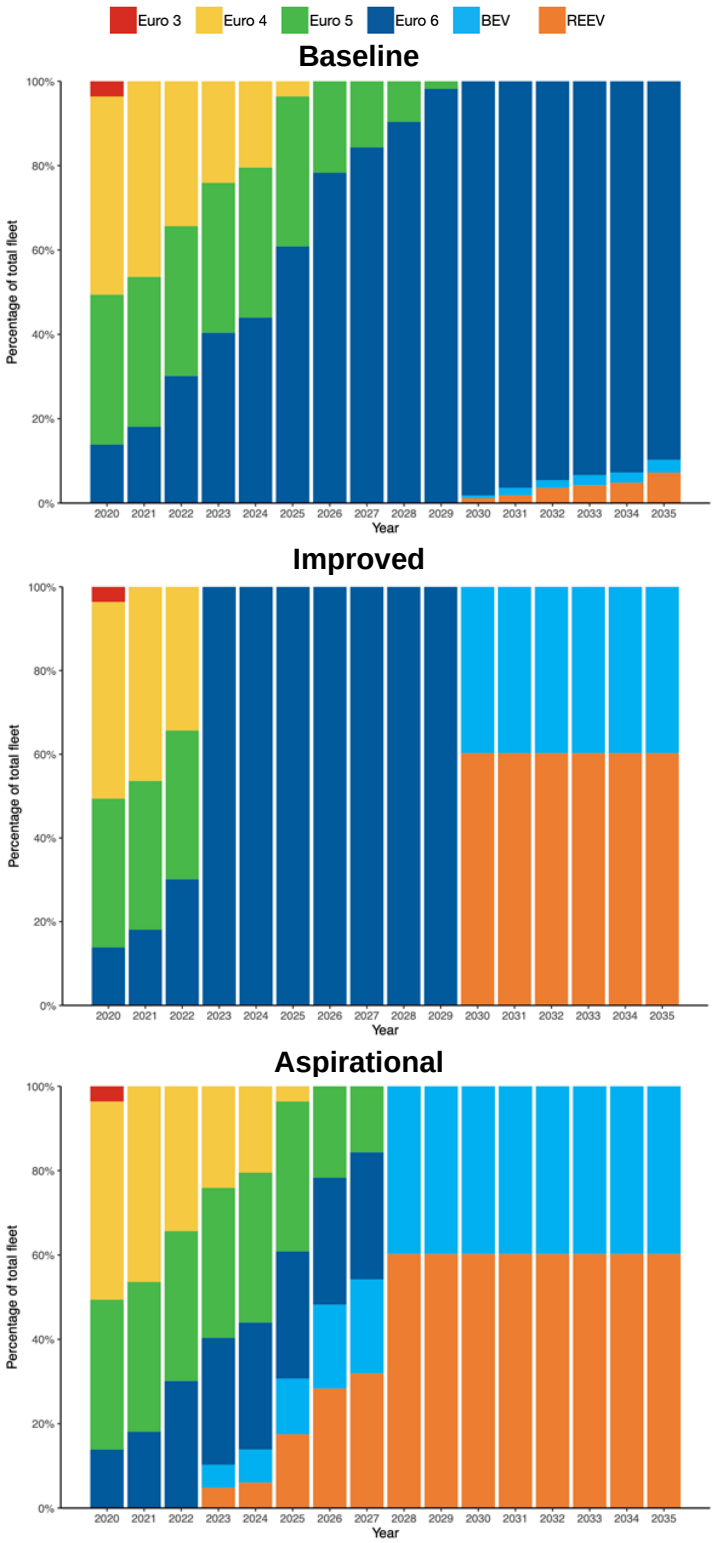


Figure 17 - Fleet Composition by Technology Type; Hackney Carriage Vehicle Fleet

- **Baseline** – over 50% of the fleet is Euro 6 by 2025, nearly all vehicles are Euro 6 by 2029. Only 17 vehicles (10% of the fleet) are ULEVs by 2035.
- **Improved** – two steps changes to 100% Euro 6 in 2023 and 100% ULEVs in 2030.
    - BEVs are currently only operationally suitable for 40% of the fleet (~110 mile electric range on average), REEVs have adequate total range but increase TCO by at least 4%.
- **Aspirational** – just under 50% of the fleet is ULEV by 2026 and 100% of the fleet is ULEV in 2028. In 2027, the fleet consists of 22% BEV, 32% REEV, 30% Euro 6 and 16% Euro 5 vehicles.
    - Same ULEV fleet composition as improved scenario.

Figure 18 shows a breakdown of WTW CO_2e emissions for hackney carriage vehicles by scenario. Horizontal dashed lines represent the emissions if all vehicles where the same stated technology.

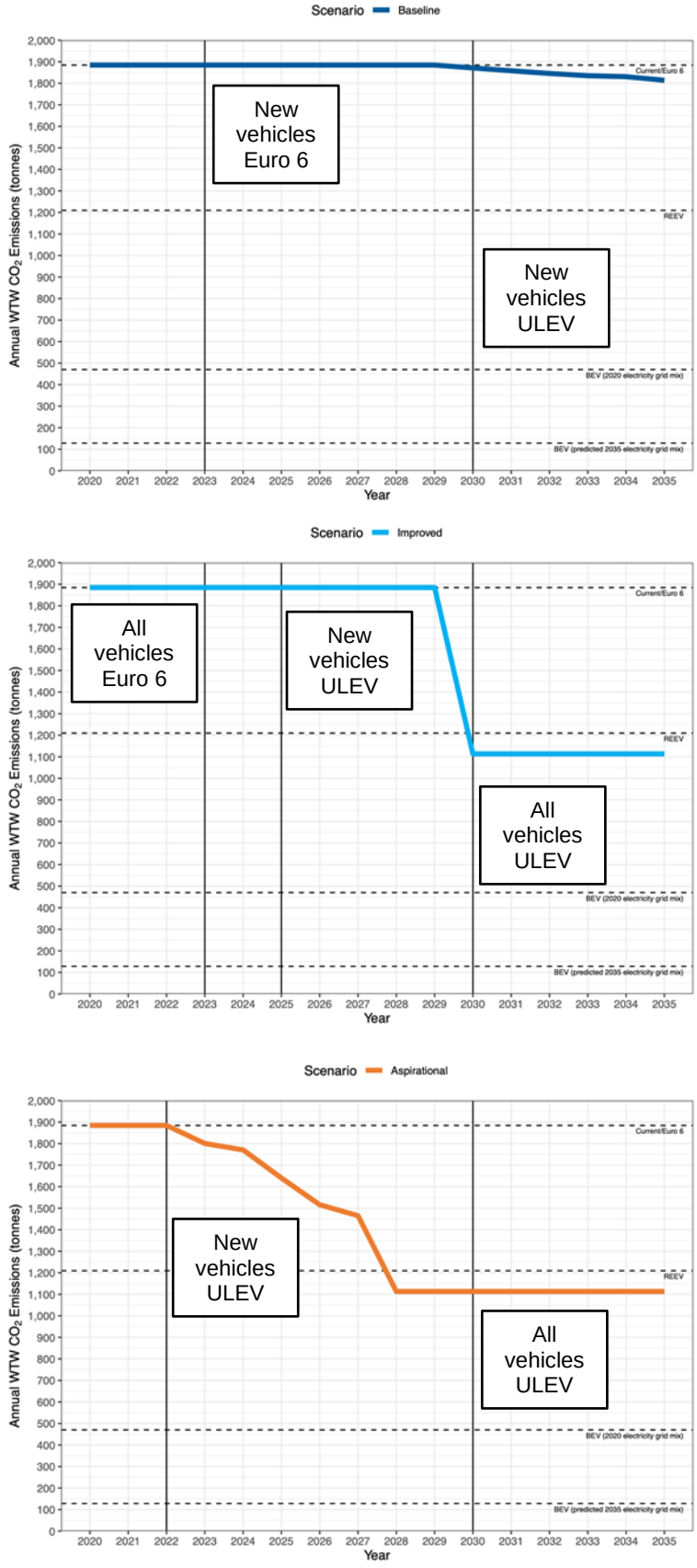


Figure 18 – Breakdown of WTW CO_2e Emissions; Hackney Carriage Vehicle Fleet

Figure 19 shows a summary of WTW CO_2e emissions for hackney carriage vehicles by scenario.

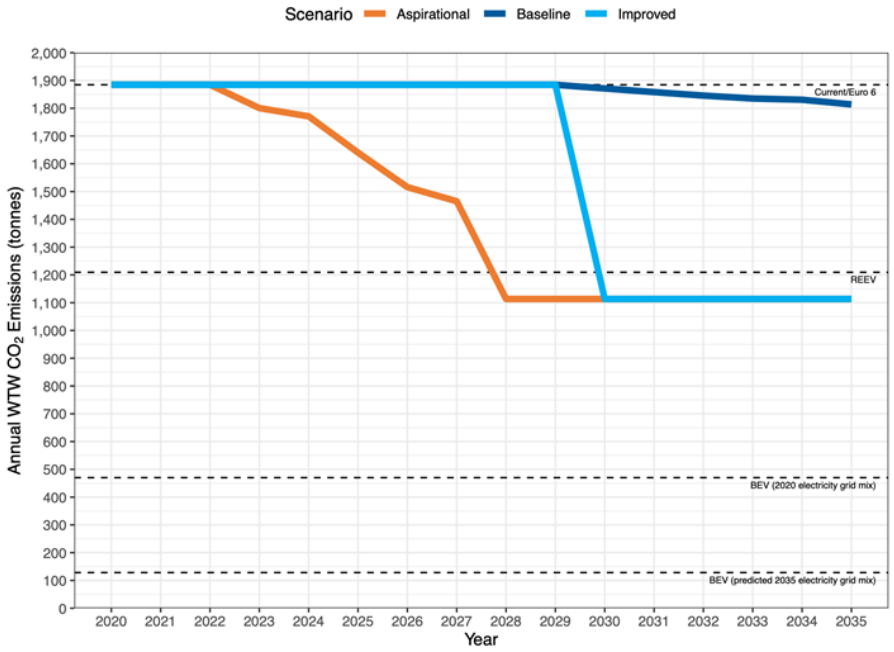


Figure 19 – Summary of WTW CO_2e Emissions; Hackney Carriage Vehicle Fleet

- **Baseline** – **1% reduction in cumulative WTW CO_2e emitted between 2020 and 2035**.
- **Improved** – 41% reduction in annual WTW CO_2e emissions from 2030 onwards (when all vehicles must be ULEVs). This results in a **15% reduction in cumulative WTW CO_2e emitted between 2020 and 2035**. Should suitable BEVs become available the reduction in annual WTW CO_2e emissions would increase to 75% and 93%, depending upon the percentage of BEVs and carbon intensity of grid electricity.
- **Aspirational** – reductions in annual WTW CO_2e emissions from 2023 onwards (when new vehicles must be ULEVs). 15% reduction in cumulative WTW CO_2e emitted between 2020 and 2029, compared to negligible reductions in the baseline and improved scenarios. **25% reduction in cumulative WTW CO_2e emitted between 2020 and 2035**.

Figure 20 shows a summary of NOx emissions for hackney carriage vehicles by scenario.

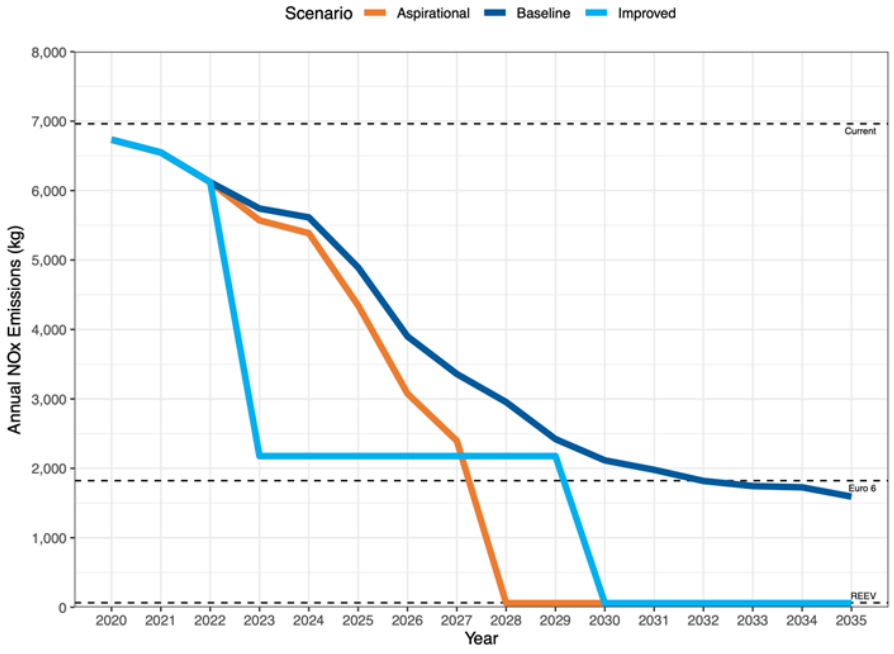


Figure 20 - Summary of NOx Emissions; Hackney Carriage Fleet

- **Baseline** – 64% reduction in annual NOx emissions by 2030 (due to the introduction of Euro 6 vehicles).
- **Improved** – **66% reduction in annual NOx emissions in 2023**, some older Euro 6 vehicles retained on fleet (e.g. 2016 vehicles). 99% reduction in annual NOx emissions from 2030 onwards (when all vehicles must be ULEVs).
- **Aspirational** – 99% reduction in annual NOx emissions by 2028 (when all vehicles must be ULEVs). **Provides lowest levels of NOx emissions out of all three scenarios from 2027**. Emissions reductions could be brought forward by reducing the maximum age limit for diesel vehicles from 16 years to 12 years (in line with private hire vehicles).

Reducing the age limit to 12 years significantly increases the uptake of ULEVs in all scenarios. **In the baseline scenario with a 12 year age limit over 80% of the fleet is an ULEV by 2035 compared to 10% with the current 16 year age limit.**

Table 27 provides a summary of the total (cumulative) emissions savings in each scenario from 2020 to 2035 alongside the association social damage cost savings by emissions type. The red, amber, green scale denotes the overall contribution the social damage cost savings. Green values represent larger savings and red values represent smaller savings.

Table 27 - Summary of Emissions and Social Damage Cost Savings; Hackney Carriage Fleet

Emission Type	Total Emissions Saving from 2020 to 2035 (% compared to baseline)		Social Damage Cost Saving (£)	
	Improved Scenario	Aspirational Scenario	Improved Scenario	Aspirational Scenario
WTW CO_2e	-15%	-24%	£219,000	£368,000
NOx	-41%	-31%	£271,000	£201,000
PM	-25%	-10%	£11,000	£4,000
Total	NA	NA	£501,000	£573,000

The aspirational scenario provides social damage cost savings of £573,000 (WTW CO_2e accounts for 64% of these savings) through cumulative reductions in WTW CO_2e, NOx and PM emissions of 24%, 31% and 10%, respectively.

As most of the hackney carriage vehicle fleet only meets Euro 4 emissions standards, NOx and PM emissions are relatively high. As such, the improved scenario also provides social damage cost savings of £501,000. This is due to the introduction of Euro 6 as the minimum standard for all vehicles in 2023. It is worth noting that the savings in the improved scenario are the maximum available whereas the aspirational scenario savings represent the minimum and can be increased through the introduction of a greater proportion of BEVs (and with reductions in the carbon intensity of the electricity grid).

Based on current costs, **an additional £2.3m of additional capital funding would be required** to transition the entire hackney carriage vehicle fleet to ULEVs (compared to new Euro 6 diesel vehicles). Additionally, **the aspirational scenario provides a total of £2.3m of running cost savings by 2035** compared to £1.4m in the improved scenario.

6.2.2 Impact of ULEV Emissions Policy on Private Hire Vehicle Fleet

This sub-section shows the impact of the three licensing scenarios on the private hire vehicle fleet with the information presented in several parts, namely: the number and type of replacement vehicles, a detailed breakdown of the WTW CO_2e emissions by scenario with key dates overlaid, a summary of the WTW CO_2e and NOx emissions, and a summary of the associated costs (additional capital cost, running cost savings and social damage cost savings). PM emissions can be found in Appendix B – Additional Tables and Charts.

Table 28 shows the percentage of the private hire vehicles due for replacement in each scenario. It should be noted that the baseline scenario represents the normal turnover rate, assuming that vehicles are replaced at the maximum age limit (some vehicles will be replaced prior to this).

Table 28 - Percentage of Fleet Replaced Each Year; Private Hire Vehicle Fleet

	Baseline	Improved	Aspirational
2020	1%	1%	1%
2021	7%	7%	7%
2022	12%	12%	12%
2023	11%	48%	11%
2024	12%	0%	12%
2025	11%	0%	11%
2026	12%	0%	12%
2027	11%	10%	11%
2028	9%	9%	42%
2029	5%	5%	0%
2030	3%	74%	0%
2031	2%	0%	0%
2032	1%	0%	0%
2033	7%	0%	0%
2034	12%	0%	0%
2035	11%	0%	0%

- **Baseline** – on average, only 900 vehicles (8% of the fleet) are replaced each year with a peak of 1,342 vehicles (11% of the fleet) in 2026.
- **Improved** – 5,256 vehicles (48% of the fleet) are replaced by Euro 6 diesel vehicles in 2023 and the entire fleet is replaced by ULEVs in 2030 (resulting in an effective seven-year ownership period for new diesel vehicles). No vehicles are replaced between 2024 and 2027 due to the maximum age limit of 12 years.
- **Aspirational** – until 2028 the aspirational scenario requires the same number of replacement vehicles as the baseline scenario but in this scenario ULEVs are required instead of Euro 6 vehicles. As such 6,359 vehicles (58% of the fleet) are replaced on the current maximum age limit between 2023 and 2027, **with the peak of 1,342 ULEVs (11% of the fleet) occurring in 2026**. The remaining 4,668 vehicles (42% of the fleet) are replaced by ULEVs in 2028.

Figure 21 shows the corresponding private hire fleet composition where euro emissions standards are denoted by number and ULEVs are denoted by the relevant technology types.

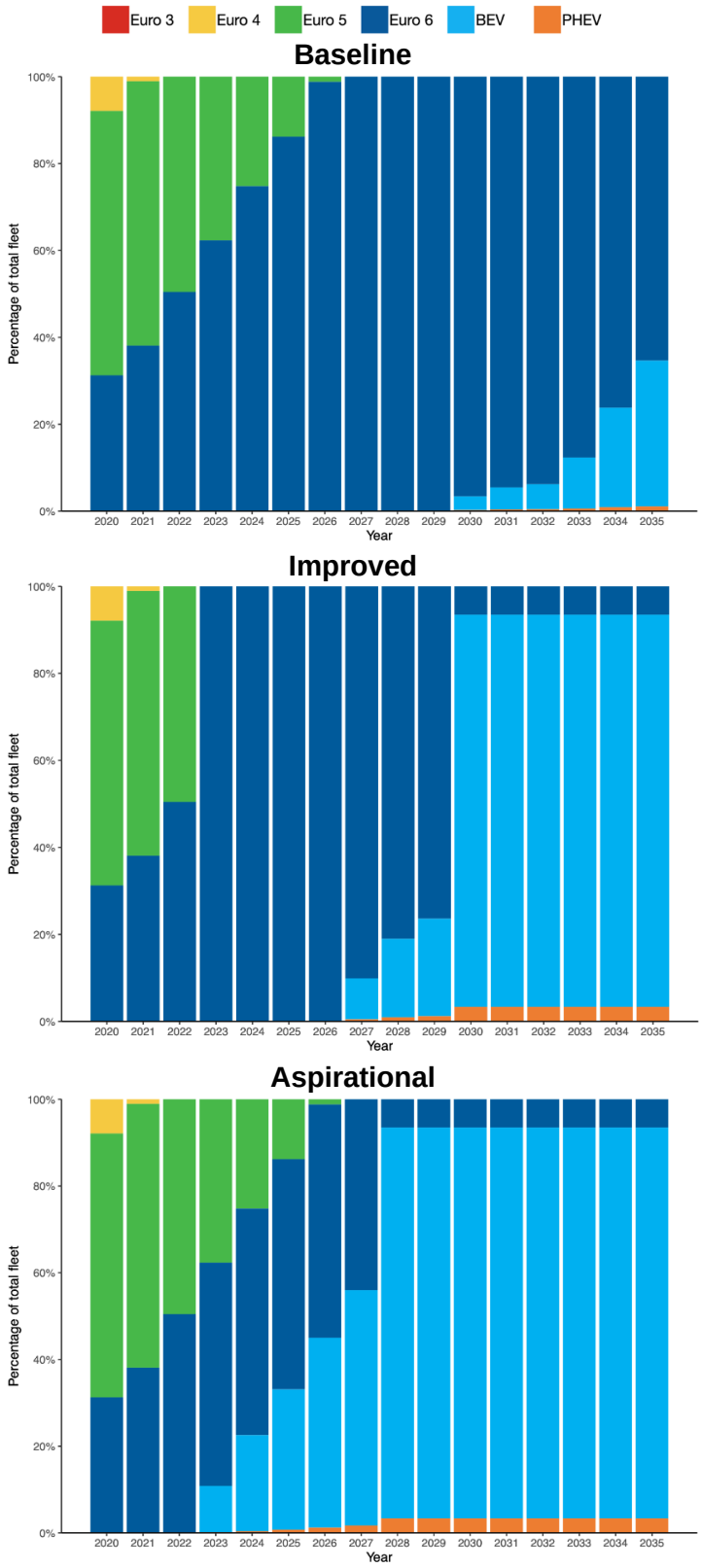


Figure 21 - Fleet Composition by Technology Type; Private Hire Vehicle Fleet

- **Baseline** – entire fleet is Euro 6 by 2027. 3,978 vehicles (36% of the fleet) are ULEVs by 2035.
- **Improved** – two steps changes to 100% Euro 6 in 2023 and 100% ULEVs in 2030.
    - BEVs are not currently operationally suitable for some medium MPVs which remain Euro 6.
- **Aspirational** – just under 50% of the fleet is ULEV by 2026 and 100% of the fleet is ULEV in 2028. In 2027, the fleet consists of 56% BEV, 2% PHEV, and 42% Euro 6.
    - Same ULEV fleet composition as improved scenario.

Figure 22 shows the WTW CO_2e emissions for private hire vehicles for each scenario. Horizontal dashed lines represent the emissions if all vehicles where the same stated technology. It should be noted that a full fleet of PHEVs increase the WTW CO_2e emissions. Each scenario follows a similar trajectory to the same scenario in the hackney carriage forecasts.

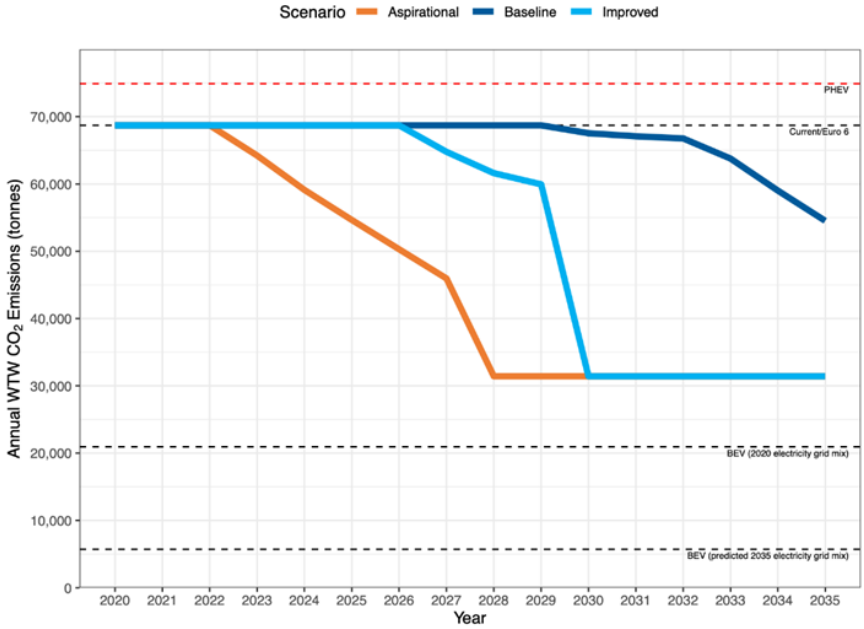


Figure 22 - Summary of WTW CO_2e Emissions; Private Hire Fleet

- **Baseline** – **3% reduction in cumulative WTW CO_2e emitted between 2020 and 2035**.
- **Improved** – 54% reduction in annual WTW CO_2e emissions from 2030 onwards (when all vehicles must be ULEVs). This results in a **22% reduction in cumulative WTW CO_2e emitted between 2020 and 2035**. Should suitable BEVs become available the reduction in annual WTW CO_2e emissions would increase to 69% and 92%, depending upon the percentage of BEVs and carbon intensity of grid electricity.
- **Aspirational** – reductions in annual WTW CO_2e emissions from 2023 onwards (when new vehicles must be ULEVs). **33% reduction in cumulative WTW CO_2e emitted between 2020 and 2035** – a 50% greater reduction than the improved scenario.

Figure 23 shows the NOx emissions forecast for the private hire vehicles for each scenario.

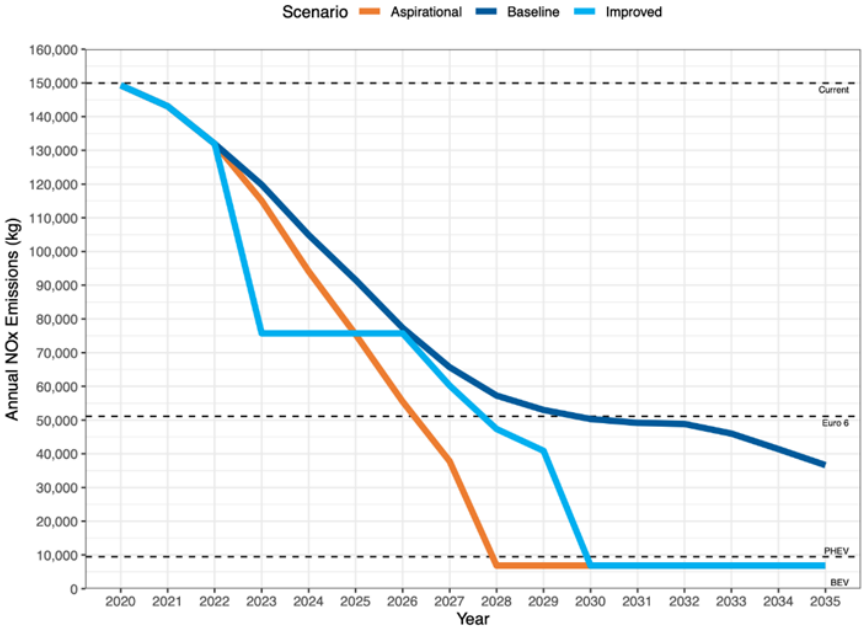


Figure 23 - Summary of NOx Emissions; Private Hire Fleet

- **Baseline** – 66% reduction in annual NOx emissions by 2030 (due to the introduction of Euro 6 vehicles). 76% reduction in NOx emissions by 2035.
- **Improved** – **50% reduction in annual NOx emissions in 2023**, some older Euro 6 vehicles retained on fleet (e.g. 2016 vehicles). 95% reduction in annual NOx emissions from 2030 onwards (when all vehicles must be ULEVs).
- **Aspirational** – 95% reduction in annual NOx emissions by 2028 (when all vehicles must be ULEVs). **Provides lowest levels of NOx emissions out of all three scenarios from 2025**.

Table 29 provides a summary of the total (cumulative) emissions savings in each scenario from 2020 to 2035 alongside the association social damage cost savings by emissions type. The red, amber, green scale denotes the overall contribution the social damage cost savings. Green values represent larger savings and red values represent smaller savings.

Table 29 - Summary of Emissions and Social Damage Cost Savings; Private Hire Fleet

Emission Type	Total Emissions Saving from 2020 to 2035 (% compared to baseline)		Social Damage Cost Saving (£)	
	Improved Scenario	Aspirational Scenario	Improved Scenario	Aspirational Scenario
WTW CO_2e	-20%	-31%	£10,589,000	£17,313,000
NOx	-28%	-32%	£3,810,000	£4,438,000
PM	-29%	-44%	£265,000	£409,000
Total	NA	NA	£14,664,000	£22,160,000

The aspirational scenario provides social damage cost savings of £22,160,000 (WTW CO_2e accounts for 78% of these savings) through reductions in cumulative WTW CO_2e, NOx and PM emissions of 31%, 32% and 44%, respectively.

Based on current costs, **an additional £92m of additional capital funding would be required** to transition the entire private hire vehicle fleet to ULEVs (compared to new Euro 6 vehicles). Additionally, **the aspirational scenario provides a total of £131m of running cost savings by 2035** compared to £86m in the improved scenario.

6.2.3 Summary of Licensing Scenarios

Table 30 shows a summary of the advantages and disadvantages of each licensing policy scenario in terms of emissions reduction potential, required ULEV availability and likely trade acceptance. A full impact assessment should be completed as part of any business case development activities.

Table 30 - Comparison of Licensing Scenarios

	Emissions Policy	Advantages	Disadvantages
Baseline	2023: EU6 (New) 2030: ULEV (New)	• Reduces air quality emissions in line with latest euro emissions standards. • No other advantages, should be considered as minimum requirement.	• No tangible improvement in greenhouse gas emissions until 2030. • ULEV uptake relies entirely on vehicle proprietor procurement decisions.
Improved	2023: EU6 (All) 2025: ULEV (New) 2030: ULEV (All)	• Largest immediate reduction in air quality emissions. • Suitable ULEVs are not required until 2025.	• No tangible improvement in greenhouse gas emissions until 2026 (private hire vehicles) and 2030 (hackney carriage vehicles). • Requires two large vehicle replacements, one in 2023 (Euro 6) and another in 2030 (ULEV).
Aspirational	2023: ULEV (New) 2028: ULEV (All)	• Largest cumulative saving in greenhouse gas and air quality emissions. • Clear messaging to the trade with only one regulated vehicle replacement required. • Vehicles are replaced on maximum vehicle age limits until 2028.	• Suitable ULEVs are required from 2023. • Improved scenario provides lower air quality emissions from 2023 to 2025 (private hire vehicles) and 2023 to 2027 (hackney carriage vehicles). • Potential for the introduction of new internal combustion engine vehicles before 2023.

The aspirational scenario is the only option that offers significant improvements in greenhouse gas and air quality pollutant emissions over the next vehicle replacement cycle.

Additionally, it provides clear messaging and certainty to the trade regarding expected emissions standards (ZEV or ULEV) whilst guaranteeing that replacement vehicles will have an appropriate lifecycle. Likewise, a focused package of ULEV measures can be implemented that provides incentives on a weighted scale for vehicle technologies that provide the largest emissions savings (e.g. those with the largest zero emissions range), thereby improving value for public money.

Strategy Recommendation: Submit draft vehicle emissions policy proposals to the Licensing Committee for approval, including all licensed vehicles to be zero emission or ultra-low emission by 2028 (subject to review) and newly licensed vehicles to be zero emission or ultra-low emission from 2023 (subject to vehicle suitability).

Publish draft proposals including timescales, expected standards, and details of any planned trade engagement or consultation.

6.3 Vehicle Age and Emissions Policy Best Practice

Figure 24 provides a summary of local authorities that are known to have introduced vehicle emissions-based licensing policies, with a particular focus on ULEVs (right columns) and consideration for Euro 6 based policies (left columns). Key dates have been overlaid for context. This information has been produced from desk-based research of publicly available policy and strategy documents during this review and previous projects undertaken by Cenex.

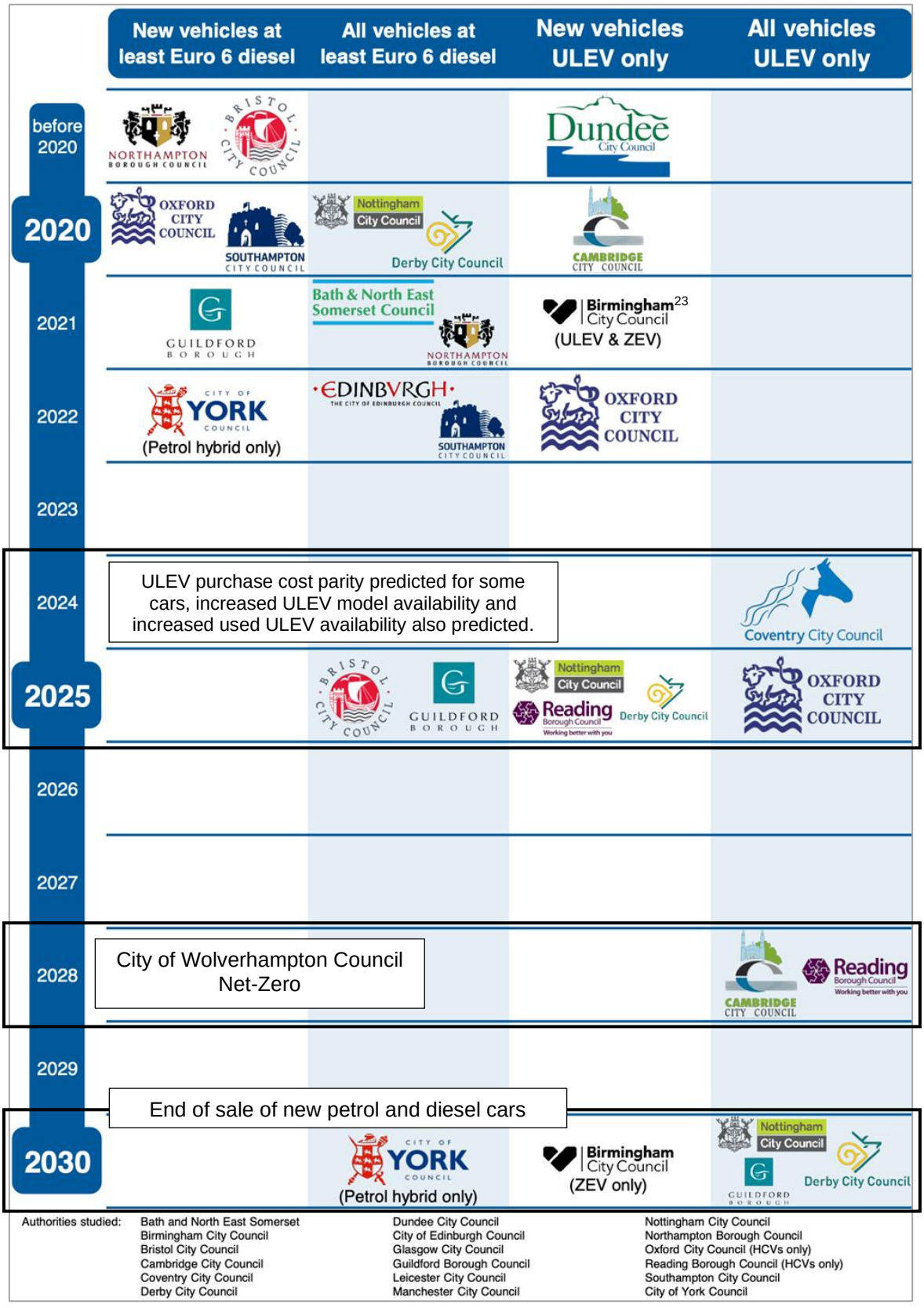


Figure 24 - Summary of Vehicle Emissions Policy Best Practice

It should be noted that most local authorities with ULEV based emissions policies have received external funding from either the Clean Air Fund (Department for Environment, Food & Rural Affairs) or Ultra-Low Emission Taxi Infrastructure Scheme (Office for Zero Emission Vehicles).

Based on vehicle emissions policies developed to date, there are four potential stages of introduction of minimum emissions standards. These are summarised as follows:

1. **New vehicles must be at least Euro 6 diesel (2020 to 2022)**

These local authorities require any vehicle that is being replaced by a newer vehicle to be at least Euro 6. City of York Council have a similar policy, but it is more restrictive as the minimum emissions standard is Euro 6 petrol hybrids only (e.g. no diesel vehicles). It should be noted that in some duty cycles, such as motorway driving, petrol hybrid vehicles can emit higher amounts of greenhouse gas emissions compared to equivalent diesel vehicles. **Most new Euro 6 vehicles are expected to remain on the fleet for a full ownership period**, as an example a Euro 6 vehicle licensed by Nottingham City Council in 2020 can remain on the fleet until 2030 at which point it must be replaced by an ULEV.

2. **All vehicles must be at least Euro 6 diesel (2020 to 2025)**

Many local authorities are requiring all vehicles to be Euro 6 diesel or better for licence renewals (e.g. all licensed vehicles). Some local authorities, such as Bristol City Council, are bringing about the same results but with a different mechanism. Instead, they have reduced age limits for lower emission standards and will therein remove all non-Euro 6 compliant vehicles from the fleet by 2025.

3. **New vehicles must be at least an ULEV (2020 to 2025)**

Seven local authorities require any vehicle that is being replaced by a newer vehicle to be an ULEV by 2025, renewal can occur on existing or reduced maximum age limits for non-ULEVs. For example, Cambridge City Council has a 9 year age limit for non-ULEVs compared to 12 years for ULEVs and 15 years for ZEVs. **Birmingham City Council has a tightening of the minimum emissions standard for new vehicles in 2030 when only ZEVs will be allowed**, effectively limiting new vehicles to BEV, FC REEV and FCEV[23].

Some local authorities such as **Bristol City Council and Coventry City Council have this policy for new entrants to the fleet only**. In other words, new vehicles that are not replacing an older vehicle must be ULEVs. This effectively caps the fleet emissions as new entrants will make a minimal additional contribution. It also allows currently licensed vehicles more time to change to ULEVs.

4. **All vehicles must be at least an ULEV (2024 to 2030)**

Seven local authorities will require all vehicles to be ULEVs for their licence to be renewed. Except for Oxford City Council and Reading Borough Council, **these policies refer to all licensed vehicles including both hackney carriage and private hire vehicles**.

[23] In 2020, following a report, Birmingham Licensing and Public Protection Committee agreed to defer the introduction of the ULEV requirement for all newly licensed Hackney Carriage and Private Hire vehicles from 1 January 2021 to 1 January 2026. The COVID-19 pandemic and a lack of suitable ULEVs were cited as reasons for the deferment.

6.4 Financial, Practical and Regulatory Incentive Measures

Cenex has previously undertaken trade engagement activities for several local authorities. Based on these studies, the main barriers to the adoption of ULEV taxi vehicles (amongst other smaller concerns) are as follows:

- High initial purchase cost (combined with difficulties accessing low interest finance)
- Real-world operating range and vehicle reliability (e.g. vehicle capabilities)
- Access to suitable electric vehicle charging infrastructure (both public and domestic)

Prior to the introduction of revised vehicle emissions policies, it is important that local authorities offer a coordinated package of incentive measures to accelerate the transition to ULEVs.

It is expected that **such incentive measures will be required until suitable ULEVs are available across all vehicle segments and purchase cost parity is achieved** for new vehicles, or there is a substantial used vehicle market. Several **market analysts forecast that BEV cars will achieve cost parity with new internal combustion engine vehicles by 2024**[24,25].

This subsection provides a high-level summary of the financial, practical and regulatory measures introduced by other local authorities to accelerate the transition to ULEVs in advance of introducing revised vehicle emissions policies.

This information has been gathered from publicly available licensing policy documents and strategy documents supplemented by interviews with other local authorities, interviews with WAV suppliers and previous experience from other projects[26].

A basic qualitative assessment has been undertaken to provide a priority rating based on the amount of effort (and resources) required by City of Wolverhampton Council and the potential impact on the uptake of ULEVs prior to the introduction of a revised vehicle emissions policy.

Table 31 shows the criteria that has been applied to categorise the priority of ULEV measures.

Table 31 – Indicative Priority for ULEV Measures

Measure Priority	Description
1. Quick wins	**Lower effort, higher impact** – priority measures that should be implemented as soon as practically possible. These measures should be targeted at potential early adopters and should be designed to encourage the uptake of vehicles that best meet the long-term objectives of the project (plug-in grant eligible ULEVs).
2. Major projects	**Higher effort, higher impact** – projects that could have some of the highest impacts but require significant resources and have longer implementation timescales. May only be possible to implement a limited number of such measures in parallel.
3. Small gains	**Lower effort, lower impact** – relatively easy to implement but only provide incremental gains. Consider beside existing measures or if there is spare resource or if a package of such measures results in a high impact (which would represent a quick win).
4. Least recommended	**Higher effort, lower impact** – least recommended in the short term

It is acknowledged that the relative effort and impact will vary significantly within these broad categories. **To date there is little or no precedent for the wide scale adoption of ULEV taxi vehicles, as such these measures and their effectiveness are relatively untested**. Additionally, implementation of a package of such measures requires dedicated resources both in terms of funding and labour.

[24] https://about.bnef.com/blog/battery-pack-prices-cited-below-100-kwh-for-the-first-time-in-2020-while-market-average-sits-at-137-kwh/
[25] https://www.theguardian.com/environment/2020/oct/21/electric-cars-as-cheap-to-manufacture-as-regular-models-by-2024
[26] https://www.cenex.co.uk/case-studies/cardiff-capital-region-ulev-taxi-strategy/

Table 32 shows a summary of the main financial, practical and regulatory measures available to local authorities to increase ULEV uptake assessed against the indicative priority criteria.

Table 32 - Summary of ULEV Measures and Action Priority Rating

Measure	Primary Intended Purpose	Priority
Financial Measures		
Free / Preferential Prices for Electricity	Reduced running costs, incentive to use chargepoints	1
Interest Free Loan Scheme	Reduced capital expenditure, more affordable finance	**2**
Non-repayable Grant Scheme	Reduced total cost of ownership	**2**
Free Parking	Reduced operational costs	3
Public Sector Transport Services	Increase likelihood of winning contracts for ULEVs	3
Practical Measures		
Trade Engagement Events	Forum for the trade to discuss the topic of ULEVs	1
ULEV Suitability Assessments	Enable trade to make informed procurement decisions	1
Electric Vehicle Charging Infrastructure	Enable charging for early and wide scale adoption	**2**
Support WAV Market Development	Increase availability of suitable ULEVs (WAVs)	**2**
ULEV Trial Scheme	Demonstrate whether ULEVs are fit for purpose	**2**
Support Used Vehicle Market	Increase availability of suitable used ULEVs	3
Regulatory Measures		
Review Suitability of Rear Entry WAVs	Increase availability of suitable ULEVs (WAVs)	**2**
Reduce Percentage of WAV Hackney Carriage Vehicles	Increase availability of suitable ULEVs	**2**
Bus Lane Access	Reduced journey times on major routes	3
Access Restrictions for non-ULEVs	Influence / control over local emissions standards	4
ULEV Only Taxi Ranks	Increase income by allowing access to prime locations	4

<u>Implementation Recommendation</u>: Engage with the trade to establish the required type and level of support required to transition to ULEVs under the aspirational licensing scenario.

Cenex are scheduled to deliver trade engagement activities on behalf of City of Wolverhampton Council in 2021. This includes an online trade survey and a trade engagement workshop that can be used as an initial scoping exercise for potential ULEV measures.

<u>Strategy Recommendation</u>: Assign a dedicated project manager responsible for the development, implementation and ongoing management of a three year 'Ultra-Low Emission Hackney Carriage and Private Hire Vehicle' project covering vehicle emissions policy, ULEV measures and infrastructure.

Develop a detailed project delivery plan and determine the specifics of the recommended strategy including, but not limited to, conditions that must be met prior to the introduction of new emissions standards, definition of required emissions standards and maximum vehicle age limits. Care should be taken to avoid the introduction of any licensing conditions that could directly or indirectly result in the introduction of an additional generation of internal combustion engine vehicles.

Establish SMART objectives (Specific Measurable Achievable Realistic Time-bound) for the overall project and individual measures.

Assign responsibility for annual reporting of hackney carriage and private hire fleet emissions. Determine key performance indicators for ULEV uptake and monitor progress during the project.

Ensure that there is a coordinated approach across the project. Examples could include providing benefits for recipients of multiple incentive scheme (such as priority applications for financial incentive scheme applicants that have participated in a ULEV trial scheme).

<u>Strategy Recommendation</u>: Develop a full business case to support external funding applications for ULEV measures that are identified as major projects.

Cenex has experience of developing business cases for ULEV hackney carriage and private hire vehicle measures using the Five Case Model provided by HM Treasury and the Welsh Government which includes the Strategic Case, Transport Case, Financial Case, Commercial Case and Management Case. City of Wolverhampton Council should ensure that any business case produced should include a quantitative assessment of capital costs, revenue costs, value for money and a robust review of procurement options and associated risks.

Major projects should focus on fleet wide adoption of ULEVs. It is suggested that these measures should be introduced the year before the introduction of an ULEV emissions policy (~2022) and should be made available for at least two years (longer if appropriate).

Interim measures (e.g. prior to the introduction an ULEV emissions policy) **should focus on increasing confidence in ULEVs and providing potential early adopters with the knowledge and tools required to make informed procurement decisions**. Many of the quick wins highlighted above fulfil these requirements and require relatively less funding. It is however worth noting that ULEV Trial Schemes provide the most direct experience of using ULEVs but are a major project.

6.4.1 Quick Wins – Lower Effort, Higher Impact

The following sub-sections include 'ULEV Measure Summary Tables' for quick wins (1), major projects (2) and lower impact (3, 4) measures, respectively. The following information is reported for each summary table – a brief description of each measure, an expanded description of the intended purpose, key implementation considerations / risks, recommendations, and notable examples.

Free / Preferential Rates for Electricity (Financial Measure)	
Description	Chargepoints are made available to registered hackney carriage and private hire vehicles to charge at a discounted rate (or even for free). This measure reduces the running cost of an electric vehicle and encourages drivers to charge during the day, thereby reducing the range limitations of the vehicle.
Considerations	• Lost income for the chargepoint providers must be covered. Previous research by Cenex in May 2020 showed that free BEV charging could save the driver around £1,500 a year. • An identification or reimbursement system for the drivers must be set up. This should be within the capability of most chargepoint providers. • Set expectations regarding the introduction of future tariffs.
Notable Examples	In 2019, Bromsgrove Council installed 13 rapid chargepoints under the Ultra-Low Emission Taxi Infrastructure Scheme and made them free to registered taxi drivers for the first year. The discount was then reduced to 75% for the next four years.

Trade Engagement Events (Practical Measure)	
Description	Programme of taxi trade engagement events for the trade to find out about the benefits of ULEVs and see or test drive relevant vehicles. Provides direct engagement and guidance to the trade by facilitating discussions with impartial industry experts, vehicle suppliers, chargepoint suppliers, other trade representatives and local authorities.
Considerations	• Events should be held at locations convenient to the trade and should be aligned with key regional milestones. • Events should be delivered in an informal manner with ample opportunities for discussion. Sessions should be specifically focused on ULEVs and avoid broader trade issues (e.g. illegal plying for hire, rank provision etc.)
Notable Examples	Cenex has direct experience of managing taxi trade engagement events for local authorities (Derby City Council, Nottingham City Council and Oxford City Council). An initial trade engagement workshop, to be delivered on behalf of City of Wolverhampton Council, is scheduled for 2021.

ULEV Suitability Assessments (Practical Measure)	
Description	Personalised ULEV suitability reports showing current vehicle usage patterns (based on vehicle telematics data) and advice on the real-world operating range, total cost of ownership and emissions of ULEVs under specific vehicle usage conditions. Allows early adopters to make well informed procurement decisions.
Considerations	• Can be challenging to recruit volunteers to have telematics devices fitted to vehicles so a targeted approach is required. • Can be used to add value to trade engagement events and ULEV vehicle trial schemes. Results of such activities such be disseminated to all licence holders and updated as new vehicle models become available.
Notable Examples	Derby City Council, Nottingham City Council, Oxford City Council, Southampton City Council. 15 personalised ULEV suitability reports and a public trade summary report will be delivered by Cenex, on behalf of City of Wolverhampton Council, in 2021.

6.4.2 Major Projects – Higher Effort, Higher Impact

Interest Free Loan Scheme (Financial Measure*)	
Description	Interest free loan covering some or all the purchase cost of an eligible ULEV.
Purpose	Reduces the amount of capital required by allowing the vehicle proprietor to spread the purchase cost over a period of years (typically four to six years).
Advantage (✓) Consideration (~) Disadvantage (✗)	✓ Direct incentive resulting in the introduction of a licensed ULEV taxi vehicle. ✓ Small reduction in interest payments and the total amount of finance payable (interest payments on a £30k, five-year loan = ~£2.3k at 3% interest). ✓ Improves access to affordable finance. ~ High risk if local authority managed, increased set up times if third party managed (~10-12 months) ~ External funding is required to cover revenue costs (interest, default, and administration costs) ✗ Does not reduce vehicle total cost ownership. ✗ Amount of funding required to cover default costs. A proportion of owners may be considered 'sub-prime' lenders which typically results in high interest rates. ✗ Significant administrative and management burden (eligibility, affordability and credit checks, loan agreements, enforcement etc.) ✗ Low uptake of ULEVs if offered alongside diesel and petrol vehicles. Conversion rate could be low due to administrative burden on trade.
Implementation Recommendation	• Seek financial advice and request quotes from potential suppliers to accurately quantify funding requirements for loan revenue costs. • Interest free loan scheme to be available for eligible ULEVs only.
Notable Examples	Bath and North East Somerset Council (£9k over five years), Energy Saving Trust / Transport Scotland (£35k over six years), Leeds City Council (£10k over four years)

Non-repayable Grant Scheme (Financial Measure*)	
Description	Non-repayable grant to cover the operating / transitional costs of upgrading to an eligible ULEV. Examples of eligible costs include vehicle licensing fees, insurance, servicing, rank fees, vehicle equipment and vehicle electricity costs.
Purpose	Slightly reduces the amount of capital required. Reduces total cost of ownership.
Advantage (✓) Consideration (~) Disadvantage (✗)	✓ Direct incentive resulting in the introduction of a licensed ULEV taxi vehicle. ✓ Provides an incentive for vehicles that are currently uneconomical such as those with low annual mileages, short ownership periods or are in challenging vehicle segments (e.g. REEV purpose-built hackney carriages). ✓ Easier to administer than interest free loans. ~ Additional measures required to ensure state aid compliance. ~ Grant payment mechanism – direct vs. indirect costs, direct payment to suppliers, cash payment to vehicle owners, evidence of running costs. ✗ Cannot be used to directly reduce the purchase cost of a plug-in grant eligible ULEV. To avoid additionality with the plug-in grant (and achieve state aid compliance) the value of the grant is typically limited to less than the equivalent plug-in grant or ~10% of the purchase cost of a new ULEV (£3,000 for cars, £7,500 for purpose-built hackney carriage vehicles). ✗ Low uptake of ULEVs if offered alongside diesel and petrol vehicles.
Implementation Recommendation	• Seek legal advice to ensure state aid compliance (running costs only, limit of funding for individuals, applicants required to sign a state aid declaration). • Non-repayable grant scheme to be available for eligible ULEVs only.
Notable Examples	Birmingham City Council, Leeds City Council (+ many others)

* Previous research, completed by Cenex in May 2020, shows the minimum cost of entry to the taxi trade is ~£9k (medium car) to ~£23k (WAV) for a three-year old, low mileage, Euro 6 diesel vehicle. This should be considered the baseline cost which new ULEVs are assessed against. On this basis a financial incentive of £8k to £30k would be required to cover the full cost premium of procuring a new plug-in grant eligible ULEV compared to a new and used Euro 6 diesel, respectively.

Electric Vehicle Charging Infrastructure (Practical Measure)	
Description	Provision of a dedicated taxi vehicle chargepoint network to enable drivers to charge their vehicles as and when required. This measure is considered critical to increasing the uptake of plug-in ULEVs.
Purpose	Provide suitable charging infrastructure to support the uptake of plug-in taxi vehicles for early and wide scale adoption. Suitable chargepoints must be readily available, easily accessible, appropriately located, affordable and future proofed.
Advantage (✓) Consideration (~) Disadvantage (×)	✓ Highly visible and practical measure which overcomes one of the largest barriers to the adoption of ULEVs (lack of suitable charging infrastructure). ✓ Free / reduced electricity prices (and funding for domestic chargepoints) have been used as eligible costs under non-repayable grant schemes. ~ Required number, type (rated power), and locations against time. ~ Asset ownership, business model / tariff and ongoing operations. ~ Access arrangements, booking system, how to prevent misuse. × Installation and grid upgrade costs are location specific and therefore susceptible to variation. × Revenue depends on vehicle uptake and chargepoint utilisation. × High amount of stakeholder management (Distribution Network Operator, chargepoint suppliers / installers, energy suppliers, landowners, internal) × Lack of off-street parking remains a potential barrier to adoption.
Implementation Recommendation	• Map existing infrastructure and hold trade workshops to discuss preferred locations and types of chargepoints. • Undertake vehicle data logging activity to map dwell times and locations compared to energy consumption (optional). • Develop vehicle and chargepoint technology roadmaps. • Determine proposed locations, numbers and power output of chargepoints to provide an effective network.
Notable Examples	The Ultra-Low Emission Taxi Infrastructure Scheme has awarded capital funding of £20.9m across 27 local authorities to support the procurement and installation of 557 ‘rapid’ and 228 ‘fast’ chargepoints. City of Wolverhampton Council was awarded £478k to install 20 rapid chargers and 4 fast chargers. Most local authorities listed in this report are recipients of this funding scheme.

Strategy Recommendation: Undertake a review of infrastructure requirements to confirm the capacity of the current chargepoint network to support potential early adopters and to develop a proposal for an expanded regional chargepoint network to support the wide scale adoption of ULEVs resulting from the aspirational licensing scenario (newly licensed vehicles = ULEV in 2023 and all licensed vehicles = ULEV in 2028).

Support WAV Market Development (Practical Measure)	
Description	Procurement of an individual / small fleet of the latest ULEV van derived passenger vehicles to be used as proof of concept for the conversion to WAV hackney carriage vehicles.
Purpose	Grow the market for ULEV wheelchair accessible hackney carriage vehicles by supporting the development and introduction of new vehicle models. Increase the number of potential options from the two vehicles currently available (Dynamo and LEVC).
Advantage (✓) Consideration (~) Disadvantage (×)	✓ Accelerates the development process in advance of market demand which should highlight any challenges (e.g. battery location, floor / roof changes) and associated additional costs for converting ULEV van-derived passenger vehicles into WAVs. ✓ Proactively demonstrates the latest potential ULEVs which should offer improved suitability as real-world range increases (latest generation of vehicles have official ranges of 140+ miles), charging power increases (e.g. 11 kW AC, 100+ kW DC) and purchase cost decreases. ✓ Majority of WAVs are currently medium van derived vehicles such as the Mercedes-Benz Vito and Vauxhall Vivaro. Type approved ULEV versions of such vehicles will likely be popular with the trade. ✓ Opportunity for City of Wolverhampton Council to become an exemplar for providing additional measures and options to the local hackney carriage trade. Increased likelihood of achieving a ULEV hackney carriage fleet on similar timescales to the private hire vehicle fleet. ~ Potential alternative use of funds that are typically allocated to ULEV trial schemes. × Vehicles may not meet current eligibility criteria for plug-in taxi grant due to requirement to meet London conditions of fitness (which may be more stringent than required). × Potential that conversions could be unsuccessful or unsuitable for use under current licensing conditions.
Implementation Recommendation	• Document minimum technical requirements and vehicle specifications. Ensure that these requirements allow for different technology options, different vehicle types, and are therefore not overly prescriptive. • Engage with potential suppliers either directly, or through an exploratory innovation procurement tender process. Focus should be on the supplier's ability to meet the technical requirements rather than the capital cost. • If implemented, gain feedback on vehicle suitability from the hackney carriage trade and other local authorities to demonstrate whether there is adequate market demand for such vehicles.
Notable Examples	No known precedent

Vauxhall Vivaro-e Life (50 kWh, 9-seater) and Mercedes-Benz eVito Tourer (100 kWh, 9-seater)

ULEV Trial Scheme (Practical Measure)	
Description	Procurement of a fleet of ULEVs to be used for short term trials (preferably part or fully funded or, alternatively, on a rental basis at market rates).
Purpose	Provide an opportunity for the trade to test the capabilities of ULEVs under their standard real-world working conditions. Increase the number of drivers that have experience of using ULEVs.
Advantage (✓) Consideration (~) Disadvantage (×)	✓ Demonstrates day to day operationally suitability of ULEVs including electric only range, ease of recharging / use and short-term reliability. ✓ Increased visibility of operational ULEVs (if branded appropriately) ✓ Vehicles could potentially be resold into the trade to reduce the amount of capital required for early adopters and provide guaranteed uptake of a small number of ULEVs. ✓ Option for long term rental scheme for those unable to commit to the trade. ~ Procurement options – local authority or third party managed, fully funded trials, or rented at market rates. ~ Trial management – vehicle storage, valeting, handover process, hire and reward insurance, resolution of issues, trade relationship management. ~ Provision of adequate electric vehicle charging infrastructure during trial. × Indirect incentive – no requirement to procure an ULEV, value for money relies on a high conversion rate from trial participant to ULEV owner. × High vehicle utilisation required to maximise value for public money (40% to 75% typical). × Vehicle, and potentially operator, licensing requirements for trial vehicles.
Implementation Recommendation	• Include vehicle telematics to either monitor the success of the trial or to provide participants with personalised ULEV suitability advice. • Establish key performance indicators (target number of participants and utilisation, target conversion rate – typically 20% to 30%) and minimum number of vehicles required (typically less than 10 participants per vehicle depending on trial length).
Notable Examples	Birmingham City Council (third party managed rental scheme), Coventry City Council, Leeds City Council (local authority managed trial scheme), Nottingham City Council (third party managed trial scheme)

Nottingham City Council – Electric Taxi Trial Scheme and Leeds City Council – Electric Private Hire Vehicle Trial Scheme

Review Suitability of Rear Entry WAVs (Regulatory Measure)	
Description	Review of the suitability of rear entry WAVs to be licensed as hackney carriage vehicles.
Purpose	Improve the availability of suitable ULEVs by allowing vehicle proprietors to replace medium van derived WAVs with small van derived WAVs (or similar rear entry WAVs) on the condition that it is replaced by an ULEV.
Advantage (✓) Consideration (~) Disadvantage (×)	✓ Improves the availability of suitable ULEVs and reduces hackney carriage fleet emissions by using smaller more efficient vehicles. ✓ Rear entry WAVs are significantly cheaper to purchase than side entry WAVs (~£15-20k less). ~ Ease of use (ramp angle, securing the passenger, wheelchair types). ~ Lack of a partitioned driver compartment. × Potential safety concerns during pick up and drop off, particularly at taxi ranks and around kerbs, and in the event of an accident whilst driving. Vehicles are available that meet European Community Whole Vehicle Type Approval. × Vehicles may not meet current eligibility criteria for plug-in taxi grant due to requirement to meet London conditions of fitness (which may be more stringent than required). × Few known examples of ULEV rear entry WAV hackney carriage vehicles[27].
Implementation Recommendation	• Consult with the hackney carriage trade, customers (including wheelchair users), support groups, WAV converter trade associations and other local authorities to understand the feasibility of using rear entry WAVs within the hackney carriage vehicle fleet. Views should be sought from both sides of the discussion including the City of Wolverhampton hackney carriage trade and another local authority that currently license rear entry WAVs. Focus should be whether vehicles are safe and fit for purpose rather than the cost and emissions benefits. • Investigate the feasibility of providing a limited number of vehicle licences for the purposes of trialling rear entry WAVs in Wolverhampton. • If implemented, investigate the feasibility of providing dedicated space at or near the front of taxi ranks for WAVs to pick up wheelchair users.
Notable Examples	Brighton and Hove City Council (preferred type with a minimum target of 60%), Cardiff County Council (>50% of WAV hackney carriage vehicles). Rear Entry WAVs are licensed by City of Wolverhampton Council as private hire vehicles. Similar vehicles are also used by other organisations.

Rear Entry WAV Hackney Carriage Vehicle (Dundee, Supplied by Vic Young)

[27] https://www.vicyoung.co.uk/news/switching-my-taxi-to-electric-i-wish-id-done-it-years-ago/

Reduce Percentage of WAV Hackney Carriage Vehicles (Regulatory Measure)	
Description	Reduction of the total percentage of WAVs within the hackney carriage vehicle fleet.
Purpose	Improve availability of suitable ULEVs by allowing vehicle proprietors to replace a WAV with a standard passenger vehicle on the condition that it is replaced by an ULEV.
Advantage (✓) Consideration (~) Disadvantage (×)	✓ Improves the availability of suitable ULEVs and reduces hackney carriage fleet emissions by using smaller more efficient vehicles. ~ Number of WAVs must cover the local demand and wheelchair users should not have to wait disproportionately longer for vehicles. ~ A range of vehicle types are required to meet the needs of all customers, including other disabled people that may not be wheelchair users. × Potential for under provision of WAVs.
Implementation Recommendation	• Consult with the hackney carriage trade, customers including wheelchair users and support groups to understand the feasibility of reducing the number of WAVs within the hackney carriage vehicle fleet. • Ensure that the results of unmet demand surveys are reviewed with consideration for hackney carriage fleet emissions. • If implemented, investigate the feasibility of providing dedicated space at or near the front of taxi ranks for WAVs to pick up wheelchair users.
Notable Examples	Cambridge City Council (65% to 50%, 213 to 163 WAVs)

Strategy Recommendation: Undertake an impartial review of all recommended WAV related measures then publish a list of actions to increase the availability of suitable wheelchair accessible ULEVs by 2023.

Review to cover the following measures: 'Support WAV Market Development', 'Review Suitability of Rear Entry WAVs' and 'Reduce Percentage of WAV Hackney Carriage Vehicles'.

Review to be based on latest available evidence and modern operating / booking practices. It is suggested that a long list of measures should be reviewed at some level, including those that have previously been assessed and those that may lead to significant operational changes (such as redesigned ranks or new booking methods). All measures to be assessed against their impact on fleet emissions, safety and market needs.

It is suggested that City of Wolverhampton Council should aim to demonstrate all possible variants of wheelchair accessible ULEVs to the taxi trade before implementing the preferred solution.

6.4.3 Lower Impact Measures

Free Parking for ULEVs (Financial Measure)	
Description	Allow ULEV drivers to park for free. Whilst this would be an incentive to switch to a ULEV, the scheme is likely to be low impact due to the low levels of savings it offers taxi drivers.
Considerations	• Identification of ULEVs could be challenging. Green flashes on ULEV numberplates introduced in autumn 2020 should alleviate this issue. • Unlikely to be a significant financial incentive, merely supplementary.
Notable Examples	Dundee City Council has made the use of all council owned multistorey carparks free to use for BEVs. The carpark barriers are controlled by an ANPR system that can identify registered BEVs.

Public Sector Transport Services (Financial Measure)	
Description	Include criteria in public sector contract tenders to make them more favourable to operators with fleets of ULEVs. Operators would be incentivised to obtain ULEVs if it would increase the likelihood of winning a contract.
Considerations	• Unlikely to be a significant financial incentive for most vehicle proprietors.
Notable Examples	Unknown.

Support Used Vehicle Market (Practical Measure)	
Description	Increase the availability of suitable used ULEVs by engaging with large fleet operators and leasing companies currently procuring new ULEVs.
Implementation Recommendation	• Investigate options for securing a supply of used ULEVs in the future, local authority owned vehicles may provide some opportunities at the end of their planned ownership periods. • Investigate options for retaining ULEVs within the hackney carriage and private hire vehicle fleets. • **Relax requirement for hackney carriage vehicles to be brand new at first licensing.**
Notable Examples	N/A

Bus Lane Access (Regulatory Measure)	
Description	Allow ULEVs to use bus lanes to reduce journey times.
Considerations	• Unlikely to have a major impact on a driver's decision to buy a ULEV, will merely be a supplementary bonus. • Many ULEVs using the bus lane could cause congestion and slow buses down. Some taxi vehicles are already permitted to use bus lanes.
Notable Examples	Nottingham City Council has allowed both buses and ULEVs to use the bus lane on a major A-road into the city. Non-compliant vehicles driving in the lane will be issued with a Penalty Charge Notice. Additionally, Bedford Borough Council has made an Experimental Traffic Order to allow ULEVs in bus lanes, however, taxi vehicles are already allowed so the measure will not increase the uptake of ULEVs significantly.

Access Restrictions for non-ULEVs (Regulatory Measure)	
Description	Restrict access to certain areas of the city to ULEVs only. This would allow the council to target air quality emissions reduction and would incentivise the upgrade to ULEVs as the restricted locations are lucrative to the trade.
Considerations	• Provides a level of control over the emissions standards of 'out of town' private hire vehicles. Can be implemented using a charging clean air zone or an operating permit system. • Without sufficient uptake of ULEVs this measure could lead to unmet demand in the city centre. Negatively impacts those who are unable to transition to an ULEV. • Alternatively, a large uptake of ULEV taxi vehicles due to licensing changes removes the need for this measure.
Notable Examples	Hackney Borough Council has launched two zones that will be restricted to ULEVs during peak hours (weekdays, 7-10am and 4-7pm) however they are not main roads. In the future, Cambridge City Council will be investigating the feasibility of restricting city centre access to ULEVs only in 2029.

ULEV Only Taxi Ranks (Regulatory Measure)	
Description	Restrict taxi ranks in prime locations to ULEVs only. This would provide a financial incentive to hackney carriage drivers to upgrade to an ULEV.
Considerations	• This measure would require a high level of enforcement to ensure that only ULEVs are entering the taxi rank. A high level of engagement with the trade is also required. • Negatively impacts those who are unable to transition to an ULEV and risks fragmenting the trade.
Notable Examples	Derby City Council are undertaking a review of existing ranks to prioritise low emission vehicles. Permitting ULEV only taxi ranks will be considered during this process, but they have not committed to it.

6.5 Examples of Coordinated Vehicle Emissions Policy and Measures

Table 33 shows notable examples of local authorities that have implemented revised vehicle emissions policies supported by a package of measures aimed at increasing the uptake of ULEVs. It is worth reiterating that the earliest date for the wide scale adoption of ULEVs is 2024.

Table 33 - Examples of Coordinated Vehicle Emissions Policy and Measures

Local Authority (Top Level Approach)	Proposed Policy Changes and Incentives (*access to Clean Air Fund, **ULEV Taxi Infrastructure Scheme)
Coventry City Council (Early phased ULEV adoption*,**)	• Phased emission-based condition for the licensing of hackney carriage and private hire vehicles. • 2019 – New vehicles must meet Euro 6 . • 2020 – New vehicles must be a ULEV or ZEV. • **2024 – All licensed vehicles must be a ULEV or ZEV.** • Go Electric Taxi Scheme (two-week test drive of LEVC TX, £2,500 financial incentives for first 60 drivers). Funded by the Office of Low Emission Vehicles, the Clean Air Fund and the project partners, vehicles managed by LEVC.
CAMBRIDGE CITY COUNCIL (Early phased ULEV adoption,**)	• Revised policy agreed in April 2018. • Since 1 April 2020 – New saloon vehicles must be an ULEV or ZEV. • **2028 – All licensed saloon vehicles must be an ULEV or ZEV.** • **2028 – All licensed WAVs must be an ULEV or ZEV (to be reviewed in 2026).** • Reduction of total % of WAV hackney carriages to 50% to encourage the uptake of ULEVs. • Licence fee exemption for ZEVs for up to 5 years, 50% discount for ULEVs for up to 5 years. • 9 year age limit for non-ULEVs, 12 year age limit for ULEVs, 15 year age limit for ZEVs. • 2029 – To restrict city centre access to ULEV or ZEV licensed vehicles only.
Nottingham City Council (Go Ultra Low City*,**) Derby City Council (Phased ULEV introduction)	• Clean Air Zone (CAZ) compliant fleet followed by phased ULEZ adoption. • 2020 – All hackney carriage vehicles must be at least Euro 6. • 2025 – New vehicles must be an ULEV. • **2030 – All licensed vehicles must be an ULEV.** • Nottingham – LEVC TX 'try before you buy scheme', free rental for 30 days. Council owned vehicles acquired through the Early Measures Fund. • Nottingham – Council run electric vehicle service centre (Nottingham Electric Vehicle Services) that caters for a range of vehicles including taxis. • Derby – Designation of taxi ranks as ULEV only.
Birmingham City Council (Charging CAZ*,**, Early phased ULEV adoption)	• Revised policy agreed in April 2019. • 2021 - £8 charge per day for hackney carriage and private hire vehicles that do not meet Euro 4 petrol or Euro 6 diesel standards. • 2020 – maximum age limit of 15 years for hackney carriage vehicles and 12 years for private hire vehicles. • 2021 – New vehicles must be an ULEV or ZEV. • **2030 – New vehicles must be an ZEV**, to be reviewed in 2025. • DEFRA funding – £2.75m for the council to buy a fleet of electric taxis to be rented by drivers on a long term or 'try before you buy' basis, £5,000 financial incentive for up to 1,000 hackney carriage vehicles, up to £2,500 towards the running costs of ULEV private hire vehicles.

7 Conclusions

The City of Wolverhampton Council target of achieving a zero-tailpipe emission or ultra-low emission hackney carriage and private hire vehicle fleet by 2028 is achievable but very challenging with immediate progress requiring a coordinated approach to licensing policy, incentive measures, and chargepoint infrastructure delivered by a dedicated, appropriately funded, programme of work.

Adopting a highly aspirational licensing policy under which all licensed vehicles must be zero emission or ultra-low emission by 2028 and newly licensed vehicles must meet the same standards from 2023 at the earliest (subject to the availability of suitable vehicles) would require the introduction of 1,500 ultra-low emission vehicles each year between 2023 and 2027 followed by 4,700 vehicles in 2028. Between 2020 and 2035, this would reduce cumulative greenhouse gas emissions by 31% and cumulative air quality pollutant emissions by 35%. From 2028 annual greenhouse gas and air quality pollutant emissions would be reduced by at least 54% and 95%, respectively. This would also provide running cost savings of £119m and social damage cost savings of £22.5m.

To support such a policy, direct incentives should only be provided for the introduction of zero emission and ultra-low emission vehicles which meet the latest plug-in grant emissions eligibility criteria[28] (instead of diesel, petrol and hybrid vehicles with improved Euro emission standards). This ensures an earlier transition to ultra-low emission vehicles and crucially reduces both greenhouse gas and air quality pollutant emissions. Any new diesel, petrol or hybrid vehicles introduced will delay significant greenhouse gas emissions reductions by an entire vehicle life cycle.

Interim measures such as trade engagement events, ride and drive opportunities, personalised suitability advice, and increasing the availability of suitable wheelchair accessible vehicles should aim to increase the awareness, knowledge and experience of using ultra-low emission vehicles amongst potential early adopters. At the point of introduction of ultra-low emission as the minimum emissions standard, a targeted package of measures is also required including financial incentives, additional electric vehicle charging infrastructure and ultra-low emission vehicle trial schemes.

Supporting Justification

- Ultra-low emission vehicles are available in key vehicle segments with at least 50 models available in 2020. The number of ultra-low emission vehicle models is expected to increase by 89% before 2025 at which point cost parity with new petrol / diesel vehicles is expected.
- 64% of the combined fleet already meets the suitability criteria to be replaced by a battery electric vehicle, with medium and large cars representing the most immediate opportunities.
    - Battery electric vehicles have real-world electric only ranges of 110-196 miles[29]. 89% of the combined fleet can complete their average daily mileage on one charge only.
    - Except for executive cars, battery electric vehicles provide total cost of ownership savings of £3,000 to £22,000 compared to buying a brand-new Euro 6 vehicle.
    - Battery electric vehicles produce zero tailpipe emissions and provide a 60-75% reduction in fuel lifecycle greenhouse gas emissions.
- The recommended strategy provides clear messaging and certainty to the trade regarding expected minimum emissions standards and replacement vehicle ownership periods. Likewise, a focused package of ultra-low emission vehicle measures can be implemented that provides incentives for vehicle technologies with the largest zero emissions range, thereby improving value for public money.
- Cenex acknowledge that the proposed dates for the aspirational scenario are highly ambitious. These timescales allow for negotiation with the trade and are aligned with other local authorities aiming to have ultra-low emission hackney carriage and private hire fleets by 2030 including Coventry (2024), Cambridge and South Cambridgeshire (2028), and Derby and Nottingham (2030). It should however be noted that City of Wolverhampton Council have far more private hire vehicles (>11,000) and have not yet developed a new licensing policy.

[28] Currently defined as 'CO_2 emissions of less than 50 g/km and can travel at least 70 miles without any emissions at all'.
[29] Based on standard battery capacities, a large car with a 75 kWh battery has an estimated real-world electric range of 267 miles.

Key Risks (shown in descending order of likely risk to implementation)

- **Provision of adequate funding to offer short term incentive measures** to increase confidence in ultra-low emission vehicles and to overcome the increased purchase cost.
  - Recommendation: Develop a full business case to support external funding applications.
- **Limited availability of suitable wheelchair accessible vehicles** (and to a lesser extent 7-seater vehicles and executive cars).
  - There are currently only two models available, the Dynamo Nissan e-NV200 (40 kWh battery electric vehicle) and LEVC TX (31 kWh range extended electric vehicle).
  - Due to a relatively high average daily mileage (109 miles), only 38% of hackney carriage vehicles are currently suitable for replacement by a battery electric vehicle. On average, range extended electric hackney carriage vehicles increase total cost of ownership by £5,000 and reduce greenhouse gas emissions by 37% (compared to a 75% reduction for battery electric vehicles). Currently, both technologies would be heavily reliant on the availability of DC rapid chargepoints for 'top-up' charging during shifts.
  - Recommendation: Support the development of a demonstration fleet of new to market ultra-low emission wheelchair accessible hackney carriage vehicles. Recommended demonstration fleet to include side entry and rear entry wheelchair accessible vehicles based on the latest generation of small and medium van derived passenger vehicles.
  - Recommendation: Ensure that the introduction of ultra-low emission vehicles is conditional on the availability of suitable vehicles across all essential services.
- **Provision of adequate electric vehicle charging infrastructure** to support the wider scale adoption of plug-in ultra-low emission vehicles.
  - The private hire vehicle fleet operates nationally, this may make provision of adequate infrastructure more challenging.
  - Recommendation: Undertake a review of infrastructure requirements to develop a proposal for a regional chargepoint network to support the aspirational licensing policy.
- **Plug-in hybrid electric vehicles are not well suited to City of Wolverhampton Council private hire vehicle operations** but are currently classified as ultra-low emission vehicles.
  - Plug-in hybrid electric vehicles increase total cost of ownership for all vehicle types, additionally plug-in hybrid electric vehicles are no longer eligible for the plug-in grant.
  - If charged once per day, plug-in hybrid electric vehicles increase greenhouse gas emissions for 38% of executive cars and 73% of medium cars. Most plug-in hybrid electric vehicles have an electric only range of 20-30 miles and do not have DC rapid charging capabilities.
  - Recommendation: Do not provide additional incentives (regulatory, financial or otherwise) for current plug-in hybrid electric vehicles or Euro 6 diesel, petrol or hybrid vehicles.
- **The number of City of Wolverhampton Council licensed private hire vehicles has increased from around 650 vehicles in 2013 to over 11,000 vehicles in 2020**. **Only 10% of these vehicles are based in Wolverhampton postcode districts**. Further measures are required to minimise the impact of any future increases in vehicle numbers on emissions and to ensure that incentives are prioritised for vehicles operating locally or in the West Midlands.
  - Recommendation: Introduce ultra-low emission vehicles as the minimum emission standard for new private hire vehicle licence applicants as soon as possible and establish appropriate targets for the number of ultra-low emission vehicles to be licensed by large private hire vehicle operators.
  - Recommendation: Investigate the feasibility of aligning ultra-low low emission vehicle licence policies and incentive measures across the West Midlands. Establish eligibility criteria for preferred incentive measures.

8 Recommended Ultra-Low Emission Hackney Carriage and Private Hire Vehicle Strategy

Stage 1 (2021)	Gain political support for draft ultra-low emission vehicle policy
Submit draft vehicle emissions policy proposals to the Licensing Committee for approval.	
All licensed vehicles to be zero emission or ultra-low emission by 2028 (subject to review).	
New vehicles to be zero emission or ultra-low emission from 2023 (subject to vehicle suitability).	
Maximum vehicle age limits to be reviewed for diesel, petrol and hybrid vehicles.	
Publish draft proposals including timescales, expected standards, and trade engagement plans.	

Stage 2a (2021)	Review infrastructure and wheelchair accessible vehicle measures
Review infrastructure requirements to support the forecast uptake of plug-in vehicles.	
Undertake a feasibility study for the procurement of a battery electric, 9-seater, passenger van to be converted to a wheelchair accessible hackney carriage vehicle.	
Review the suitability of rear entry wheelchair accessible vehicles as hackney carriage vehicles.	
Publish a list of actions to increase the availability of suitable wheelchair accessible vehicles.	

Stage 2b (2021-2022)	Introduce interim measures to support potential early adopters
Identify and engage with potential early adopters.	
Increase awareness, knowledge and experience of using ultra-low emission vehicles: • Publish a provisional list of approved vehicles with revised vehicle conditions of licensing to maximise ultra-low emission vehicle availability. • Facilitate trade engagement events with ride and drive opportunities. • Provide personalised advice and suitability assessments. • Develop pilot scheme for an ultra-low emission vehicle trial scheme.	
Engage with the trade to establish the type and level of financial support required. Implement a non-repayable grant scheme covering direct licensing costs for select early adopters.	

Stage 3 (2021-2023)	Develop then approve final proposals and targeted measures
Assign a dedicated programme manager responsible for the delivery of multiyear projects covering vehicle licensing policy, ultra-low emission vehicle measures and infrastructure.	
Determine objectives and key performance indicators to be monitored during the programme.	
Determine the specifics of the recommended strategy including, but not limited to, the following: • Definition of an ultra-low emission vehicle e.g. 'CO_2 emissions of less than 50 g/km and can travel at least 70 miles without any emissions at all'. • Maximum vehicle age limits for different emissions standards. • Conditions on the availability of suitable ultra-low emission vehicles. • Emissions policy introduction dates.	
Develop a full business case to support external funding applications for measures that are major projects such as an interest free loan scheme, a non-repayable grant scheme, electric vehicle charging infrastructure, and an ultra-low emission vehicle trial scheme.	
Undertake a public consultation regarding final proposals and measures.	

Stage 4 (2023-2025)	Implement final ultra-low emission vehicle policy and measures
Undertake a final review of ultra-low emission vehicle suitability.	
Launch final package of measures six months prior to the new licensing policy, measures to be reviewed annually and made available for at least two years.	
Implement ultra-low emission vehicle policy for newly licensed vehicles.	

Addendum – Trade Engagement and Promotion

To be completed from May 2021, pending appropriate easing of UK Government Coronavirus (COVID-19) restrictions relating to gatherings.

Appendix A – Detailed Methodology

Annual Mileage Calculation

The annual mileage for each vehicle was taken from MOT records. The calculation took the latest two MOT odometer readings and dates then extrapolated the difference in mileage to a full year. Four criteria were applied to use this annual mileage in the subsequent analysis:

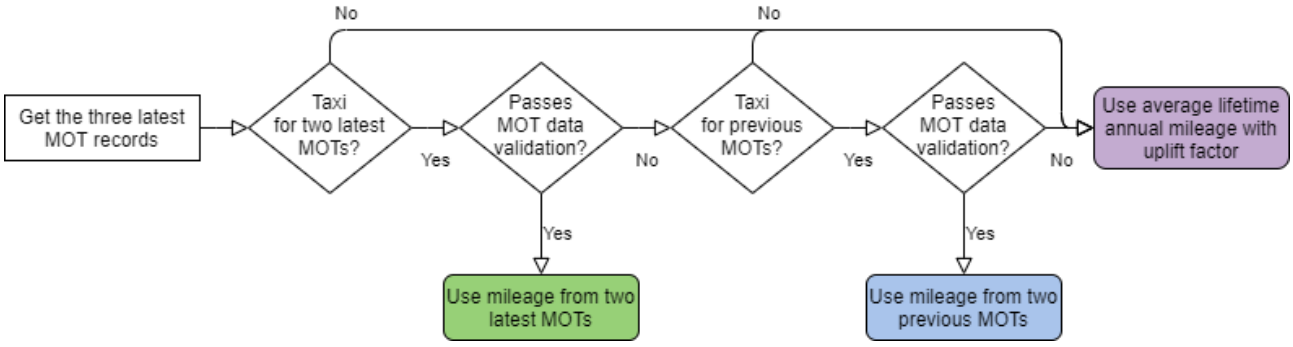
- **The MOTs had to be greater than 3 months apart.** If the MOTs are too close together then the extrapolation to an annual mileage is unreasonable.
- **The MOTs had to be less than 13 months apart.** If the MOTs are too far apart then again, the extrapolation to an annual mileage is unreasonable.
- **The last MOT had to occur before the start of the first COVID-19 lockdown.** The annual mileages are significantly lower if they include the period after 23 March 2020.
- **The annual mileage had to be less than 150,000 miles.** Some vehicles may return unrealistically large annual mileages, leading to potential outliers. Therefore, a sufficiently high limit was used to remove the erroneous mileages.

For vehicles that failed one of these tests, the two previous MOT records were then used so long as the vehicle was a licensed vehicle for both MOTs. The four tests were applied again.

For any vehicle that failed the tests for both the latest and the previous MOTs, an average annual mileage over the vehicle's whole life was calculated from acceptable MOT records. Many of the private hire vehicles will have been bought second-hand and they will therefore have a lower lifetime annual mileage than the annual mileage from when they are taxi vehicles. To remedy this, an "uplift factor" was introduced to increase the lifetime annual mileages to an equivalent tax vehicle annual mileage. The uplift factor was calculated as follows:

$$Uplift\ factor = \frac{Median\ annual\ mileage\ of\ known\ taxi\ vehicles}{Median\ lifetime\ annual\ mileage} = 1.23$$

A further 128 vehicles were excluded during this process as they returned no annual mileages from the MOT database. The figure below shows the mileage method as a flow diagram.



Annual Mileage Calculation Method

Real-World Fuel Economy

The table below shows the estimated real-world fuel economy for each vehicle segment based on independent real-world testing of petrol, diesel and hybrid vehicles.

Estimated Fuel Economy

	Powertrain	Real-World Fuel Economy (mpg)
Small Car	Petrol	39.1
	Diesel	49.6
	Hybrid	58.0
Medium Car	Petrol	39.4
	Diesel	50.2
	Hybrid	58.4
Large Car	Petrol	34.2
	Diesel	46.4
	Hybrid	50.5
Executive Car	Petrol	31.2
	Diesel	44.6
Medium MPV	Petrol	34.4
	Diesel	46.3
	Hybrid	51.0
Midsized SUV	Petrol	28.3
	Diesel	40.2
Small Van	Diesel	43.6
Medium Van	Diesel	35.9
Large Van	Diesel	28.9

Appendix B – Additional Tables and Charts

Rural-Urban Classification

The table below shows Rural-Urban Classification of the proprietor postcodes. The top three Local Authorities which the postcode district lies in have been shown.

Rural-Urban Classification by Local Authority District and Number of Vehicles

Rural-Urban Classification (most urban to least)	Local Authority District (Top Three)	Number of vehicles
London		**246**
	Tower Hamlets	106
	Waltham Forest	36
	Newham	12
Urban with Major Conurbation		**7,564**
	Birmingham	3,698
	Wolverhampton	1,058
	Manchester	680
Urban with Minor Conurbation		**474**
	Nottingham	355
	Gedling	47
	Broxtowe	25
Urban with City and Town		**2,331**
	Coventry	703
	Leicester	505
	Derby	330
Urban with Significant Rural		**340**
	Staffordshire	159
	Redcar and Cleveland	65
	Cheshire East	44
Largely Rural		**87**
	Shropshire	67
	Newark and Sherwood	7
	Bassetlaw	3
Mainly Rural		**47**
	North Warwickshire	36
	Stratford-on-Avon	3
	Wychavon	2
Total		**11,089**

Detailed Vehicle Emissions Tables

The tables below show a detailed emissions breakdown of the Wolverhampton fleet. The first table shows the Tank-to-Wheel CO_2e emissions of the different vehicle segments. The medium vans are the largest polluters on a per vehicle basis and the medium cars are the largest contributor to the total fleet emissions as they are the most common vehicle segment.

TTW CO_2 Emissions by Vehicle Segment

	Number of Vehicles	Annual TTW CO_2e emissions per vehicle (tonnes)	Total annual TTW CO_2e emissions (tonnes)	% contribution to total TTW CO_2e emissions
Small Car	164	4.5	745	1%
Medium Car	4,961	5.3	26,083	42%
Large Car	3,024	5.8	17,429	28%
Executive Car	635	6.1	3,873	6%
Medium MPV	1,762	5.6	9,830	16%
Midsized SUV	63	6.3	394	1%
Large 4x4 / SUV	4	6.9	28	0%
Small Van	57	5.8	333	1%
Medium Van	228	9.8	2,239	4%
Medium Van (WAV)	166	9.3	1,539	2%
Large Van	6	8.4	42	0%
		Total	**62,535**	**100%**

The table below shows the Well-to-Wheel CO_2e emissions of the Wolverhampton fleet. The relative contribution to the total emissions is the same as for Tank-to-Wheel emissions.

WTW CO_2 Emissions by Vehicle Segment

	Number of Vehicles	Annual WTW CO_2e emissions per vehicle (tonnes)	Total annual WTW CO_2e emissions (tonnes)	% contribution to total WTW CO_2e emissions
Small Car	164	5.7	928	1%
Medium Car	4,961	6.6	32,745	42%
Large Car	3,024	7.2	21,655	28%
Executive Car	635	7.6	4,797	6%
Medium MPV	1,762	6.9	12,238	16%
Midsized SUV	63	7.8	490	1%
Large 4x4 / SUV	4	8.6	34	0%
Small Van	57	7.2	412	1%
Medium Van	228	12.2	2,774	4%
Medium Van (WAV)	166	11.5	1,906	2%
Large Van	6	10.4	52	0%
		Total	**78,031**	**100%**

The table below shows the detailed NOx emissions breakdown. As with CO_2 emissions, the medium vans are the largest polluters on a per vehicle basis and the medium cars are the largest contributor to the total fleet emissions.

NOx Emissions by Vehicle Segment

	Number of Vehicles	Annual NOx emissions per vehicle (kg)	Total annual NOx emissions (kg)	% contribution to total NOx emissions
Small Car	164	13.0	2,125	1%
Medium Car	4,961	9.8	48,421	30%
Large Car	3,024	17.4	52,559	32%
Executive Car	635	18.8	11,907	7%
Medium MPV	1,762	15.3	26,963	17%
Midsized SUV	63	15.9	1,004	1%
Large 4x4 / SUV	4	30.4	122	0%
Small Van	57	37.9	2,082	1%
Medium Van	228	45.1	10,091	6%
Medium Van (WAV)	166	42.0	6,895	4%
Large Van	6	25.6	128	0%
		Total	**162,298**	**100%**

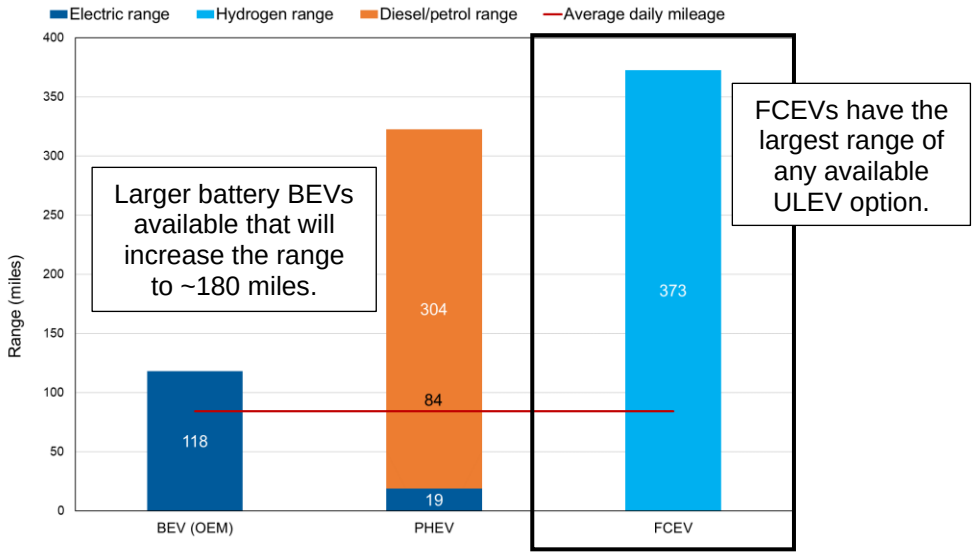
The table below shows the detailed PM emissions breakdown. The medium vans (WAV) are by far the largest polluter on a per vehicle basis as they are the oldest and largest vehicles on the fleet. Once again however, the medium cars are the largest contributor to the total fleet emissions.

PM Emissions by Vehicle Segment

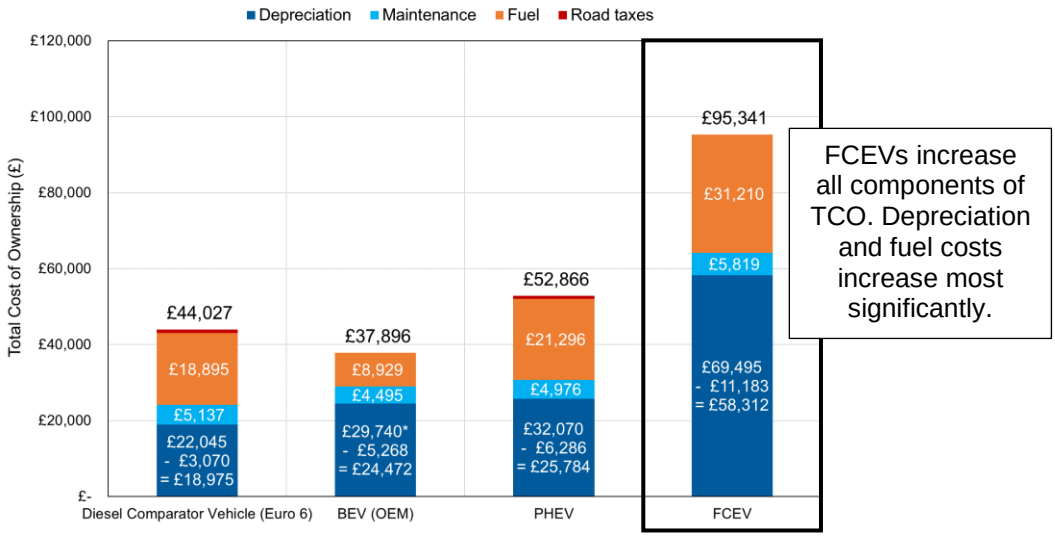
	Number of Vehicles	Annual PM emissions per vehicle (kg)	Total annual PM emissions (kg)	% contribution to total PM emissions
Small Car	164	0.13	21.9	2%
Medium Car	4,961	0.10	472.9	34%
Large Car	3,024	0.15	442.6	32%
Executive Car	635	0.11	68.2	5%
Medium MPV	1,762	0.14	237.9	17%
Midsized SUV	63	0.07	4.3	0%
Large 4x4 / SUV	4	0.03	0.1	0%
Small Van	57	0.04	2.3	0%
Medium Van	228	0.09	20.8	2%
Medium Van (WAV)	166	0.68	112.2	8%
Large Van	6	0.04	0.2	0%
		Total	**1,384**	**100%**

Ultra-Low Emission Vehicle Performance Review – Medium Car, Fuel Cell Electric Vehicle

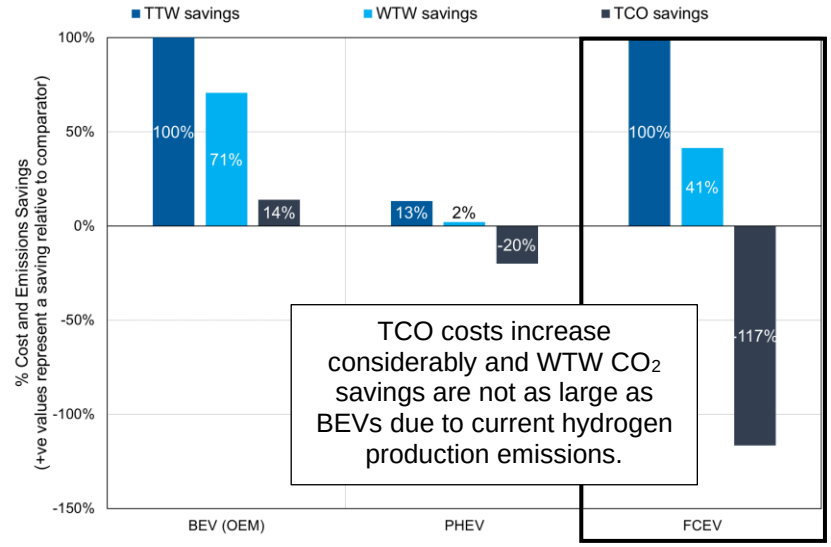
The figures below show the performance of medium car ULEV technologies with the FCEV included.



Operating Range; Medium Car, Fuel Cell Electric Vehicle



Total Cost of Ownership; Medium Car, Fuel Cell Electric Vehicle



CO_2e Emissions Savings vs. Cost Savings; Medium Car, Fuel Cell Electric Vehicle

ULEVs Models Available in the UK, 2020

The table below shows the ULEV models available in the UK in 2020. Vehicles shown in red cost over £65,000 and are likely only suitable for executive or chauffeur services.

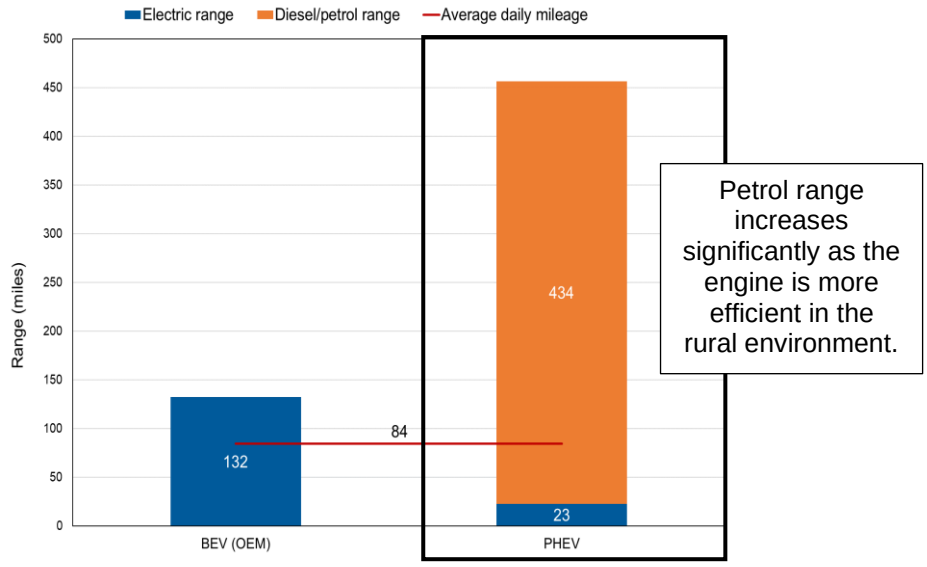
ULEV Models Available in UK, 2020

	BEV	PHEV / REEV
Medium Car	Citroen DS3 Crossback Citroen e-C4 Hyundai IONIQ Hyundai Kona Kia e-Niro Kia Soul Mazda MX-30	Hyundai IONIQ Kia Niro PHEV Kia XCeed Mercedes-Benz A-Class Mini Countryman Peugeot 3008 Seat Leon
Large Car	Tesla Model 3 Tesla Model Y	BMW 3-Series Mercedes-Benz C-Class Peugeot 508 Skoda Superb Volkswagen Passat GTE Volvo S60 Volvo V60
Executive Car	Jaguar I-PACE Mercedes-Benz EQC Tesla Model S* Tesla Model X*	Audi A6 BMW 5-Series Mercedes-Benz E-Class Volkswagen Arteon Volvo S90 Volvo V90
Medium MPV	Nissan e-NV200	BMW 2-Series Mercedes-Benz B-Class
Medium Van (8-Seater)	Citroen e-SpaceTourer Mercedes-Benz EQV* Peugeot Traveller-e Vauxhall Vivaro e-Life	Ford Tourneo Custom
Hackney Carriage	Dynamo Nissan e-NV200	LEVC TX

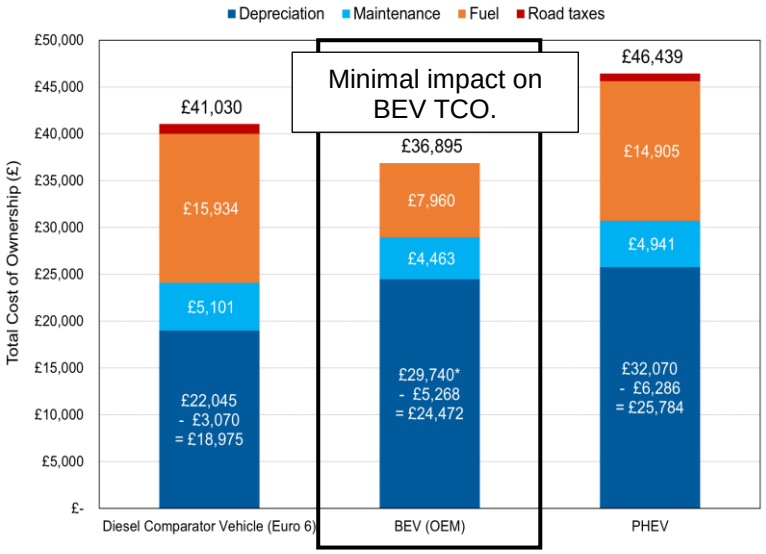
* vehicles cost at least £65,000 and are likely only suitable for executive / chauffeur services.

Ultra-Low Emission Vehicle Performance Review – Mostly Rural Driving Environment

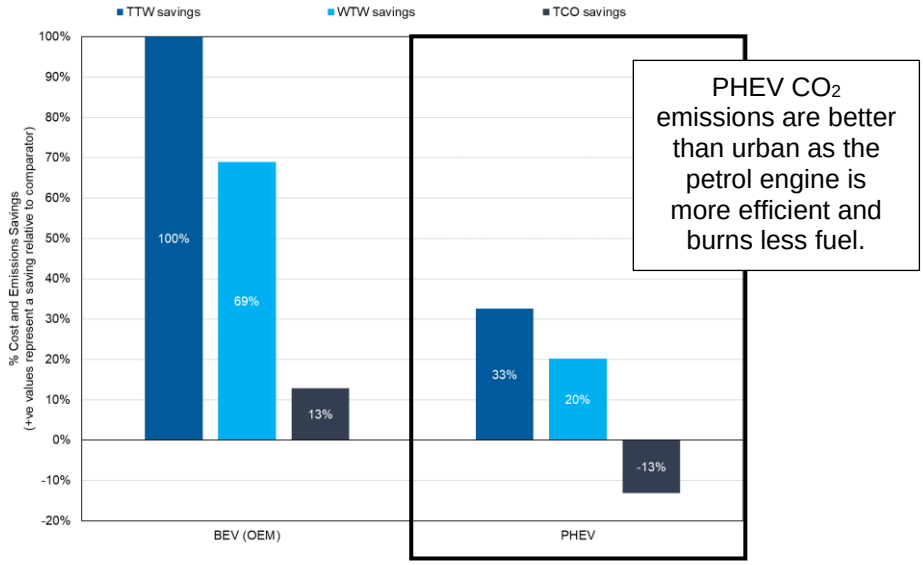
The figures below show the performance of ULEVs for medium cars in mostly rural environments.



Operating Range; Medium Car, Mostly Rural Driving Environment



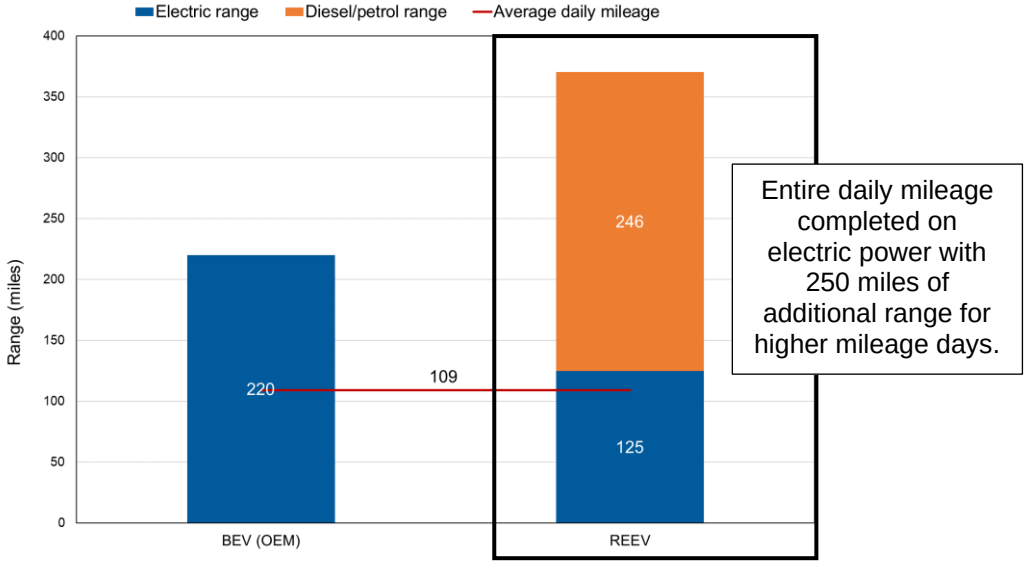
Total Cost of Ownership; Medium Car, Mostly Rural Driving Environment



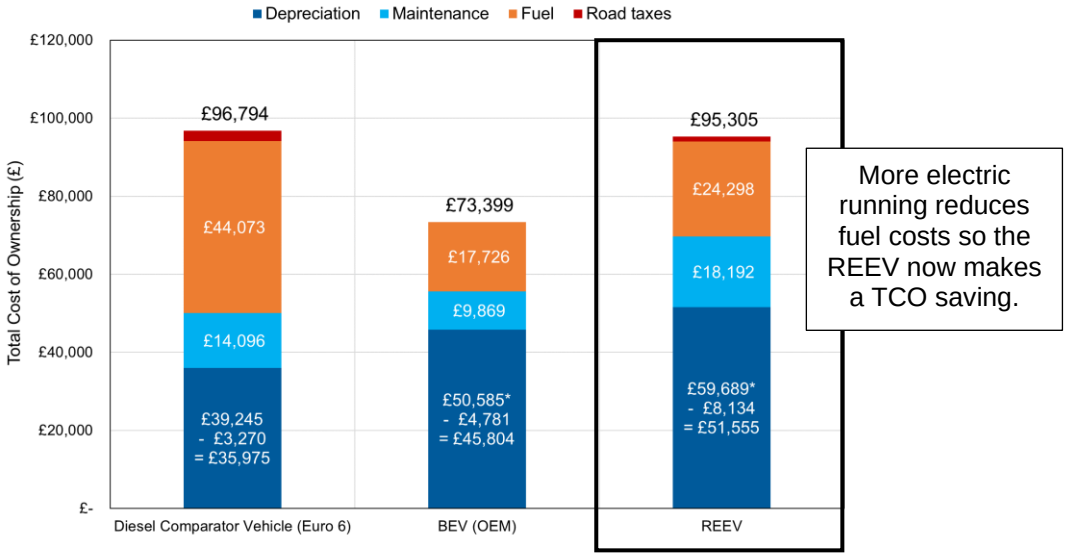
CO_2e Emissions Savings vs. Cost Savings; Medium Car, Mostly Rural Driving Environment

Ultra-Low Emission Vehicle Performance Review – Medium Van (WAV), Two Charges per Day

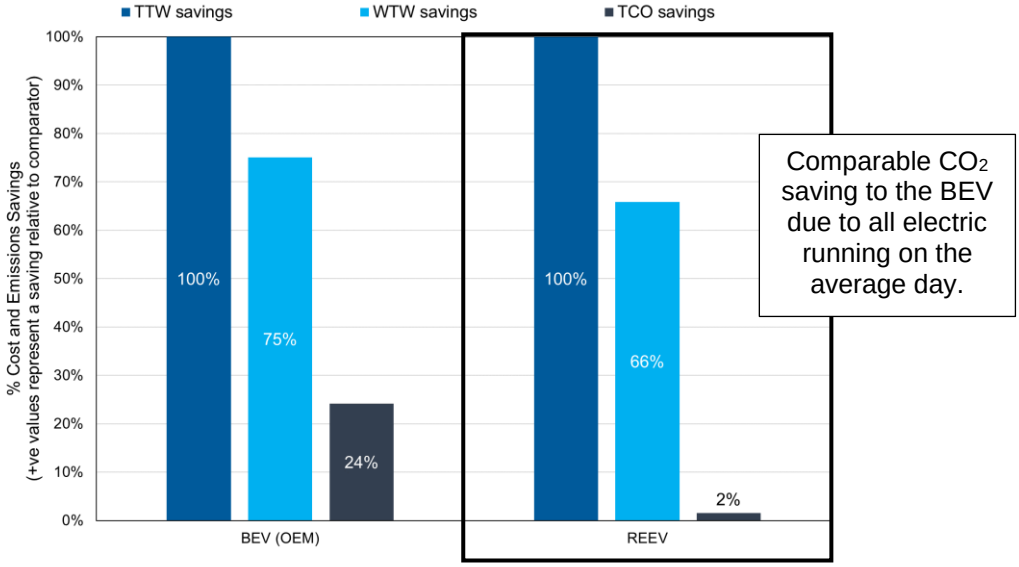
The figures below show the performance of ULEVs for medium vans when charged twice per day.



Operating Range; Medium Van (WAV), Two Charges per Day



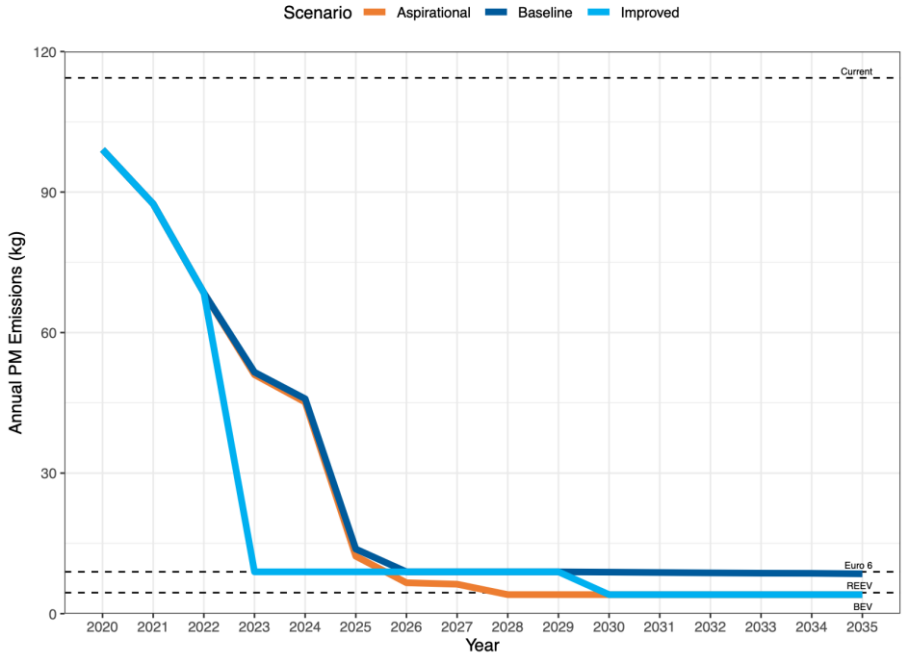
Total Cost of Ownership; Medium Van (WAV), Two Charges per Day



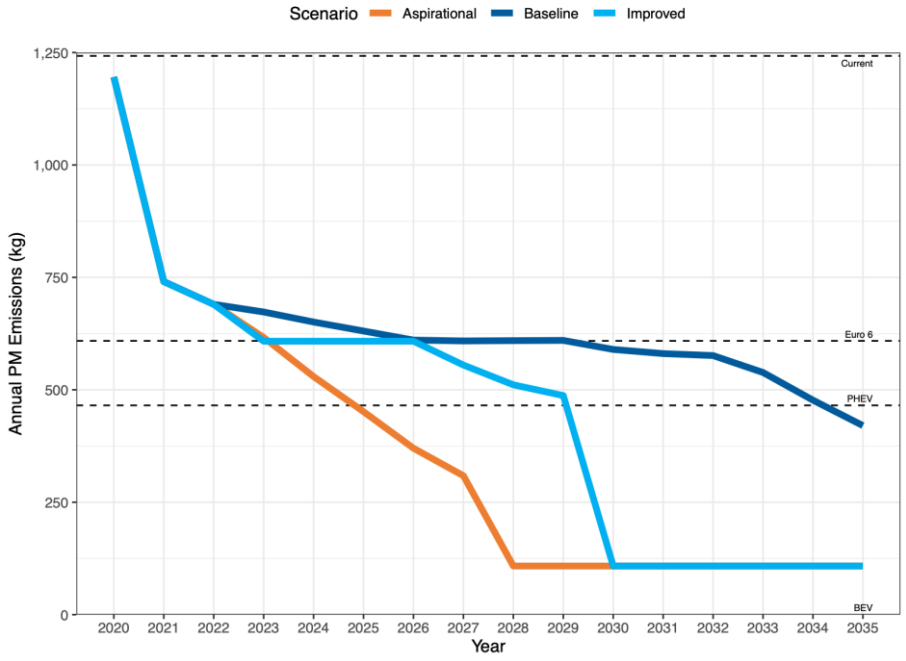
CO_2e Emissions Savings vs. Cost Savings; Medium Van (WAV), Two Charges per Day

PM Emissions Forecasts by Licensing Scenario

The figures below show the PM emissions forecast by licensing scenario for the hackney carriage vehicles and private hire vehicles, respectively.



PM Emissions Forecast, Hackney Carriage fleet



PM Emissions Forecast, Private Hire fleet

A significant reduction in PM emissions occurs in all scenarios as the oldest Euro 4 vehicles leave the fleet. After 2023 the scenarios follow a similar path to the NOx emissions.

Appendix C – Fleet Review References

The table below shows the references used during the fleet review. It should be noted that wherever possible data provided by the fleet takes priority over supplementary data sources (such as baseline fuel economy) and likewise, independent data takes priority over information provided by suppliers.

Table of References

Parameter	Reference
Vehicle Details	**Driver and Vehicle Licensing Agency (DVLA)** https://ukvehicledata.co.uk/dvla-data-api
Annual Mileage	**Driver and Vehicle Standards Agency (DVSA)** https://www.gov.uk/check-mot-history
Baseline Fuel Economy	**Emissions Analytics** – Passenger Vehicles and LCVs https://www.emissionsanalytics.com/
Greenhouse Gas Emissions Factors and Energy Content	**UK Government** https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020
Air Quality Pollutant Emissions Factors	**National Atmospheric Emissions Inventory (NAEI)** https://naei.beis.gov.uk/data/ef-transport
Low Emission Vehicle Energy Consumption	**Cenex** – ULEV passenger vehicles and LCVs https://www.cenex.co.uk/ **Cenex and LowCVP** – LCVs Unpublished testing of plug-in commercial vehicles completed on behalf of LoCITY in 2019
Vehicle Costs Purchase Cost Maintenance Costs Predicted Residual Values	**Fleet News and Commercial Fleet** – Passenger vehicles and LCVs https://www.fleetnews.co.uk/car-running-costs-calculator https://www.commercialfleet.org/tools/van/running-costs/ **Vehicle Suppliers and Fleet Operators** – Any remaining technologies
Fuel Prices	**AA** – Diesel, petrol and LPG https://www.theaa.com/driving-advice/driving-costs/fuel-prices **Department for Business, Energy and Industrial Strategy (BEIS)** – electricity https://www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics **Low Emission Fuel Suppliers** – hydrogen

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