The Shift:

Decarbonising Supplier Transport and Mobile Power for London’s Film and Television Industry - **Methodology Statement**

A carbon footprint analysis of London's film and TV suppliers’ transport and mobile power fleets, and a plan for its successful shift to low-carbon technologies.

Contents

Glossary of terms

CV	Calorific Value. Gross CV
CO_2e	Carbon dioxide equivalent. Metric for standardising all greenhouse gases to one common factor for climate change intensity, known as global warming potential (GWP).
GHG	Greenhouse Gases
HOP	Head Of Production for Film, TV and Advertising
HVO	Hydrotreated Vegetable Oil. This is a renewable diesel made from a variety of sources. This study focuses on HVO derived from UCO (Used Cooking Oil).
kVA	Kilovolt-ampere. A unit of power capacity, commonly used for fuel-based generators.
kW	Kilowatt. A unit of actual power.
kWh	Kilowatt Hour. A unit of energy capacity, commonly used for battery storage.
MPU	Mobile Power Unit(s). Any solution delivering mobile power including traditional generators and batteries.
MPG	Miles Per Gallon. A measure of fuel economy for UK vehicles.
SOC	State Of Charge. A percentage measure of how much charge is in a battery.
TCO	Total Cost of Ownership. A model for measuring the long-term cost benefit of an investment.
TRL	Technology Readiness Levels. A method for measuring the progress of an innovation, from idea (TRL 1) through to commercial reality (TRL 9).
VECTO	Vehicle Energy Consumption calculation TOol, a simulation software for calculating energy and emissions factors for road transport (European Commission, 2017).
WLTP	Worldwide Harmonised Light Vehicles Test Procedure. The common standard for measuring fuel efficiency and emissions of new vehicles.

Introduction

The purpose of this document is to explain the full methodological approach taken within *The Shift: Decarbonising Supplier Transport and Mobile Power for London's Film and Television Industry*. In its second phase, this project is a series of research to drive decarbonisation among film and TV production suppliers.

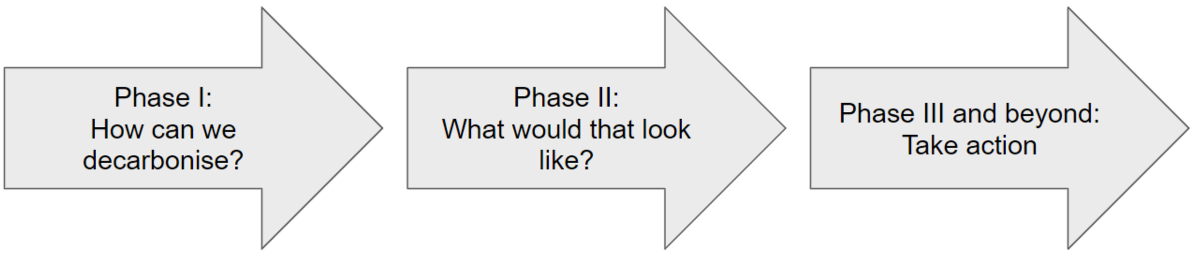

Figure 1: the phases of The Fuel Project.

Aim of research

This project sought to achieve three key aims:

1. Build a carbon footprint and fleet assessment for the sector's current road transport and mobile power units;
2. Create just and equitable decarbonisation scenarios for these supplier-owned high carbon assets;
3. Report the state of mind and readiness for transition for key industry stakeholders.

Research Design

Research Questions

To achieve its aims, the study explored five key research questions:

- **RQ1:** What does the transport and MPU fleet of London's film and TV supply industry look like?
- **RQ2:** What is the carbon footprint of transport and mobile power from London's film and TV suppliers?
- **RQ3:** When will the fleet's transition away from fossil fuels be possible?
- **RQ4:** How much will this transition cost?
- **RQ5:** What is the appetite for this transition within the industry, and how might it be increased and expedited?

Methodologies were selected to achieve each of the five research questions. Due to differences in data access and methodology, transport and mobile power research questions were treated independently of each other, resulting in some small differences. This document explains these differences in the following sections.

Scope

This study focuses on fossil fuel use by suppliers of London's film and TV production industry. This fuel use can be from transport, i.e. fuel use in vehicles, or from mobile power, i.e. fuel use in Mobile Power Units (MPUs). Supplier participation in the study is voluntary.

There is no pre-existing common definition of a London film and TV production supplier. This study has categorised them as shown in Figure 2:

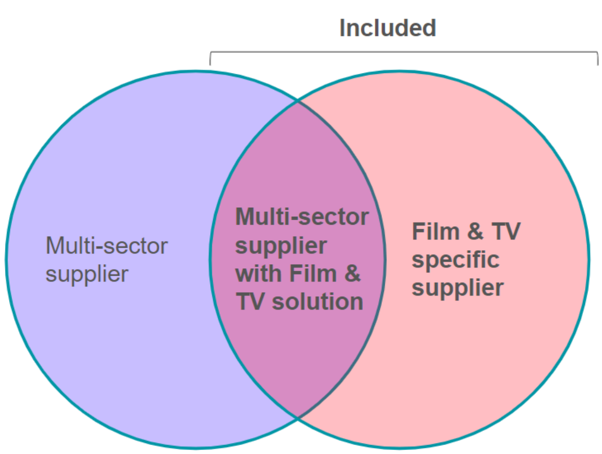

Figure 2: Definition of suppliers that are considered part of the film and TV industry.

Category	Definition
Film and TV specific supplier	This supplier only exists to serve film and TV production industries. E.g.: camera, grip and lighting suppliers.
Multi-sector supplier with film and TV solution	This supplier has a general product but with a film and TV production-specific solution. E.g.: a generator rental supplier that tailors services for film and TV production as well as construction and events.
Multi-sector supplier	This supplier has a general product that may be used within the film and TV production industry but has no specific solution. E.g.: a car rental supplier.

Specifically, the scope is limited to the following criteria:

	Included	**Excluded**
Transport use	• Transport fleets delivering to or running on productions.	• Company/freelance car and minibus fleets. • Other business transport including business travel and commuting.
Mobile power use	• MPUs running on productions.	• Heaters running on productions.
Supplier category	• Film and TV specific supplier • Multi-sector supplier with film and TV solution	• Multi-sector supplier.
Geography (see map)	• Suppliers with a base inside the M25. • Suppliers with a base within the red boundary and predominantly working inside the M25.	• Suppliers with a base within the red boundary but working predominantly outside the M25.
Data collection	• January 2022 to January 2024.[1]	• Data from before 2022.

[1] This was done to the best of the research team's knowledge. Valid but undated production data may have fallen outside of this boundary but the decision was made to include this.

period		
Analysis period	• 2022 up to 2040.	• Historic analysis. • Beyond 2040.

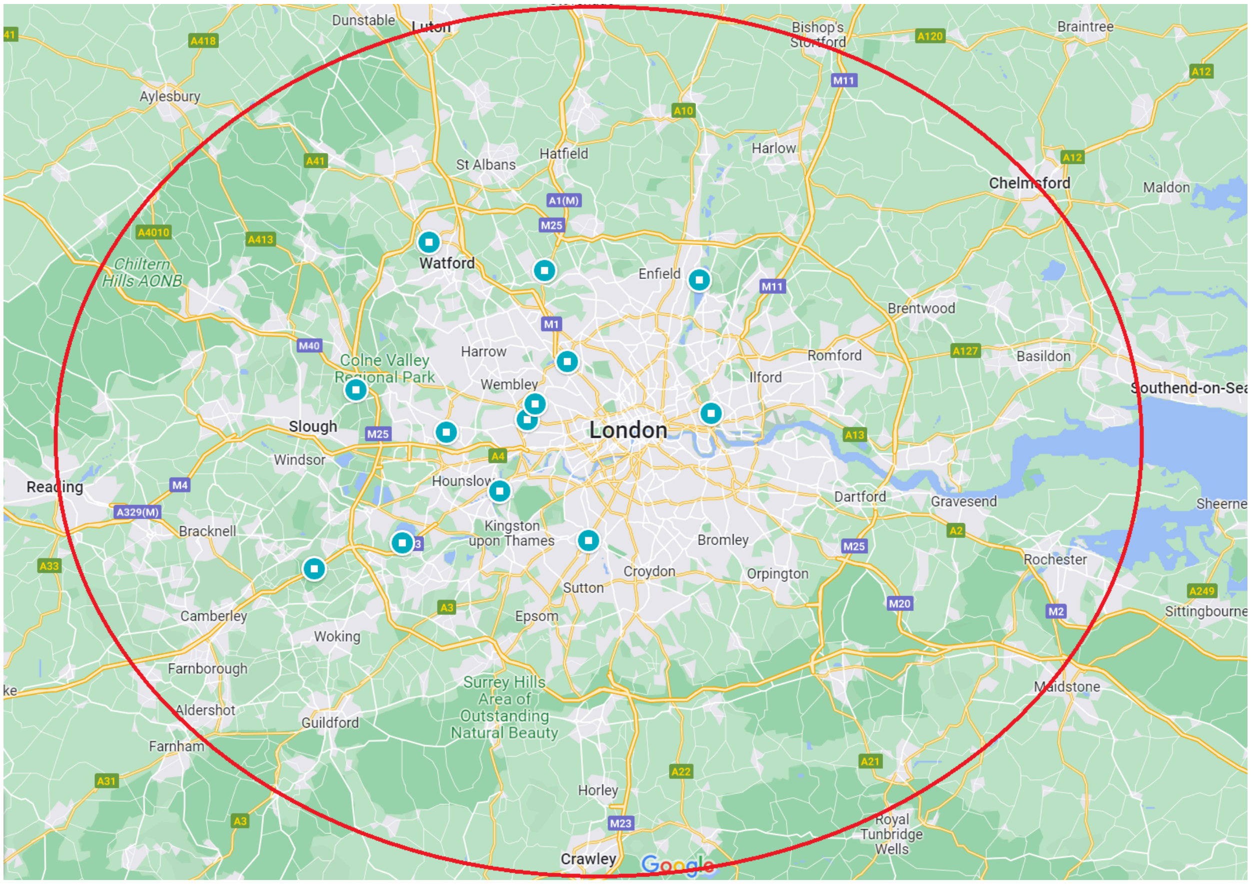

Figure 3: Map of the geographical boundary considered for this study, with certain studio locations highlighted.

Data Approaches

As already mentioned, a major challenge to such analysis is data, both in terms of:

1. A lack of data: it does not exist.
2. A lack of consistency of data: data may exist but is isolated and unused across sources that do not correlate.

To overcome this challenge, this study collected multiple sources of data with multiple methodologies. It took the approach of creating "data levels" that vary depending on the source of the data and the levels of accuracy and coverage each dataset offered. The image below summarises the three levels of data considered, how the study categorises it and the contrasting characteristics. The result is building the best understanding possible based on a hierarchy of data quality for both asset and operations data.

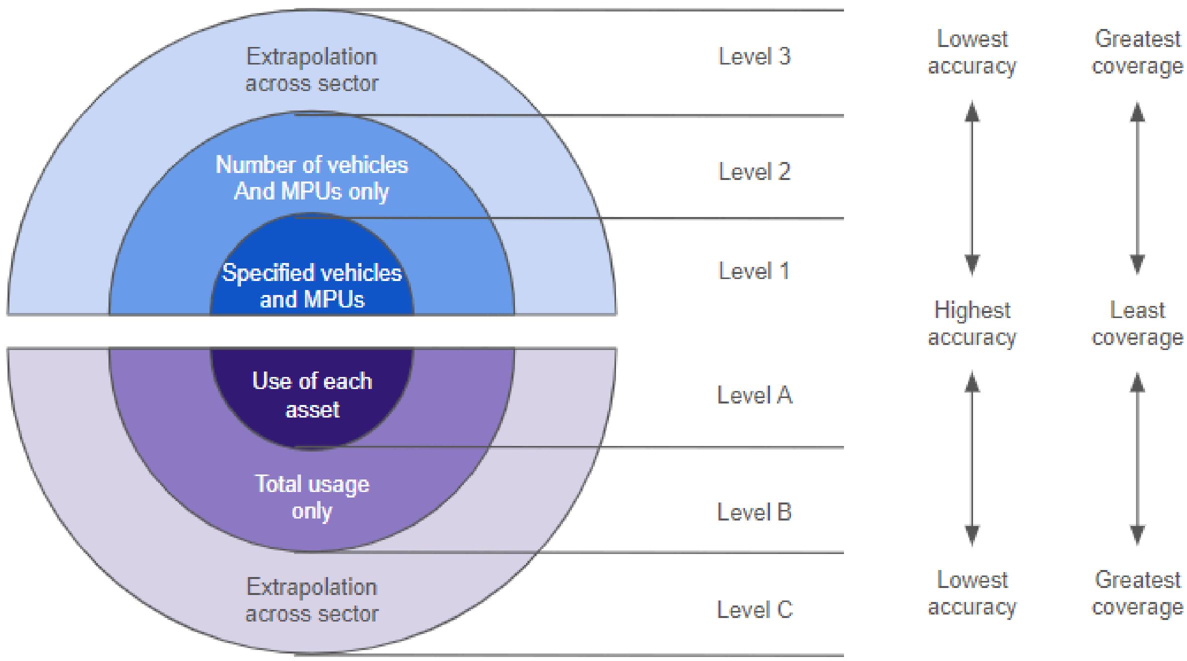

Figure 4: this studies approach to "data levels".

Research Methods

The data analysis conducted within this study has been conducted using a mixed methods approach. In the absence of similar comparable analysis conducted beforehand, this data level approach is designed to offer the greatest accuracy and coverage to answer the research questions.

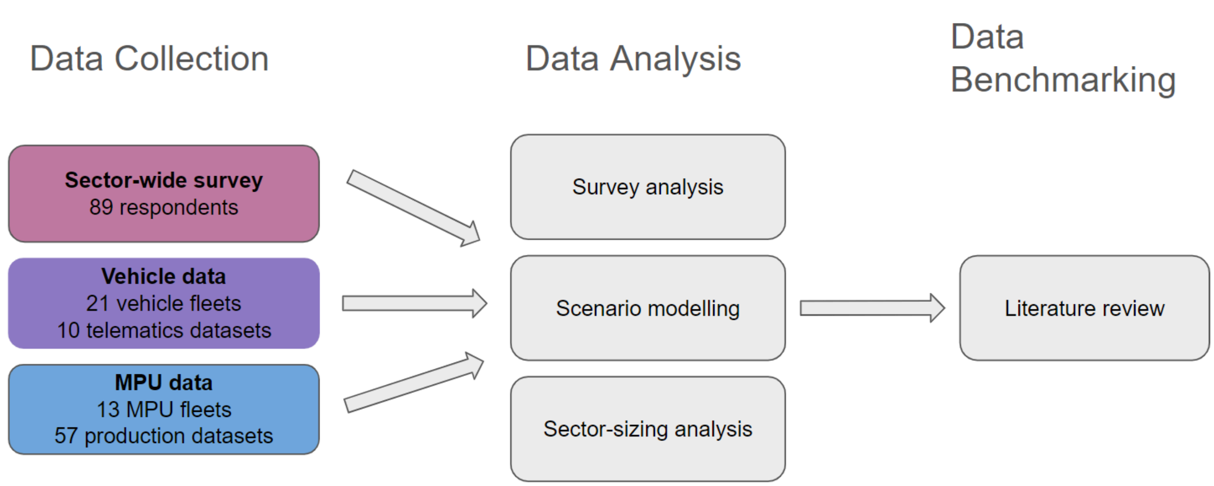

Figure 5: a summary of the methodologies used across the research project.

Sector-wide survey

An online survey was conducted between October and January 2024 targeted at stakeholders across the film and TV production industry including but not limited to suppliers. These stakeholders were limited to the production side of the industry, distribution and exhibition stakeholders were outside of the scope. The targeted stakeholder groups included:

- Broadcasters, streamers or major studios (from commissioning, sustainability or operational departments)
- Production companies or freelance producers (including production units within broadcasters)
- Suppliers:
    - film and TV production-specific suppliers
    - Transport and/or mobile power suppliers
    - Refuelling and/or recharging suppliers
    - Sustainability initiatives[2] or related consultancies

The size of London's film and TV production supplier network is 165 organisations. A campaign for distribution via social media and email was used to promote participation. A prize draw was used to incentivise participation.

In total, 89 individual responses were received to the survey:

- Broadcaster, Streamer, Major Studio = 7
- Supplier = 56
- Producer, Production Company = 15
- Studio Spaces = 4
- Sustainability Initiative, Consultancy = 7

Key assumptions:

- This survey targeted a minimum participation rate of 10% of London's stakeholder network for film and TV production-specific suppliers. Other stakeholders were not possible to substantiate a minimum participation level because the total population was not known and not part of this study.
- The online survey was conducted using the survey software Typeform and used routing logic to only allow relevant stakeholders the ability to participate in relevant questions.

Vehicle data

To attain "Level 1" data as described in Figure 4, suppliers who own or lease vehicles were invited to provide greater detail on their respective fleets. This was achieved within the sector-wide survey; a template table was made available to users to download, fill in and upload

[2] The "sustainability initiatives" phrase is a collective term to include publicly and privately funded organisations involved in sustainability. E.g. Albert.

within the survey software. These templates can be viewed via Film London's website here: https://filmlondon.org.uk/resource/fuel-project-phase-ii-data and in the appendices.

Key assumption: This fleet data was correct for the time period of the survey: October 2023 - January 2024.

Telemetry data analysis

To attain "Level A" use data for transport, survey respondents were also asked to offer data not just on what their vehicles are but how they are used. The upload of telematics was requested. Telematics data is data collected from smart devices connected to each vehicle that record a range of metrics. These can include location, fuel consumption, power and emissions.

Key assumptions:

- Fleet data matching: Using number plates for vehicles as a primary key, the analysis ensured only in-scope vehicles were analysed. I.e. telemetry data for a number plate that was not included in the fleet list was excluded from the analysis.
- Quality of data: A range of telematics solutions were accepted. CAN bus is optimal but rarely available. GPS data was the most common.
- Time-frames: due to the writers' strike of Summer 2023, data was requested for any period between 1 January 2022 and 30 April 2023 as well as some submissions from October to December 2023.
- Amount of data: the study wants to understand typical usage profiles, including days when the vehicles or MPUs are not in active use.
    - A period of at least 30 sequential days and no more than 365 days was requested from each respondent. Extremely large datasets were excluded due to the complexity of data processing.
    - A mix of warm and cold months were considered within the sample.
    - A mix of assets were included.

Telematics data was cleansed and integrated into one dataset for analysis.

MPU data

To attain "Level 1" data for mobile power, suppliers who own MPUs were invited to provide greater detail on each asset within the sector-wide survey. a template table was made available to users to download, fill in and upload within the survey software. These templates can be viewed via Film London's website here:
https://filmlondon.org.uk/resource/fuel-project-phase-ii-data and in the appendices.

Key assumptions:

- This fleet data was correct for the time period of the survey: October - December 2023.

Production datasets: The generator monitoring project

One particular challenge established when scoping the project is the lack of knowledge around MPU use patterns within the film and TV production industry, specifically, traditional generators running on diesel fuel. From discussions with industry stakeholders, it was anticipated that telematics data submissions would be limited from diesel generators.

Primary data was captured through collaboration with industry, including through the HOP4Climate network, taking place between November 2023 and February 2024. This primary data was used to understand daily fuel use, average load and peak loads for different types of generators on film productions.

Primary data was also collected from other sources, where generator-monitoring is a requirement of the production.

Key assumptions:

- Data quality: A minimum of 5 productions were required to participate in the study to ensure validity.
- Diversity of production and power use case: Varying MPU situations were included to ensure the data was not biassed towards particular uses.
- Time of year: Historic and real time data was accepted under this analysis. This study acknowledged the limitation of only examining data collected during winter months (low levels of daylight and lower outdoor temperatures). Historic data not from the winter period was included from certain providers.

Literature Review

Reports from academia, industry and public industry bodies were used throughout the research project for two purposes:

1. To select and optimise methodologies
2. To fill gaps in the data with appropriate assumptions.

All literature, referenced and unreferenced, is available in the bibliography at the end of this document.

Sector-sizing analysis: London’s supplier network

To attain “Level 3” and “Level C” data levels (Figure 4), this study extrapolated the analysis to the scale of the whole of London’s film and TV production supply industry. The sector-sizing analysis helped define the scale of the supplier network, allowing the analysis to be extrapolated beyond the sample of the research.

Method

Step 1: Filter and categorise

All suppliers listed were reviewed to exclude any that did not meet the scope or were no longer in operation. This included reviewing company websites, where available.
The remaining suppliers were labelled by the type of product or service they offer to film and TV production:

- Camera/grip
- Catering/craft
- Fuel
- Lighting
- Location/facilities
- Power
- Set build
- Sound
- Vehicles

Step 2: Companies House look up

Remaining suppliers were reviewed on companies house to understand their size and relevance based on the following data points:

- SIC code
- Annual turnover
- Number of employees

Suppliers were separated into the following standard categories:

	Category	**Employees**	**Annual turnover**
A	Micro Business	Less than 10	Under £2 million
B	Small Business	10-49	£2-9 million
C	Medium Business	50-249	£10-49 million
D	Large Business	250 or more	£50 million and higher

Step 3: sector-sizing by company

Suppliers were categorised by supplier type and size category. Those suppliers that participated in the research were then separated and again categorised by supplier type and size category.

Comparing the participating suppliers with the total supplier network provided a ratio of participation for the research.

Step 4: sector-sizing by asset

The same comparison was then applied to vehicles and MPUs to understand coverage for each of the transport and power datasets. This created a separate ratio of participation to the above.

These separate ratios allow for greater accuracy in the extrapolation. E.g., the sample may represent 20% of the total population, therefore a ratio of 1:5. However, if that 20% represented 50% of the vehicles, the ratio of 1:5 would be overestimating the industry’s vehicle coverage.

Results presented in the report have followed this sector-sizing analysis.

Decarbonisation technologies

A transition model requires a baseline technology and a destination technology. With multiple viable alternatives to regular diesel, how do you choose which is the preferred destination?

This study has an aim to offer a just and equitable decarbonisation pathway for the industry. This relies on remaining technology-agnostic while selecting a destination that best meets the social and commercial priorities, in addition to the environmental goal. This requires selection to be technology-pragmatic.

From Phase I of The Fuel Project, it was established that three key technologies are in consideration for both transport and power: battery electric, hydrogen fuel cell and HVO (Hydrotreated Vegetable Oil)[3]. The transition would see combinations across fleets including hybrids of these technologies within vehicles and MPUs.

To consider what this mix should look like and when, a hierarchy is established based on the following three considerations:

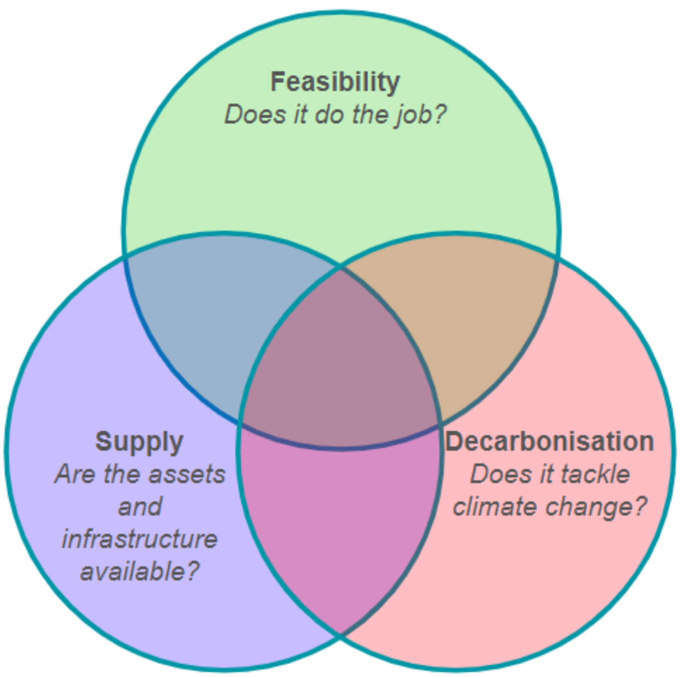

Figure 5: Three considerations for selecting the decarbonisation technology.

The following summary provides as assessment of the current state of the three predominant technologies considered in this report:

[3] For HVO, this study assumes UCOME sourcing. See Glossary of terms for further details.

		Batteries	HVO	Hydrogen	HVO-Battery Hybrid
	Intended feedstock, fuel or energy source	Grid	Used cooking oil (UCO)	Green Hydrogen	UCO and Grid
Cars, Pick-ups and 4x4s	Feasibility	[green]	[green]	[orange]	[green]
	Supply	[orange]	[red]	[red]	[red]
	Decarbonisation	[green]	[orange]	[green]	[orange]
Vans	Feasibility	[green]	[green]	[green]	[green]
	Supply	[orange]	[green]	[red]	[red]
	Decarbonisation	[green]	[orange]	[green]	[orange]
Trucks	Feasibility	[orange]	[green]	[orange]	[green]
	Supply	[red]	[green]	[red]	[red]
	Decarbonisation	[green]	[orange]	[green]	[orange]
Mobile Power Units (MPUs)	Feasibility	[orange]	[green]	[orange]	[green]
	Supply	[orange]	[green]	[orange]	[green]
	Decarbonisation	[green]	[orange]	[green]	[orange]

High confidence	[green]
Medium confidence	[orange]
Low confidence	[red]

Figure 6: Summarised considerations for decarbonisation technologies.

As a result of the above, this study and the scenario modelling assumes the following hierarchy:

1. When assets are ready to be replaced, battery electric technology is prioritised.
2. Those that cannot be replaced with batteries, consider hybrid or a “next generation” solution.
3. Ahead of replacement, all diesel fuel is switched to a sustainably-sourced HVO.

Transport

Research Question 1

What does the transport fleet of London's film and TV supply industry look like?

Key Assumption: To calculate the total transport fleet, the study used multiple data sources, each with differing levels of accuracy.

Calculations

$$Total\ fleet\ =\ sum\ of\ each\ vehicle\ group$$

Road vehicles were categorised into the following groups:

Truck Heavy-Duty	40t and heavier
Truck Medium-Duty	20-36t
Truck Light-Duty	7.5-18t
Van Large	Heavier than 3.5t
Van Medium	3.5t
Van Small	Lighter than 3.5t
Pick-up / 4x4	
Car	
Bus	
Cargo bike	

Due to the limited number of responses, bus and cargo bike categories were not considered further in this analysis.

Additional descriptive analysis is provided in the report relating to the suppliers' responses to the survey.

Research Question 2

What is the carbon footprint of transport from London's film and TV suppliers?

For this report, a "carbon footprint" is defined as the impacts of operating vehicles. Well-To-Wheel (WTW) analysis is used to compare across all fuel types active in the baseline fleet.

Key assumptions:

- Emissions analysis: This is explicitly a carbon footprint analysis. Air pollution analysis is not calculated as part of this project.
- Greenhouse gas (GHG) analysis: The full GHG profile is considered, not just carbon dioxide. This study measures GHGs using the CO_2e unit.
- Fuel selection: If not stated from the fleet data, regular forecourt diesel (average biodiesel mix) is selected as the default fuel for a vehicle.

Calculations

The following calculations were used and combined for the total carbon footprint.

$$Total\ carbon\ footprint\ =\ WTW\ factor\ x\ total\ annual\ mileage\ x\ vehicle\ category\ mix$$

	definition	unit	source
WTW factor	The combined factor for GHGs for this vehicle category	kg CO2e per mile	This study, see WTW calculation below
Total annual mileage	The estimated total annual mileage for the vehicle category	miles	This study, sector-wide survey, sector-sizing analysis
Vehicle category mix	The proportion of each fuel type for each vehicle category	%	This study, sector-wide survey, Research Question 3

Step 1: WTW factor

A calculation for WTW emissions is made for every vehicle category, fuel type and fuel use. E.g.: car + diesel + 100% HVO. This is formed by multiplying the energy economy with all the individual emissions stages of a WTW analysis.

$$WTW\ factor = a * (b + c + d + e)$$

	definition	unit	source
WTW factor	The combined factor for GHGs for this vehicle category	kg CO2e per mile	This study
a	Energy economy per transition category	kWh per mile	This study, Research Question 3
b	Well-To-Tank (WTT) emissions factor	kg CO2e per kWh	(UK Government, 2023)
c	Electricity Generation emissions factor	kg CO2e per kWh	(National Grid, 2023)
d	Electricity Transmission and Distribution emissions factor	kg CO2e per kWh	(UK Government, 2023)
e	Tank-To-Wheel (TTW) emissions factor	kg CO2e per kWh	Various, see below

The methodology has been adapted from the UK Government's Greenhouse Gas Reporting: Conversion Factors 2023 (UK Government, 2023). The energy economy conversion is used from Research Question 3.

Diesel emissions

Emissions factors for the average forecourt blend have been adopted from the UK Government's Greenhouse Gas Reporting: Conversion Factors 2023 (UK Government, 2023). This does not change across time.

Petrol emissions

Emissions factors for the average forecourt blend have been adopted from the UK Government's Greenhouse Gas Reporting: Conversion Factors 2023 (UK Government, 2023). This does not change across time.

Electricity emissions

National Grid offers annual forecasts for the decarbonisation of electricity supply in the UK. A mean average of the five published scenarios is adopted (National Grid, 2023). 2023 data is used as the baseline year.

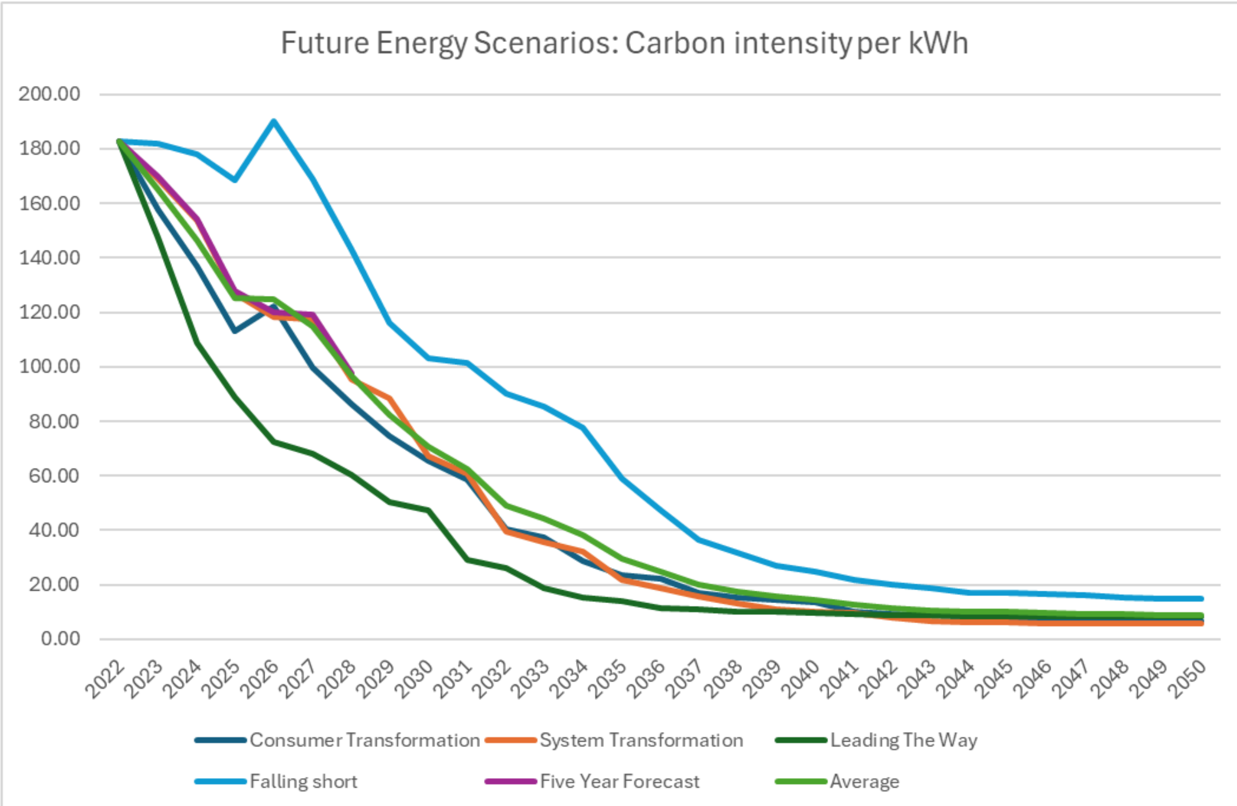

Figure 7: Data showing a forecast for carbon intensity of UK electricity supply (National Grid, 2023).

HVO emissions

HVO is derived from many sources each leading to a varying mix of emissions. This analysis applied the average blend based on values published in the EU's updated Renewable Energy Directive (REDII) (European Commission, 2018).

Key assumption: the supply of UCO in the blend of HVO in the EU is uncertain. There is a risk that UCO supply cannot meet HVO demand in the 2030s. As a result, a less sustainable blend is highly likely in that decade. This analysis adds a 59% uplift factor based on Annex V of RED II.

Hydrogen emissions

This analysis adopts the emissions factors published by Albert for its film production carbon calculator (Albert, 2023).

Key assumption: the supply of hydrogen can come from a variety of sources and most are not sustainable in 2024. This analysis assumes that only "green" hydrogen will be used. Those making the investment in green hydrogen fleets are assumed likely to guarantee a green hydrogen supply for their fleets (i.e. this sector will only make such an investment if it comes with the decarbonisation benefit). As such, only green hydrogen is considered in the supply when "next generation" technologies are adopted in the model.

Step 2: Total annual mileage

A calculation for total annual mileage was made from Level 1 fleet data analysis:

- Fleets that submitted the annual mileage for each vehicle were included and compared.
- Fleets that did not submit the annual mileage, an estimated value was used based on the mean average for submitted data for that vehicle category.
- Sub-totals were calculated for each individual vehicle category. These were used for each calculation in the total carbon footprint required.

Step 3: Vehicle category fuel mix

A calculation was made for the proportion of each vehicle category that belonged to each fuel type. This percentage enabled the analysis to estimate how many miles, and therefore kWh, were attributable to that particular WTW factor.

E.g., there were 4% of cars in the baseline data that were electric, therefore the estimated total carbon footprint from electric cars in London's fleet is 4% of total car mileage.

Research Question 3

When will the fleet's transition away from fossil fuels be possible?

This question challenges the study to establish pathways to transition away from fossil fuels. The method for this is a feasibility model based on a series of mathematical tests. Telematics and survey data is combined, cleansed and fed into a transition model. The results from this model are aggregated and extrapolated to see what this could look like for the whole industry.

Calculations

The first test is to explore the feasibility for the transition. As per the transition hierarchy outlined in the decarbonisation technologies section, the calculation is made for the transition to electric. The calculation requires three tests to be carried out:

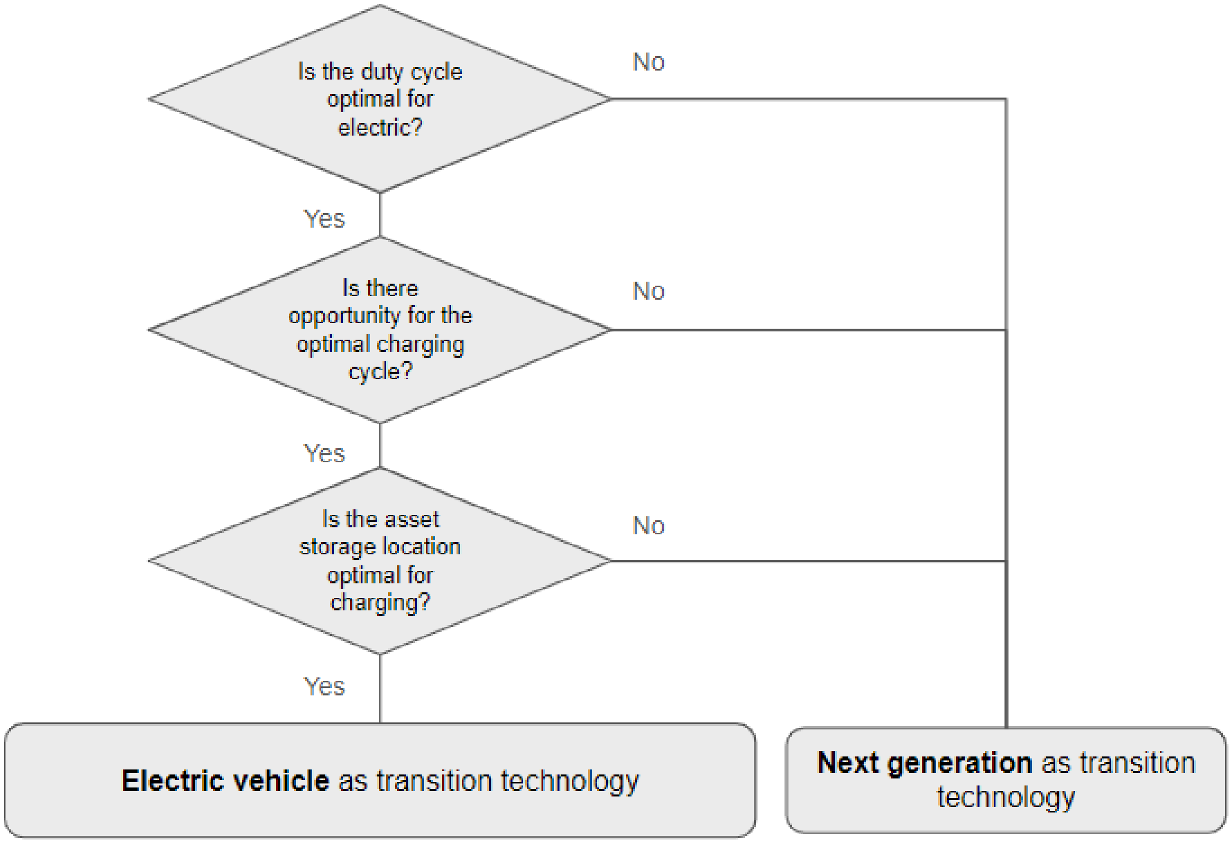

Figure 8: a flow chart of the series of tests for the vehicle transition model.

"Next generation" technologies

When an electric vehicle solution is found to not be suitable a "next generation" technology was considered. This category follows the development of the hydrogen fuel cell vehicle powered by green hydrogen but is not limited to this technology. As such, it is not expected to play a role in the vehicle mix until the 2030s.

Key Assumption: Any diesel vehicle that had reached the limit of its current investment cycle but was not suitable for the electric model would have a transition delayed until the "next generation" model becomes available in the 2030s.

Test 1: Optimal duty cycle for electric vehicles

To calculate whether the electric vehicle is a feasible decarbonisation technology, the model seeks to understand viability on a daily use case.

A calculation is used to work out if a day of using the incumbent technology could have been done using an electric vehicle instead. The following rule is applied:

$$Electric\ feasible\ day\ =\ Electric\ daily\ energy\ demand\ <\ Electric\ daily\ energy\ capacity$$

Step 1: Daily energy demand

$$Daily\ energy\ demand\ = a\ *\ (b\ *\ c\ *\ d)$$

value	definition	unit	source
Daily energy demand		kWh per day	
a	Recorded distance	Miles per day	Telemetry data
b	Energy economy for transition category	kWh per mile	(DESNZ, 2023)
c	Operational adjustment factor	%	(DESNZ, 2023); Telematics submissions
d	Technical adjustment factor	%	(HBEFA, 2022)

Step 1 faced two particular challenges:

1. A lack of telemetry data for certain vehicle groups
2. A lack of energy consumption telemetry data for all groups

For challenge 1, a simplified model was assumed for these vehicle categories, including cars, pick-ups, 4x4s and small vans. From industry discussions, it is anticipated that these vehicle categories are the least likely to use additional auxiliary sources of energy, so simple mileage is assumed to be sufficient.

For challenge 2, a lack of energy consumption telematics data prevented the study from calculating actual energy consumption for each vehicle and duty cycle. The energy data that was received was too narrow to extrapolate within the sector-sizing analysis.

This is important as mileage alone is not a good proxy for energy consumption for larger vehicle categories. There are many other major consumers of energy including auxiliaries, i.e. power-take-off technologies that power on-board equipment like cranes.

To resolve this, the energy consumption profile of each vehicle was estimated based on adjusting real daily mileage to additional energy demands. To capture a holistic view of energy demand from transport, the calculation combines methods from the UK Government's GHG Conversion Factor methodology and the VECTO methodology.

- **Energy economy for transition category** was calculated by reversing the method used by the UK Government's GHG Conversion Factors to establish fuel economy for different vehicles and fuel types in MPG.[4] All fuels are converted to kWh (net CV).

- **An operational adjustment factor** has been included to reflect additional energy loads that can be estimated from telematics data that included energy metrics. This has been based on observing the difference between mileage-only energy consumption and real world energy consumption. This included:
    - idling, an estimate has been assumed from fleets with idling values in their telematics submissions.
    - Payload, this has been assumed as 50% throughout.

- **A technical adjustment factor** is an uplift from the kWh calculated previously for each fuel. This is to account for additional energy consumption and losses associated with running vehicles, especially trucks. The VECTO simulation tool has been applied.

In the EU, the VECTO simulation tool has been established to ensure accurate energy and emissions data is attributed to each vehicle at the point of purchase (European Commission, 2017). VECTO considers numerous dynamic and fixed variables based on real world tests[5]. While VECTO is not a model designed for the nature of this study, the outputs published using this method have been used to provide a more accurate estimation of transport emissions (HBEFA, 2022). HBEFA provides energy consumption data for various European countries.

Key assumption: An average for German and French results (MJ/km) was adopted and compared with UK MPG data. An uplift % was attributed to the difference between these two values. All energy values were converted to kWh using standard conversions (see appendices).

Step 2: Daily energy capacity

$$Daily\ energy\ capacity = a * b$$

value	definition	unit	source
Daily energy capacity		kWh	
a	Total battery capacity	kWh	Published specifications (see appendices)

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[4] DfT ended the regular collection of MPG data from fleets in 2017. Fleets reported difficulties in monitoring and reporting this data. The UK Government GHG Conversion Factors in 2023 remain based on the last submission of MPG data dating from 2017.
[5] Calculations within the VECTO model include engine profile, air resistance, rolling resistance, gradient, vehicle characteristics, mission profile and auxiliary systems.

b	Usable battery capacity	%	This study

Individual battery capacities for each vehicle category were assumed as follows. These batteries improved in three year increments with an assumption of a doubling of capacity by 2033.

Vehicle category	2024 (kWh)	2027 (kWh)	2030 (kWh)	2033 (kWh)
Truck Heavy-Duty	460	690	690	920
Truck Medium-Duty	420	504	630	840
Truck Light-Duty	210	252	315	420
Van Large	110	132	165	220
Van Medium	110	132	165	220
Van Small	50	60	75	100
Pick-up / 4x4	88	105.6	132	176
Car	60	72	90	120

The electric range is adjusted down to better reflect real world conditions. Data for this is extremely limited so high level assumptions have been made. The results of real world testing carried out by Cenex for the BETT project have been used to select this assumption (Cenex, 2023). Further data is required to better understand the impact of real world conditions in these specific fleets.

Step 3: Minimum operational viability

$$Electric\ feasibility\ =\ \%\ of\ Electric\ feasible\ days\ >\ 96\%\ of\ operational\ days$$

For each vehicle, a measure of feasibility is calculated from the number of operational days across a calendar year that the battery electric alternative was feasible.

Key assumption: The analysis has not required 100% battery electric feasibility for a vehicle to be considered for transition. A threshold of 96% of operational days was set based on industry discussions. This is equivalent to one day a month not being feasible. The reason for this is that “business-as-usual” is not expected to remain static in transitioning from diesel to electric. An electric transition for each vehicle is based on a range of additional aspects to consider, including route-optimisation and fleet allocation tasks by the fleet manager. There is no common "rule-of-thumb" for the transition to electric for any individual vehicle, but the 96% rule is used to offer a high level estimate of the viability.

Test 2: Optimal charging cycle for electric vehicles

Suitable vehicles were considered for whether they had sufficient time to be recharged during typical working day conditions.

$$charging\ feasible\ day\ =\ recharging\ opportunity\ \geq\ energy\ requirement$$

A "charging feasible day" is considered one where the vehicle is depot-located and there is a sufficient recharging window between operations.

Key assumption: For medium vans and heavier categories, only return-to-depot fleets were considered feasible for battery electric in 2024. This is due to the lack of a public charging infrastructure for commercial vehicles. A viable infrastructure is expected by 2027 onwards. However, with results from the survey showing that almost 100% of storage was return-to-depot, this was not a major consideration.

Step 1: Recharging opportunity

$$recharging\ opportunity\ =\ a\ *\ b\ *\ c$$

value	definition	unit	source
Recharging opportunity	How much could be recharged each day	kWh	
a	Total available minutes per day	minutes	This study; telematics data
b	Charging capacity	kW	Published specifications
c	Energy losses	%	Industry discussions

A key limitation acknowledged is the potential for overnighting on-base. Facilities vehicles that remain on location will have high levels of down-time but without access to recharging infrastructure coupled with additional energy consumption. This data was not included in any telematics or any fleet data.

Total available minutes per day is calculated for each vehicle considered in the telematics data. This is a measure of the minutes available in the 24 hour period where the vehicle is expected to be stored at the depot.

Capacity for charging is calculated using assumed factors for AC and DC charging capacity. These are given for each vehicle category in the table below. It is assumed that AC charging would be the predominant use for EV charging at depot, but DC was considered if AC charging was not feasible.

Energy losses are applied at a simple percentage of 20%, making EV charging 80% efficient. It is understood that maximum charging capacities are rarely achieved but there is limited common data on the amount of losses. For this reason, a flat rate of 20% is applied to ensure the recharging time is not over-estimated.

Vehicle category	AC charging capacity (kW)	DC charging capacity (kW)
Truck Heavy-Duty	22	375
Truck Medium-Duty	22	150
Truck Light-Duty	22	100
Van Large	22	100
Van Medium	22	80
Van Small	11	80
Pick-up / 4x4	11	80
Car	11	150

Step 2: Energy requirement

A sufficient recharging time period is considered an opportunity to recharge either 60% of the battery or up to 80% SOC (State of Charge). Electric vehicles return to depot at different levels of SOC, the analysis will not penalise insufficient charging windows if the SOC remains above 50%.

The following maximum charging power capacities are considered for depots:

	2024	2027	2030	2033
Car; Pick-up / 4x4; Van Small	22kW AC	22kW AC	22kW AC	22kW AC
Van Medium	43kW AC;	43kW AC;	43kW AC;	43kW AC;

and heavier	150kW DC	150kW DC	350kW DC	350kW DC

After Step 2, the analysis will have concluded which vehicles will be technically feasible for transition using electric vehicles.

Test 3: Optimal location for infrastructure

The final test is for whether the infrastructure can exist at the location of the storage depot for each vehicle. This was based on a response collected within the survey data. 36% of survey respondents who were suppliers answered that they were unable to install infrastructure at their operational facility. As such, it was assumed that for van and truck fleets 36% would be restricted by infrastructure installation.

Investment cycle

$$date\ of\ electric\ transition\ =\ (date\ of\ vehicle\ replacement\ \geq\ date\ of\ vehicle\ availability)$$

This final calculation offers a theoretical year of transition for each individual vehicle.

Vehicle replacement is on a “one in, one out” basis applying the investment cycles as stated and extrapolated from the Level 1 fleet summary sheet.

Scenarios

Three scenarios were developed to illustrate the impact of no limitations, alongside key possible limitations of the transition.

Scenario 1: Base Scenario

This is the core scenario adopted by the research and all general findings presented in the report that do not relate to a scenario. This assumes all vehicle transitions occur as desired with no additional limitations experienced. It should therefore be considered the soonest the transition could occur and relies on additional interventions.

Transition to HVO is defined by whether the diesel vehicle had the opportunity to install infrastructure onsite: those that have the opportunity but do not use HVO yet, do adopt by 2025; those that do not have the opportunity, adopt by 2029.

Scenario 2: Limited Vehicles Scenario

This scenario assumes that electric vehicle model supply will not meet the demand of the fleet. The model for vehicle transition is limited for vans and trucks only - no limit is expected for cars, pick-ups and 4x4s.

This model is generated by a limit to the number of vehicles in each category being transitioned per year (after a quota for that vehicle category is filled, all further vehicles that could transition are postponed until the next available quota). This creates a smoothing effect on the transition, softening any dramatic curves.

Scenario 3: Limited Infrastructure Scenario

This scenario assumes that infrastructure for renewable fuels and electricity is not able to be installed in line with the opportunity to transition. The model for vehicle transition is again limited for vans and trucks only - no limit is expected for cars, pick-ups and 4x4s with the maturity of the public charging infrastructure for these vehicle categories already established.

This model is generated by a delay factor of five years. This is applied to each vehicle category being transitioned each year. This creates a delayed effect but does not affect the transition curve.

Research Question 4

How much will this transition cost?

This research question applies a dynamic TCO (Total Cost of Ownership) model to the transition that previous research questions have created. The TCO model calculates a cost for each pathway scenario and compares this against the baseline scenario. It is dynamic in that it is considering each asset over its own individual lifespan. Collectively, this allows the study to understand the cost (positive or negative) of making this transition happen.

The TCO model used existing literature as a template. It compares diesel and electric (battery and hydrogen fuel cell) drivetrains for the heavy goods vehicle market. The same model, with different assumptions has been applied to all other categories of vehicle and MPU.

Not in scope of this TCO is a Net Present Value (NPV) calculation. This calculation indicates the profitability or lack of of the investment and is outside of the focus of this research.

Data Sources

This TCO model is based on existing literature. No single TCO analysis of all vehicle models and technologies covered here is available. Instead several have been used to provide the methodology template and inputs for the data:

- Cars, pick-ups and 4x4s (LeasePlan, 2022)
- Vans (Transport & Environment, 2022)
- Trucks (TNO, 2022) (ICCT, 2021) (Green Finance Institute, 2023)

Where gaps in the data existed, assumptions have been made using the existing data available.

The table below illustrates the key parameters included for the model:

Parameter	Value
Timeframe	2024-2040
Ownership perspective	First ownership
Vehicle cost	included
Infrastructure cost	included
Maintenance costs	included
Fuel and energy costs	included
insurance costs	included
Cost of capital	included
VAT (and other recoverable taxes)	excluded
Taxes and tax benefits	excluded
Emission zone charges	excluded
Personnel costs	excluded
Overheads	excluded
Carbon tax	excluded

Time frame

This model matches the time frame for transition established in Research Question 3, the output will include a year of transition from 2024 onwards for every asset in London's film and TV production industry. Data presented in the report limits the TCO results to scenario time frames.

Vehicle price

This study found that there is no single common method of vehicle acquisition and retention. To provide a useful common estimate across vehicle categories, this TCO analysis has created an annual cost of the vehicle based on a straight-line depreciation method:

$$annual\ vehicle\ cost\ =\ \left(\frac{a-b-c}{d}\right)\ *\ (1\ +\ e)$$

value	definition	unit	source
Annual vehicle cost	Price of the asset only, amortised to annual payments	£000s per year	
a	Upfront vehicle cost	£000s	Various, see data table below
b	Upfront vehicle subsidy	£000s	(UK Government, 2023)
c	Residual value (RV)	£000s	This study, calculation provided below
d	Investment cycle	years	This study, answers from the sector-wide survey
e	Cost of finance	%	(Green Finance Institute, 2023)

The UK Government provides purchase grants for plug-in vehicles in the financial year 2023/2024. This analysis has assumed that these would continue for vans and trucks. The cost of finance is set at an interest rate of 6%. This is based on an average of the scenarios suggested in the literature (Green Finance Institute, 2023).

Upfront vehicle cost

This is variable based on vehicle category. All prices are based on a "first owner" perspective, used vehicle pricing is not considered. Values in italic are assumed from the closest relatable technology.

	Diesel	**Petrol**	**Plug-In Hybrid**	**Electric**	**Hydrogen**	**Source**
Cars,	25	25	32	32		Own research
Pick-ups, 4x4s	30	30	40	50		Own research
Small Vans	19	*19*	*29*	29		(Transport & Environment, 2022)
Medium Vans	32	*32*	*45*	45	*45*	(Transport &

						Environment, 2022)
Large Vans	32	*32*	*45*	45	*45*	(Transport & Environment, 2022)
Light-Duty Trucks	64	*64*	*166*	166	235	(Green Finance Institute, 2023)
Medium-Duty Trucks	88	*88*	*235*	235	432	(Green Finance Institute, 2023)
Heavy-Duty Trucks	103	*103*	*283*	283	485	(Green Finance Institute, 2023)

Residual value

The RV of the asset is calculated to estimate opportunity for discounting new purchases

$$residual\,value\ =\ a\ -\ (a\ *\ b\ *\ c)$$

value	definition	unit	source
Residual value		£000s	
a	Total vehicle cost	£000s	Various, see data table below
b	Depreciation rate	%	(ICCT, 2021)
c	Investment cycle	years	This study, answers from the sector-wide survey

A fixed depreciation rate of 7.5% per year is applied (ICCT, 2021). A second depreciation rate based on ICCT's work that calculates VKT (Vehicle Kilometres Travelled) has not been employed due to a lack of data on the expected total lifespan of vehicles.

Investment cycles

This model does not have a fixed lifespan of ownership (e.g. five years). This project offers a lifespan for each vehicle based on the sector-wide survey. Where data has not been provided in the sector-wide survey, an average from all survey responses has been provided for each category. It assumes all fleets are "first owners" and this is reflected in the purchase and lease price.

Vehicle category	Average investment cycle
Car	6
Pick-up / 4x4	6
Small Van	4
Medium Van	5
Large Van	8
Light-Duty Truck	5
Medium-Duty Truck	7
Heavy-Duty Truck	8

Infrastructure costs

A transition to electric vehicles and HVO fuels is expected to involve investment in the infrastructure at the operational facility of the fleet. These have been included within the TCO of the vehicle. Hydrogen has been assumed to be a forecourt product and, therefore, not included in infrastructure. The lifespan of the infrastructure is expected to be at least that of the vehicle. A summary of technology-specific assumptions is given below:

Technology	Value (£ per vehicle)	Assumption
HVO: bunker fuel tank	50	Fuel tank costs are spread across the fleet of diesel vehicles.
Electric: chargers	200 per car 400 per van 5,000 per truck	Electric vehicle chargers are medium to high cost. AC chargers are at the lower end. This analysis assumed a £20,000 investment for 10 units at one depot for the slower options, increasing to double

		this for van fleets. Trucks are expected to require a DC network, with an investment of £25,000 per DC charger, with five vehicles able to use it over the lifespan.

A major uncertainty exists around grid upgrade costs. This can vary from zero to £100,000s of investment depending on the exact location of each installation. This is beyond the scope of this project to estimate but should be considered for specific investments.

Maintenance costs

Costs for repair, replacement and preventative care have all been considered.

$$annual\ maintenance\ cost\ =\ a\ *\ b$$

value	definition	unit	source
Annual maintenance cost		£000s per year	
a	Estimated maintenance cost per vehicle category	Pence per mile	Various, see data table below
b	Total annual mileage per vehicle category	miles	This study

Data assumptions and sources for the maintenance cost per mile are given below. All values are in the unit of pence per mile. Values in italics are assumed from the closest relatable technology.

	Diesel	Petrol	Plug-In Hybrid	Electric	Hydrogen	Source
Cars,	3.9	4.1	4.2	4.0	*4.0*	(LeasePlan, 2022)
Pick-ups, 4x4s[6]	4.8	4.9	5.0	4.9	*4.9*	(LeasePlan, 2022)
Light-Duty	3.4	*3.4*	*3.4*	3	*3*	(Transport

[6] A large SUV category was used as a proxy for the 4x4.

Vans, Medium-Duty, Vans						& Environment, 2022)
Large Vans	4.6	*4.6*	*4.6*	3.8	*3.8*	(Transport & Environment, 2022)
Trucks (all)	25	*25*	*25*	18	22	(TNO, 2022)

Fuel and energy costs

To calculate annual fuel costs (fuels, electricity or hydrogen), the following calculation was made:

$$annual\ fuel\ cost\ =\ a\ *\ (\frac{b}{c})\ *\ d$$

value	definition	unit	source
Annual fuel cost		£000s per year	
a	Estimated energy use per vehicle category	kWh per mile	This study (see Research Question 3)
b	Cost of a unit of fuel (litre, kWh, kg)	£	Published data points, see below
c	Energy capacity of a unit of fuel (litre, kWh, kg)	kWh per unit	Published data points, see below
d	Total annual mileage per vehicle category	miles	This study

Fuel prices are highly volatile, prices may go up and down for all fuels. This makes annual forecasts difficult and long-term predictions even more challenging. In the absence of a single source that compared all fuel costs for the long-term, baseline year costs have been assumed.

For petrol and diesel, this analysis assumes fuel values based on an average of 2022 and 2023 prices. VAT has been removed from the analysis as a recoverable cost. AdBlue is added as an uplift factor to diesel and HVO only[7]. Electricity values are based on an average of 2022 and 2023 prices to a small/medium sized business. Hydrogen is the fuel used for next generation technologies. It has been priced per kg at a 2020 price point. This research acknowledges that prices for hydrogen are forecast to drop for this fuel but maintains the baseline year to keep the analysis comparable. Plug-in hybrid vehicles are assumed to have a blended value of petrol and electricity at a 50:50 ratio. All other technology mixes have been excluded as per the methods outlined above.

	Value (pence per unit)	Source
Diesel price ex. VAT	139.9	(UK Government, 2024)
HVO	153.89 (10% uplift to diesel price)	Industry discussions
AdBlue	3% uplift to diesel price (diesel = 144.10) (HVO = 158.50)	Industry discussions
Petrol price ex. VAT	130.2	(UK Government, 2024)
Grid electricity	26.2	(UK Government, 2023)
Green hydrogen	937[8]	(ICCT, 2022)

Insurance costs

Costs for insurance of each vehicle have been considered.

$$annual\ insurance\ cost\ =\ a\ *\ b$$

[7] There is no consistency from previous TCO analyses as to whether AdBlue is considered as a fuel cost or a maintenance cost. For the purposes of this analysis, it has been included as a fuel cost.
[8] Converted from the cost of €11.00 as written in the cited source.

value	definition	unit	source
Annual insurance cost		£000s per year	
a	Estimated insurance cost per vehicle category	Pence per mile	Various, see data table below
b	Total vehicles per vehicle category	vehicles	This study

Data assumptions and sources for the insurance per year are given below. All values are in the unit of pence per mile. Values in italics are assumed from the closest relatable technology.

	Diesel	Petrol	Plug-In Hybrid	Electric	Hydrogen	Source
Cars,	1	2	2.1	2	*2*	(LeasePlan, 2022)
Pick-ups, 4x4s[9]	2.4	2.4	2.5	2.4	*2.4*	(LeasePlan, 2022)
Light-Duty Vans, Medium-Duty, Vans	3.4	*3.4*	*3.4*	3	*3*	(Transport & Environment, 2022)
Large Vans	4.6	*4.6*	*4.6*	3.8	*3.8*	(Transport & Environment, 2022)
Trucks (all)	25	*25*	*25*	18	22	(TNO, 2022)

[9] A large SUV category was used as a proxy for the 4x4.

Research Question 5

What is the appetite for this transition within the industry, and how might it be increased and expedited?

This final research question uses the responses from the sector-wide survey to explore key attitudes and expectations for a transition away from diesel fuels. The method here is a descriptive analysis of the questions asked. A full list of these questions is provided separately.

Key Assumption: The sample from the sector-wide survey is representative of the film and TV production industry as a whole. It offers a broad group of stakeholders and a minimum threshold has been met for each stakeholder group.

Mobile Power

Research Question 1

What does the MPU fleet of London's film and TV supply industry look like?

Key assumption: To calculate the total power fleet of London's film and TV production industry, the study used multiple data sources, each with differing levels of accuracy.

Calculations

$$Total\ fleet\ =\ Total\ mobile\ power\ units$$

MPUs were categorised based on power output:

- 15 kVA or less
- 16-30 kVA
- 31-60 kVA
- 61-90 kVA
- 91-120 kVA
- 121-150 kVA
- 151-250 kVA
- 251 kVA or more

In addition to the number of each category of vehicle or MPU, key characteristics were captured including asset age, fleet life expectancy, adoption of alternative fuels and days of operation.

Research Question 2

What is the carbon footprint of mobile power from London's film and TV suppliers?

This study adapted the transport methodology for carbon footprint to MPUs.

Key Assumptions:

- Emissions analysis: This is explicitly a carbon footprint analysis. Air pollution analysis is not calculated as part of this project.
- Greenhouse gas (GHG) analysis: The full GHG profile is considered, not just carbon dioxide. This study measures GHGs using the CO_2e unit.
- Fuel selection: If not stated from the fleet data, regular forecourt diesel (average biodiesel mix) is selected as the default fuel for a vehicle.

Calculations

The following calculations were used and combined for the total carbon footprint.

For each owned MPU:

$$Total\ carbon\ footprint\ =\ WTW\ factor\ x\ total\ days\ x\ average\ daily\ consumption\ x\ MPU\ category\ mix$$

	definition	unit	source
WTW factor	The combined factor for GHGs for this MPU category	kg CO2e per day	This study, see WTW calculation below
Total days	The estimated total annual operational days per MPU category	days	This study, sector-wide survey, sector-sizing analysis
Average daily consumption	The estimated average for amount of energy consumed	litres/kg/kWh	This study, production datasets
MPU category mix	The proportion of each fuel type for each MPU category	%	This study, sector-wide survey, Research Question 3

Step 1: WTW factor

A calculation for WTW emissions is made for every MPU category, fuel type and fuel use.This is formed by multiplying the energy economy with all the individual emissions stages of a WTW analysis.

$$WTW\ factor\ =\ a\ +b+c+d$$

	definition	unit	source
WTW factor	The combined factor for GHGs for this vehicle category	kg CO2e per kWh	This study
a	Well-To-Tank (WTT) emissions factor	kg CO2e per kWh	(UK Government, 2023)
b	Electricity Generation	kg CO2e	(National Grid, 2023)

	emissions factor	per kWh	
c	Electricity Transmission and Distribution emissions factor	kg CO2e per kWh	(UK Government, 2023)
d	Tank-To-Wheel (TTW) emissions factor	kg CO2e per kWh	Various, see below

Note: all emissions calculations match those shown in the section Transport Research Question 2 so have not been repeated here.

Step 2: Total operational days

An assumption was made for the average operational days across all MPU categories of 170 days. A single figure was selected because of a lack of sufficient data to consider individual MPU categories. 170 days was the average across all MPUs collected in this project.

Total operational days were calculated for each MPU category by multiplying the number of each category in the fleet, from Research Question 1, by 170 days.

Step 3: Average daily consumption

This data was calculated from the production datasets collated for this project. By taking real world daily consumption of fuel, an average value for each MPU category was calculated.

Step 4: MPU category mix

A calculation was made for the proportion of each MPU category that belonged to each fuel type. This percentage enabled the analysis to estimate how many miles, and therefore kWh, were attributable to that particular WTW factor.

Research Question 3

When will the fleet’s transition away from fossil fuels be possible?

This question challenges the study to find pathways to transition to alternatives to fossil fuels. This study answers this question through a series of logical tests for the feasibility of the transition of each MPU asset between now and 2040. This result is aggregated and extrapolated to see what this could look like for the whole industry.

Calculations

As per the transition hierarchy outlined previously, the calculation is made for the transition to batteries from generators operating on fossil fuels today. If a battery is not suitable, a hybrid or “next generation” technology is selected. It is assumed that any MPUs operating already as batteries remain with this technology. It is assumed any MPUs operating with petrol always switch to batteries.

The calculation requires three logical tests to be carried out:

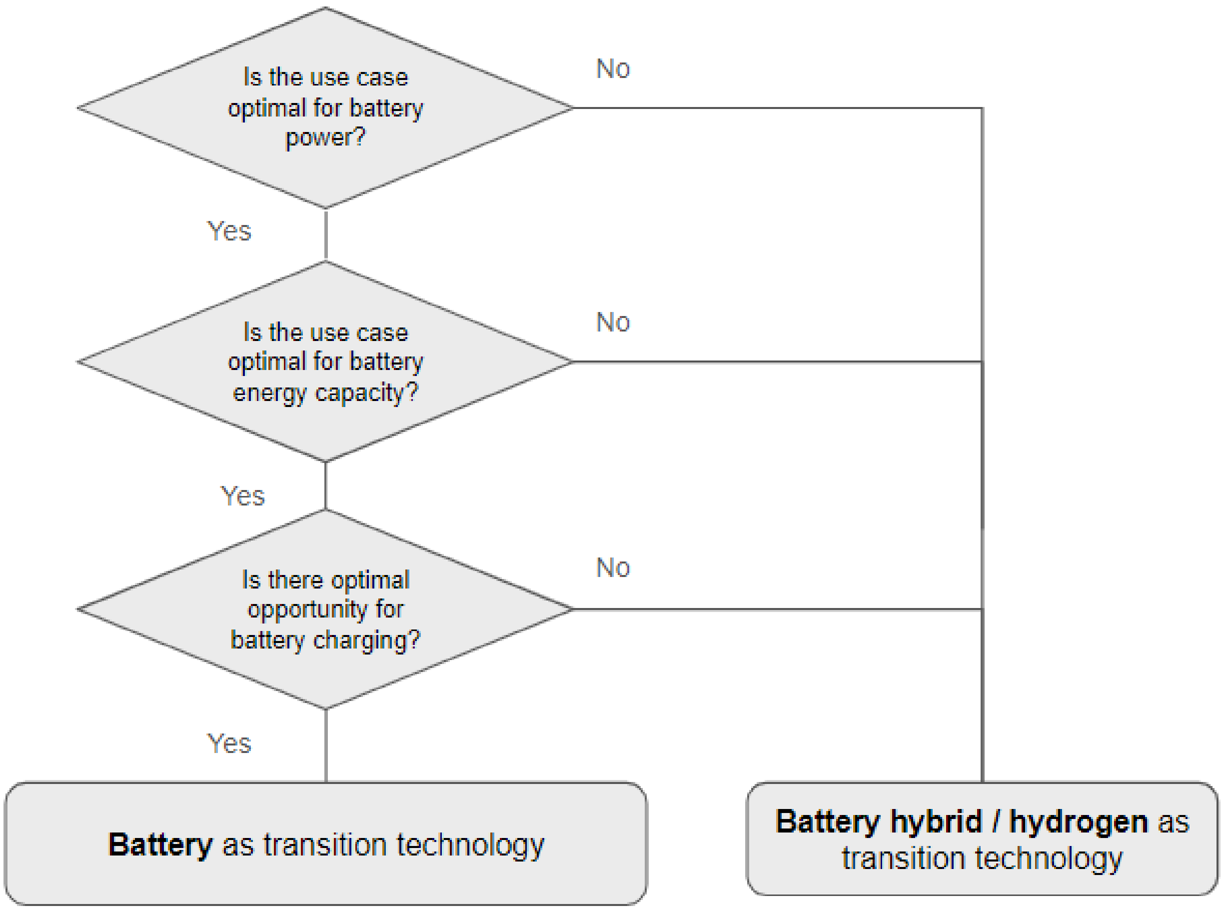

Figure 9: a flow chart of the series of tests for the MPU transition model.

Test 1: Optimal power for batteries

To calculate whether the battery is a feasible alternative to the traditional generator, the model begins by comparing usage of each MPU and the technical potential of the decarbonisation technology. Specifically, it is important to understand the power (load) that the MPU is running on. The following rule is applied:

$$Power\ feasible\ day\ =\ power\ \ demand < \ power\ capacity$$

Step 1: Daily power demand

$$Daily\ power\ demand\ =\ a\ *\ b$$

value	definition	unit	source
Daily power demand	**The peak load demanded each day**	kW per day	
a	Recorded peak load	kW per day	This study; live generator monitoring; telematics submissions
b	Additional margin	%	This study

This calculation enables the project to understand a realistic estimate of how much energy is required in the battery to begin with to deliver the energy for its intended purpose.

- **Recorded peak load** is established from data collected in the live generator monitoring project including peak kW consumption for each day of a generator's rental period. Data was provided in either real or apparent power units. A standard power factor was used to convert between the two (see appendices).

- **Additional margin** is to deliberately “overspec” to ensure all load requirements are met. A factor of 120% of power has been included for the purposes of this study (e.g. if the peak load was 10kW, the additional margin factor would make this 12kW).

Step 2: Daily power capacity

$$Daily\ power\ capacity\ =\ a$$

value	definition	unit	source
Daily power capacity		kW	
a	Total load capacity	kW	Published specifications; (Skoon, 2024)

This calculation enables the project to understand a realistic estimate of how much energy is required in the battery to begin with to deliver the energy for its intended purpose.

Load capacity is established from the specifications of batteries available to the supplier market. This methodology has not adjusted for changes to load capacity over time.

Specifications are made from analysing specification data for 95 MPUs available on the market. This data was sourced from submissions to the supplier-wide survey and a third party database for battery, hybrid and hydrogen power solutions (Skoon, 2024). All assumptions for load capacity are included in the summary table below.

MPU transition category	2024 (kW)	2027 (kW)	2030 (kW)	2033 (kW)
15 kVA or less	13	13	13	13
16-30 kVA	20	20	20	20
31-60 kVA	40	40	40	40
61-90 kVA	80	80	80	80
91-120 kVA	90	90	90	90
121-150 kVA	125	125	125	125
151-250 kVA	200	200	200	200
251 kVA or more	350	350	350	350

Test 2: Optimal energy for batteries

For MPU days that meet load specifications of the battery, they are tested for whether their energy requirements would also meet the same specification. This is to measure whether the battery would run out without completing a day's use.

Step 1: Daily energy demand

$$Daily\ energy\ demand\ =\ a\ *\ b$$

value	definition	unit	source
Daily energy demand		kWh per day	
a	Recorded peak energy consumption	kWh per day	This study; live generator monitoring
b	Technical adjustment factor	%	(ERM, 2023)

This calculation enables the project to understand a realistic estimate of how much energy is required in the battery to begin with to deliver the energy for its intended purpose.

Recorded peak energy consumption is established from data collected in the live generator monitoring project including direct kWh consumption for each day of a generator's rental period.

A technical adjustment factor is an uplift in the kWh requirement to account for efficiency losses from the powertrain. A fixed rate of 80% efficiency is assumed from a UK Government feasibility study on the potential for batteries in NRMM (ERM, 2023).

Further real world adjustment factors, such as winter conditions, have been assumed within the recorded energy requirement only. The live generator monitoring project took place during winter months, as such it is understood that there is this bias in much of the data. However, this bias has been balanced with other production datasets collated as part of the project.

Step 2: Daily energy capacity

$$Daily\ energy\ capacity = a * b$$

value	**definition**	**unit**	**source**
Daily energy capacity		kWh	
a	Total battery capacity	kWh	Published specifications; (Skoon, 2024)
b	Usable battery capacity	%	This study

Total battery capacity is established from published specifications and is provided below.

Usable battery capacity is the amount of the battery that is actually available for use. For safety and technical reasons, not the full energy capacity of a battery can be utilised. Based on observed data from certain battery specifications, this study has assumed 80% as a conservative estimate to apply to all battery chemistries.

This study’s assumptions for usable battery capacities for each transition category were assumed as follows:

MPU transition category	**2024 (kWh)**	**2027 (kWh)**	**2030 (kWh)**	**2033 (kWh)**
15 kVA or less	9.6	11.52	14.4	19.2

16-30 kVA	48	57.6	72	96
31-60 kVA	60	72	90	120
61-90 kVA	112	134.4	168	224
91-120 kVA	80	96	120	160
121-150 kVA	120	144	180	240
151-250 kVA	376	451.2	564	752
251 kVA or more	416	499.2	624	832

Test 3: Optimal charging cycle for batteries

Batteries that were successful in tests 1 and 2 were tested for whether an appropriate charging cycle could be established.

At this stage of the market for batteries, there are a wide variety of recharging models being adopted:

- Offsite battery recharging: recharging batteries while not in use away from the operations (e.g. at an electric vehicle charger) returning them when required.
- Onsite battery recharging: recharging batteries while not in use but without moving them. This could be from other batteries or a diesel generator.
- Grid power: recharging from a grid connection local to the use location.
- Auxiliary power: recharging via connected solar photovoltaics.
- Depot charging: recharging at the place of storage between rental periods.

For this analysis, the offsite battery recharging model is adopted. This is based on industry conversations and research into the growth of battery recharging services in the industry (Third Derivative, 2023). This analysis assumes a battery can be recharged faster than the rate at which it is used on a production[10]. To calculate this, the model adopted the following formula:

$$charging\ feasible\ day\ = battery\ recharging\ opportunity\ \geq recharging\ requirement$$

Step 1: Battery recharging opportunity

$$recharging\ opportunity\ = a$$

value	definition	unit	source

[10] If it takes more than a day to recharge and the battery requires replacing every day, then more than one battery will be required to replace each active battery. It is assumed that this becomes too costly as a service to run commercially.

Battery recharging opportunity	**How much could be recharged each day**	**kWh**	
a	Downtime per day	hours	This study; live generator monitoring

Step 2: Recharging requirement

$recharging\ requirement\ = \frac{a}{b}$

value	definition	unit	source
Battery recharging opportunity	**How much could be recharged each day**	**kWh**	
a	Daily energy demand	kWh	This study; live generator monitoring
b	Charging capacity	kW	This study

A sufficient recharging window is considered an opportunity to recharge the battery to the same SOC rather than to 100% SOC every time. This assumption reflects how the MPU is used.

The following maximum charging power capacities were considered for recharging. For this data point, charging capacities have not been considered for each MPU transition category because this factor is most limited by the available recharging infrastructure. This is highly variable and the data has not been collected as part of this study.

AC (kW)	DC (kW)
7	50

After Test 3, the analysis will have concluded which MPUs will be technically feasible for transition using batteries.

Hybrid or “next generation” technology options

When a battery solution is found to not be suitable for the MPU, a hybrid or “next generation” technology is selected. The hybrid solution was anticipated to be a more adopted solution due to market maturity of this particular technology. This is reflected in the technology mix of scenarios.

Key assumptions:

- The duty cycle for hydrogen fuel cell systems is assumed to match the diesel equivalent in all the parameters that the battery systems were limited. As a result, no qualification around the duty cycle or charging cycle have been considered.
- The location of storage of the MPU is the key limiting factor for hydrogen fuel cell adoption due to a lack of public infrastructure for hydrogen refuelling.

Investment cycle

$$date\ of\ battery\ electric\ transition\ =\ (date\ of\ asset\ replacement\ \geq\ date\ of\ asset\ availability)$$

This final calculation offers a theoretical year of transition for each individual MPU.

MPU replacement is on a “one in, one out” basis applying the investment cycles as stated and extrapolated from the Level 1 fleet summary sheet.

Scenarios

Three scenarios were developed to illustrate the impact of key limitations of the transition.

Scenario 1: Base Scenario

This is the core scenario adopted by the research and the findings presented in the report.

This scenario assumes all MPU transitions occur as soon as possible, but no sooner than the expected lifespan for each MPU. Transition to HVO is defined by whether the MPU had the opportunity to install infrastructure onsite: those that have the opportunity but do not use HVO yet, do adopt by 2025; those that do not have the opportunity, adopt by 2029[11].

Scenario 2: Additional Battery Scenario

This scenario assumes that every battery MPU is deployed with the capacity of an additional battery. This can be either having two connected batteries deployed or by offering a battery swapping service. This is applicable for all MPU categories.

This assumption enables an easier transition to batteries, as it directly considers the energy capacity barrier. This creates a smoothing effect on the transition, softening any dramatic curves in the transition.

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[11]The sector-wide survey found that 71% of suppliers who rent MPUs as a service have infrastructure capacity at their operational facility.

Scenario 3: Limited Infrastructure Scenario

This scenario assumes that infrastructure for renewable fuels and electric vehicle charging is not able to be installed in line with the opportunity to transition. The model for MPU transition limits all categories of MPU.

This model uses a delay factor of five years that is applied to 36% of the MPUs. Five years is selected as a high level estimate for the time taken to resolve the infrastructure issue. 36% is based on results from the survey question around infrastructure availability. This delay factor is applied to each MPU category in each year of the model. This creates a delayed effect but does not affect the transition curve.

Research Question 4

How much will this transition cost?

In the absence of an MPU-specific model, the TCO model used existing literature for vehicles as a template for costs of the MPUs.

As per the transport TCO model, a Net Present Value (NPV) calculation is outside the scope of this question.

Data Sources

The literature review found extremely limited previous TCO modelling for MPUs. For costs, the UK Government's feasibility study on NRMM has been used as a key data source (ERM, 2023). It is noted throughout the feasibility study that transport-based studies, such as those referenced in this methodology, are a useful reference for generator-based calculations due to the limited existing literature, yet similar components in the technology.

Where gaps in the data exist, assumptions have been made using the existing data available.

Key Assumptions

The table below illustrates the key parameters included and excluded for the model:

Parameter	**Value**
Timeframe	2024-2040
Ownership perspective	First ownership
MPU cost	included
Infrastructure cost	included

Maintenance costs	included
Fuel and energy costs	included
Insurance costs	included
Cost of capital	included
VAT (and other recoverable taxes)	excluded
Taxes and tax benefits	excluded
Emission zone charges	excluded
Personnel costs	excluded
Overheads	excluded
Carbon tax	excluded

Time frame

This model matches the time frame for transition established in Research Question 3, the output will offer analysis on the baseline year (2023) and every year after until the phase out date for petrol and diesel traditional generators in each scenario.

MPU price

As with the vehicle model, this MPU TCO analysis has created an annual cost of the vehicle based on a straight-line depreciation method:

$$annual\ MPU\ cost\ =\ (\frac{a-b-c}{d})\ *\ (1\ +\ e)$$

value	definition	unit	source
Annual MPUcost	**Price of the asset only, amortised to annual payments**	**£000s per year**	
a	Upfront MPU cost	£000s	Various, see data table below
b	Upfront MPU subsidy	£000s	None
c	Residual value (RV)	£000s	This study, calculation provided below
d	Investment cycle	years	This study, answers from the

			sector-wide survey
e	Cost of finance	%	(Green Finance Institute, 2023)

Upfront MPU cost

This is based on modelling established by ERM in the UK Government's NRMM feasibility study (ERM, 2023). Where a range of values was presented, a central value was selected (e.g. for batteries, from a range of £230 to £280, a £255 value was selected). All prices are based on a "first owner" perspective, used MPU pricing is not considered.

Key assumption: Hybrids represent a sum of diesel generator and battery prices. This makes the hybrid the most expensive option. No independent data source was found so this conservative approach was adopted.

£000s	Diesel	Petrol	Hybrid	Battery	Hydrogen	Source
15 kVA or less	1.04	1.04	*5.153*	4.113	2.9575	(ERM, 2023)
16-30 kVA	1.6	1.6	*18.52*	16.92	4.55	(ERM, 2023)
31-60 kVA	3.2	3.2	*25.565*	22.365	9.1	(ERM, 2023)
61-90 kVA	6.4	6.4	*48.58*	42.18	18.2	(ERM, 2023)
91-120 kVA	7.2	7.2	*39.99*	32.79	20.475	(ERM, 2023)
121-150 kVA	10	10	*58.375*	48.375	28.4375	(ERM, 2023)
151-250 kVA	16	16	*152.05*	136.05	45.5	(ERM, 2023)
251 kVA or more	28	28	*188.95*	160.95	79.625	(ERM, 2023)

Upfront MPU subsidy

At the time of writing, no regular subsidy scheme was found to support the purchase of new MPUs from the UK Government or the Mayor of London. The value for all subsidies have been left at zero.

Residual value

The RV of the asset is calculated to estimate opportunity for discounting new purchases.

$$residual\ value = a - (a * b * c)$$

value	**definition**	**unit**	**source**
Residual value		£000s	
a	Total MPU cost	£000s	Various, see data table below
b	Depreciation rate	%	(ICCT, 2021)
c	Investment cycle	years	This study, answers from the sector-wide survey

In the absence of an MPU depreciation rate, a fixed depreciation rate of 7.5% per year is applied (ICCT, 2021) to match the transport TCO analysis.

Investment cycles

This project offers a lifespan for each vehicle category, as found in the sector-wide survey analysis. It assumes all assets are “first owners” and this is reflected in the purchase and lease price.

MPU category	Average investment cycle
15 kVa or less	7
16-30 kVa	6
31-60 kVa	8
61-90 kVA	7
91-120 kVA	7
121-150 kVA	11

151-250 kVA	12
251 kVA or more	12

Infrastructure costs

Unlike vehicles, all technology transitions are expected to involve investment in infrastructure at the place of storage.

Technology	Value (£ per MPU)	Assumption
HVO: bunker fuel tank	20	Fuel tanks are relatively low cost, with the cost spread across the fleet of diesel and petrol MPUs.
Electric: chargers	200 for 61-90 kVA; 91-120 kVA 5,000 for 121 kVA and above	All battery units will be charged at storage locations. Low power units will not require additional infrastructure. Those above 61 kVA are assumed to be recharged using AC units and those above 121 kVA are assumed to be recharged using DC. These are to account for the large energy capacities and assumed windows for recharging between job allocations.
Hydrogen: fuel tank	450	A 4.5kg tank for 10 MPUs was assumed (ERM, 2023)

Hybrid solutions were calculated to include both the equivalent diesel and electric infrastructure requirement, therefore the two costs were added together.

Maintenance costs

Costs for repair, replacement and preventative care have all been considered. Using the UK Government's feasibility study as a guide (ERM, 2023), this is based on hours of operation.

Key assumption: The more powerful the MPU, the more maintenance that is required.

$$annual\ maintenance\ cost\ =\ a\ *\ b\ *\ c$$

value	definition	unit	source
Annual maintenance cost		£000s per year	

a	Estimated maintenance cost per MPU type	£ per hour per kW	(ERM, 2023)
b	Power capacity per MPU	kW	This study
c	Operational time	Hours per year	This study, Level A data (live generator monitoring)

Data assumptions for the maintenance cost are given below (ERM, 2023). All values are in the unit of £ per hour per kW.

	Diesel	**Petrol**	**Hybrid**	**Battery**	**Hydrogen**
Value (£)	0.95	0.95	*0.855*	0.57	*0.7125*
Difference from the baseline	Baseline	0%	-10%	-40%	-25%

Hybrid maintenance costs were based on an average across the battery and diesel values. Hydrogen maintenance costs are in italic as this is an assumption of the study. This demonstrates an average from hydrogen fuel cell and hydrogen combustion solutions.

Fuel and energy costs

This TCO model only considers the fuelling and/or recharging of the MPU at the start of each usage period[12], providing the asset at 100% full tank or SOC. On-production use varies.

$$annual\ fuel\ cost\ =\ a\ *\ b\ *\ c$$

value	**definition**	**unit**	**source**
Annual fuel cost		£000s per year	
a	Estimated refuel sessions per year	Sessions per year	This study, estimated using Level A (live generator modelling)

[12] Throughout the film or TV production the refuelling responsibility will vary. For rental MPUs, the responsibility for refuelling will be with the client. For MPUs for business operations, the responsibility will remain with the supplier.

b	Cost of a unit of fuel (litre, kWh, kg)	£	Published data points, see below
c	Capacity of MPU	litre, kWh, kg per unit	Published data points, see below

The same prices have been adopted as per the transport TCO assumptions. The calculations will vary based on factors such as the proportion of HVO adoption and the variation of hybrids and next generation technologies.

	Value (pence per unit)	Source
Diesel price ex. VAT	139.9	(UK Government, 2024)
HVO	153.89 (10% uplift to diesel price)	Industry discussions
AdBlue	3% uplift to diesel price (diesel = 144.1) (HVO = 258.5)	Industry discussions
Petrol price ex. VAT	130.2	(UK Government, 2024)
Grid electricity	26.2	(UK Government, 2023)
Green hydrogen	937	(ICCT, 2022)

Multiple units are in use (litres for fuel, kilograms for hydrogen). To convert to a common unit, all fuels were converted to a kWh, see appendices.

Insurance costs

Costs for insurance are highly uncertain, as highlighted in the UK Government's feasibility study (ERM, 2023). No conclusive evidence around the variability of insurance premiums surrounding different MPU power categories or technologies was found. Base assumptions have been applied to complete the TCO model.

$$annual\ insurance\ cost\ =\ a$$

value	definition	unit	source
Annual insurance cost		£000s per year	
a	Estimated insurance cost per MPU category	£000s per year	This study, own assumptions

Data assumptions and sources for the insurance per year are given in £ below. Given these are all uncertain, all are in italic.

	Diesel	**Petrol**	**Plug-In Hybrid**	**Electric**	**Hydrogen**
60 kVA or less	*500*	*500*	*500*	*500*	*500*
61 kVA - 150 kVA	*1000*	*1000*	*1000*	*1000*	*1000*
151 kVA or more	*2000*	*2000*	*2000*	*2000*	*2000*

Research Question 5

What is the appetite for this transition within the industry, and how might it be increased and expedited?

This final research question uses the responses from the sector-wide survey to explore key attitudes and expectations for a transition away from diesel fuels. The method here is a descriptive analysis of the questions asked.

Key assumptions: The sample from the sector-wide survey is representative of the film and TV production industry as a whole. It offers a broad group of stakeholders and a minimum threshold has been met for each stakeholder group.

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Appendices

Common unit conversions employed across the methodologies

	Original unit	MJ	kWh
Diesel	1 litre	36.9	11
Petrol	1 litre	33.7	10
Hydrogen	1 kilogram		33.33

Power factor
For variance between apparent power (kVA) and real power (kW) the following power factor was adopted:

1	kVa	0.8	kW

Transition models for vehicles in 2024

Vehicle category	Reference Model	Fuel Type	WLTP range (miles)	Energy Economy (kWh per mile)	Payload (t)	GVWR (t)	Battery size (kWh)	AC power capacity (kW)	DC power capacity (kW)
Car	MG MG4	Battery Electric	270		0.462	2.113	61.7	11	140
Pick up / 4x4	Maxus T90	Battery Electric	205		1	3.3	88.5	11	80
Van 1t	Maxus eDeliver 3	Battery Electric	168		1	2.475	50	11	80
Van 3.5t	Iveco eDaily	Battery Electric	249		1.1	4.2	111	22	80
Van 3.5t Luton	Iveco eDaily	Battery Electric	249		1.1	4.2	111	22	80
Van (unknown)	Iveco eDaily	Battery Electric	249		1.1	4.2	111	22	80
Truck 3.5-7.5t Rigid	FUSO eCanter	Battery Electric	87		1.7	4.25	83.6	22	104

Truck 18t Rigid	DAF XB FA Electric 19t	Battery Electric	217	0.603 273	11.7	19	282	22	150
Truck 26t Rigid	DAF XD FAG 6x2 Electric	Battery Electric	304		18	29	525	22	325
Truck 26t Artic	Mercedes Benz e-Actros 300	Battery Electric	205		17.7	27	336	22	150
Truck 36-44t Artic	Renault Trucks etech T	Battery Electric	500		30	44	468	22	250
Truck (unknown)	Volvo FM	Battery Electric	187		23	44	450	43	250

Template for vehicle fleets spreadsheet

Business name:

Registration plate	Make & Model	Category	Fuel type	Is a renewable fuel used?	Annual mileage (miles)	Storage location	First year on fleet	Expected total lifespan in fleet (years)

Template for generator fleets spreadsheet

Business name:

Make & Model	EU Emissions Stage	Power rating	Fuel type	Is a renewable fuel used?	Days in operation per year	First year on fleet	Expected total lifespan in fleet (years)	