Electric Taxi Introduction: A review of vehicle availability, performance, and economics

Introduction to electric taxis

Electric vehicle availability

Today more and more car brands are launching new battery electric vehicle models in order to meet government targets to end the sales of new petrol and diesel vehicles. There are currently 166 fully electric car models available to buy (), and a large proportion of these would be suitable for use as a taxi and offer various benefits to an owner. Electric cars are now available from both lower cost brands (e.g. MG, Kia, Nissan) and higher cost premium brands (e.g. Mercedes, BMW, Tesla). There are also increasingly more electric passenger van vehicles available from brands such as Vauxhall, Peugeot, and Citroën. However, there are currently very few offerings for this type of vehicle with wheelchair accessibility from major brands. Two example vehicles available on the market at present are shown in the table below, the Vauxhall Vivaro-e people carrier and the LEVC TX WAV taxi, which is a PHEV able to run in electric only mode.

Vauxhall Vivaro-e Life Combi M	Battery	Range	AC Charging	DC Charging	Payload	Towing
	45 kWh usable	143 miles WLTP[1]	7h15m at 7 kW	26m at 101 kW (+28 miles per 10m)	507 L 1056 kg	1000 kg
Source: https://ev-database.uk/	Price from: £37,300 (inc. VAT)					
LEVC TX (PHEV)	**Battery**	**Range**	**AC Charging**	**DC Charging**	**Payload**	**Towing**
	31 kWh	64 miles WLTP electric only	4h15m at 7 kW or 1h30m at 22kW	45m at 50 kW	440 L 625 kg	N/A
Source: https://levc.com/tx-taxi/overview/	Price from: £66,960 (inc. VAT)					

How do electric vehicles work?

A battery electric vehicle (BEV) is powered by electricity, charging a battery pack that powers the motor to turn the wheels. This is unlike petrol or diesel powered vehicles, which run off a traditional engine. Electric vehicles are recharged using a dedicated charging unit, where the car is connected to a source of electricity to then store energy in the battery.

[1] The Worldwide Harmonised Light Vehicle Test Procedure (WLTP) is the official laboratory test procedure measuring fuel consumption and CO2 emissions for all new cars.

Electric cars require chargepoints in order to plug in and charge the batteries. These chargepoints can generally be installed anywhere there is access to electricity. They are often found at service stations, specific charging hubs, taxi ranks and if possible, can be installed at drivers' homes. Charging at home requires the driver's house to have somewhere for the charger to go and the car to park up next to it (like a driveway). There are a few options for the power of chargers which affects how fast a car will charge up. For example, a higher power charger can provide a car over 100 miles of vehicle range in an hour, whereas regular home chargers provide around 20 miles per hour.

Environmental Benefits

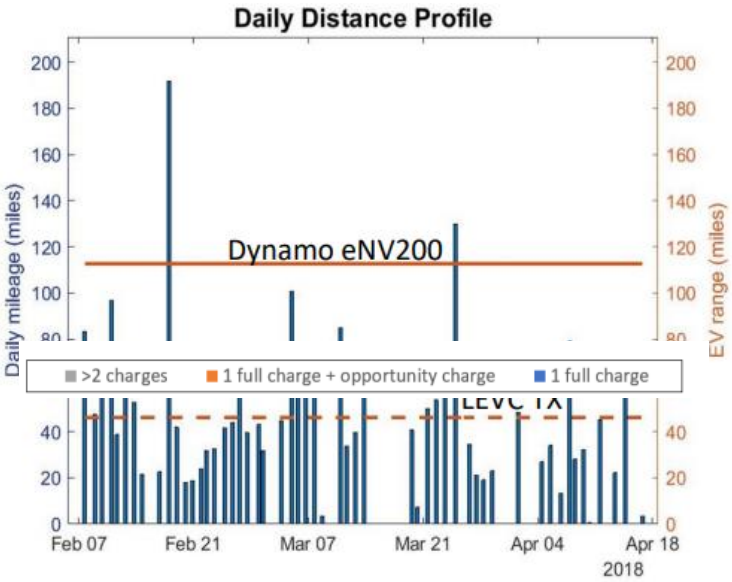
Battery electric vehicles do not have exhaust pipes and therefore produce no emissions when driving, whereas petrol and diesel vehicles produce harmful fumes such as NOx and PM. This means that air quality is vastly improved around electric vehicles, which is particularly important for those in the taxi industry, where poor air quality in taxi ranks can lead to potential future health issues.

Whilst the vehicle may be zero emission when driving, it is important to note that there are emissions involved along the whole life of a vehicle. However, overall, they are still significantly more environmentally friendly than regular vehicles and are therefore often chosen by eco-conscious drivers. An electric car currently produces roughly 3 times less CO_2 (the main greenhouse gas causing climate change) over its life. This equates to a saving of approximately 5 tonnes of greenhouse gas emissions per year for a vehicle completing 25,000 miles (including the production of the electricity), resulting in a substantially decreased contribution to climate change.

Operational Suitability of electric taxis

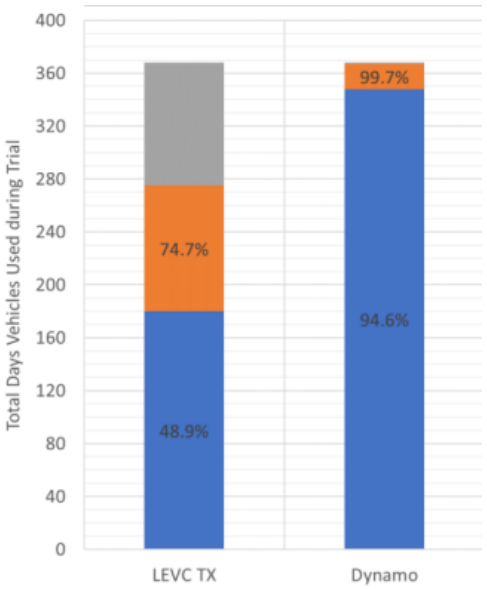
In the chart shown to the right, the daily mileage of a real-world taxi was recorded for a two-month trial and plotted against the expected EV range of the Dynamo eNV-200 WAV (vehicle not available currently but represents a typical fully electric taxi range) and the plug-in hybrid LEVC TX in full electric mode. It can be seen that only on two occasions would the fully EV taxi would have been required to charge more than once per day.

This is also reflected in the second chart to the right where it is demonstrated that during another trial, the full EV was able to complete 97% of the days driven over the trial on one charge only and of the remaining 20 days, only one day required more than two charges.



It is also shown in the two charts that the LEVC TX would be able to complete nearly half of the journeys operating entirely in electric only mode on one full charge. However, this therefore means that a significant proportion of the driving would require the use of the on-board range extender or further charging events.

This demonstrates the importance of understanding the typical daily mileage required by each driver and determining which vehicles may be best suited operationally to them. It is estimated that real world range of these vehicles is approximately 20% lower than the manufacturer reported WLTC figures. Smoother driving and urban driving environments will increase range, but cold weather can also further reduce range by around 20%.



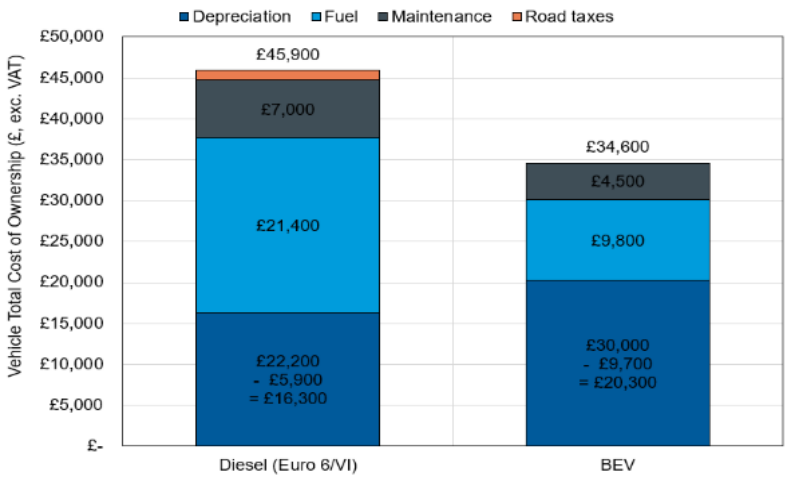
Cost factors for electric taxis

Battery electric vehicles are becoming a more realistic and beneficial option for taxi owners in the UK. The obvious benefit is the positive impact on the environment but there are other key benefits including significant potential cost reductions for taxi owners. When reviewing the potential costs of a taxi, there are differing factors such as mileage, type of vehicle and the lifespan of a vehicle to consider which all affect the overall total cost of ownership of a vehicle. The potential cost savings are also changeable dependant on the type of vehicle or driving environment.

In a recent study of a significant number of taxis, two types of vehicles were reviewed with regards to the total cost of ownership. Firstly, it was found that the most common type of taxi was a medium-sized car (nearly half of all taxis were this type) so were therefore selected for review. The other vehicle type selected was the wheelchair accessible medium-sized van, which do not make up the same kind of numbers but due to their larger size and generally older vehicle types, produce far more emissions per vehicle.

Reviewing costs of owning a medium sized car as a taxi

When looking across a large number of medium sized car taxis, it was found that a vehicle will travel an average of approximately 22,000 miles each year (84 miles per day). Using this number, and assuming a taxi generally operates in an urban environment, an owner of a medium-sized car (of which there are various electric models such as a Nissan Leaf or Hyundai Kona) taxi could save about £11,000 over the life of the vehicle if opting for a battery electric vehicle (using electricity cost at 21p/kWh and diesel at £1.48 per litre).



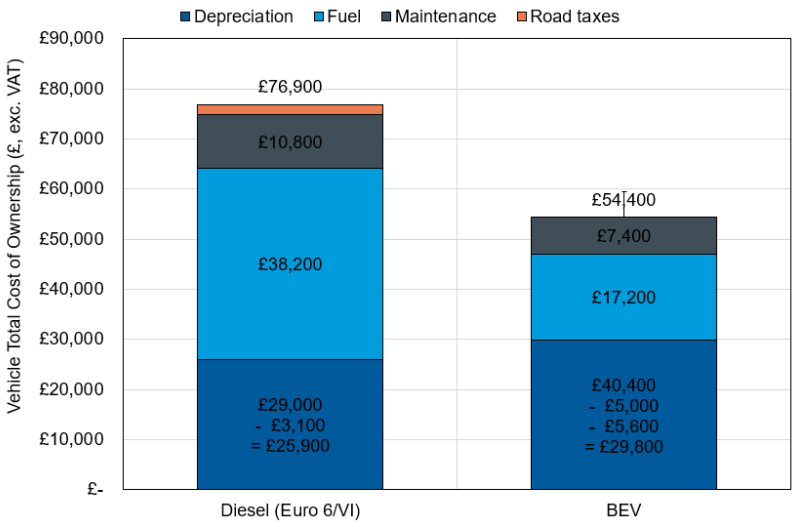
The upfront cost to purchase the vehicle is currently higher for electric vehicles, however cost parity with diesel/petrol vehicles is expected to be achieved by 2025. In order to help decrease the current cost gap, there is a plug-in grant available that allows for up to £3,000 to be discounted off the costs a brand-new car or up to £7,500 to be discounted off the price of a brand-new purpose-built taxi. (Plug-in taxi grant: eligibility and applications - GOV.UK (www.gov.uk))

This grant does not reduce the up-front costs completely and electric vehicles are initially still the more expensive option. However, as can be seen in the chart shown, the fuel costs are significantly lower for an electric vehicle, even with energy prices rising. There is also a slight reduction in maintenance costs since electric vehicles have fewer components and therefore there is less that can generally go wrong or wear out. Combining these, along with the current road tax benefits, mean that the total cost of owning an electric taxi over 7 years, is over £11,000 cheaper.

Further cost savings would be made if ownership periods are longer than the assumed 7 years or if the annual mileage driven is higher than the assumed numbers. The figures here were generated based on a mostly urban driving environment, and cost savings may be reduced if more motorways are used for example. This is because electric cars are generally far more efficient than diesel cars in urban or dense city environments but are typically less efficient (within this car class) on motorways and high-speed roads. However, this kind of driving is rare for taxis and even if a predominantly rural driving environment is considered, there would be an approximate saving of £8,000 over the seven years if an electric vehicle is purchased.

Reviewing costs of owning a wheelchair accessible medium sized van used as a taxi

In previous studies, it was seen that a typical wheelchair accessible medium-sized van taxi travelled further per day than most car-based taxis. On average, these vehicles travelled 28,000 miles annually (108 miles per day). It was assumed that the ownership period of these vehicles is higher, at 10 years and that the urban driving was still applicable. However, availability of electric versions of this type of vehicle is currently low, with very few recognised fully battery electric vehicles available (e.g. Dynamo Nissan eNV-200). However, the number of vehicles available (particularly from vehicle converter companies) is expected to grow in the future.



For the total cost of ownership of this type of vehicle, it is expected that a saving of approximately £22,500 could be made if an electric alternative is purchased. This is largely due to the significant saving due to lower running costs, saving over £25,000 from fuel, taxes and maintenance.

Similarly to the medium sized cars discussed above, if ownership periods or annual mileage was increased, then this saving would increase further. However, it is worth noting that maintenance costs after 10 years could become harder to predict due to the relative immaturity of the electric vehicle market.

Also, despite the large cost saving shown, with very few vehicles of this type available, the current options do not have a particularly suitable electric driving range, averaging at 110 miles, which is very close to the average mileage observed by these vehicles operating as taxis. This would mean that in order to make the vehicle suitable for a taxi driver, either less miles would need to be driven per day (this would also reduce the cost benefits) or a second charge during the day would likely be required.

Total cost benefits for other types of vehicle

Another study into potential total cost of ownership for other types of taxi showed that for most types of vehicle, there is a cost saving for owning an electric equivalent (assuming 25,000 miles per annum). However, as the table on the right shows, electric equivalents of executive vehicle types (such as the more premium vehicles like BMW or Mercedes) can be more expensive over the lifespan of the vehicle. This is mainly due to increased initial

Vehicle Type	Difference in cost vs Diesel equivalent
Large Cars	-£11,600
Executive Cars	£9,300
Small Vans	-£15,800
Large Vans	-£17,600

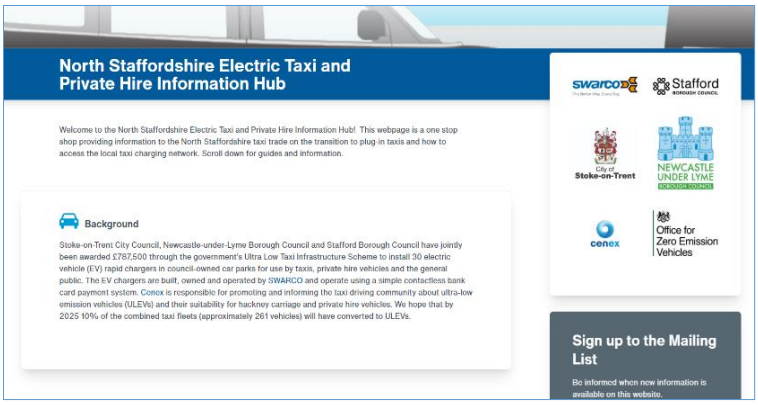
purchase costs that are so significant that fuel savings do not recover the difference.

Maximising Fuel Cost Benefits

As previously mentioned, electric cars are typically significantly cheaper to run, with fuel costs generally representing a cost saving when compared to a diesel equivalent. However, this does largely depend on the cost that is being paid for electricity, which varies considerably from home charging to public charging. Current projections from the Department for Energy Security and Net Zero (DESNZ) over the next five years suggest domestic energy will cost on average 12p/kWh whereas public energy costs could range from 35p to 75p per kWh. The table below shows the comparison of various charging mixes against the fuel costs from running a vehicle using the current average diesel cost of £1.48 per litre. Within this table, it is assumed that the vehicle (of a medium van type) will be driving an average of 28,000 miles. As demonstrated in the table, to ensure running cost savings it is important to prioritise home charging where possible and look for the lowest tariffs when charging from public infrastructure.

Proportion of Charging			Fuel Cost Difference to Diesel (%)
Home 12p/kWh	Low Public 35p/kWh	High Public 75p/kWh	
100%	0%	0%	74% cheaper
75%	25%	0%	62% cheaper
75%	0%	25%	40% cheaper
50%	25%	25%	27% cheaper
25%	50%	25%	15% cheaper
25%	25%	50%	7% more expensive
0%	50%	50%	19% more expensive
0%	100%	0%	24% cheaper
0%	0%	100%	63% more expensive

Additional help and support with owning an electric taxi



Cenex and Swarco have collaborated to provide an **online Taxi Hub** to support the taxi trade with making the switch to electric vehicles. This will act as a base for up-to-date **useful information** regarding things such as upcoming charger locations or relevant events that could provide **key knowledge** to help owners make the most out of their vehicles. On this hub there is also training material for owners to gain further understanding about the technology on their vehicles, ensuring they are using them in the most efficient way and gaining all the benefits available.