Assessing Total Cost of Ownership of Electric Light Commercial Vehicles

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Certified B Corporation

Contents

References:

Where the footnotes below appear throughout the text, this paper references the indicated source:

[1] P Lebeau, C Macharis, J Van Mierlo, 'How to Improve the Total Cost of Ownership of Electric Vehicles: An Analysis of the Light Commercial Vehicle Segment', World Electric Vehicle Journal, Vol 10, 2019.

[2] K Palmer, J E Tate, Z Wadud, J Nellthorp, 'Total cost of ownership and market share for hybrid and electric vehicles in the UK, US and Japan', Applied Energy, Vol 209, 2018.

[3] Y Yang, X He, Y Zhang, D Qin, 'Regenerative Braking Compensatory Control Strategy Considering CVT Power Loss for Hybrid Electric Vehicles', Energies, Vol 11, 2018.

[4] 'Second-life EV Batteries Market Research Report by Type, by Application - Global Forecast to 2025 - Cumulative Impact of COVID-19', 360iResearch, 2021.

Purpose

The purpose of this white paper is to provide a framework for owners of light commercial vehicle fleets to evaluate the total cost of ownership (TCO) of converting to a fleet of electric light commercial vehicles.

The light commercial vehicle fleet segment is one of the largest and fastest growing in the fleet market. Many of these fleets are diesel powered, which studies have shown have the most adverse environmental impacts per ton transported of all vehicle classes.

In this white paper, we look at the key elements to consider in assessing TCO in relation to an electrified fleet of light commercial vehicles. It is important to note upfront that the composition and usage profile of every light commercial vehicle fleet is different and there is not a generic linear formula that can be applied to calculating TCO. Instead, the key to minimising TCO for a fleet of electric light commercial vehicles lies in the optimisation an array of variables.

Overview

Many corporates have historically dismissed moving to an electric light vehicle fleet on the basis of cost and in particular, the TCO equation not being supportive of the business case. Of course, the higher upfront price of an electric light commercial vehicle can potentially be offset over time by their lower running and maintenance costs compared to traditional internal combustion engine (ICE) vehicles. Most TCO calculations are done on an Excel spreadsheet and are somewhat simplistic discounted present value calculations which do not consider all of the key factors necessary.

In a post COVID world, there is increasing impetus by many corporations to move to net zero carbon emissions, driven by demands of customers and shareholders alike. Furthermore, electric vehicle technology is improving, and prices of batteries continue to fall while diesel fuel costs remain high and subject to significant fluctuation. At a headline level, these factors are supportive of an increasingly attractive business case to embrace commercial fleet electrification.

Corporate fleet owners are now facing seemingly competing pressures to accelerate their move to net zero while at the same time reducing costs. It is imperative that they be able to make decisions based on accurate analysis, including in relation to TCO. A linear spreadsheet calculus is not enough and using mathematically driven multivariate optimisation models will be a necessity. Overly simplistic analysis can lead to incorrect decisions that may place a business at a long-term competitive disadvantage.

The key factors to consider in assessing TCO go beyond the upfront price (relative to existing diesel or petrol vehicles) and encompass the following:

- Mileage driven
- Ownership period
- Maintenance and running costs
- Regenerative braking
- Fixed payload
- Variable payload
- Residual value of batteries

- Residual value of vehicles
- Government incentives
- Government taxes

Each corporate fleet customer will be different in terms of these factors and the TCO equation will vary for each potential application. However, given declining battery costs, improving technology that is extending the life and warranty period of batteries, as well as supportive government policies, we believe that the TCO equation is now positive for most commercial fleet owners.

Over the next few pages, we will discuss the list of key factors above in further detail.

Factors in Determining TCO

Mileage Driven

On balance, the more an electric light commercial vehicle is driven, the greater the decline in TCO per kilometre. Due to the lower running and maintenance costs (discussed further below), the TCO of an electric light commercial vehicle will drop faster than the TCO of a conventional ICE vehicle.

Empirical studies suggest that, all other factors being equal, an electric vehicle starts to have a lower TCO than a comparable ICE vehicle once the distance driven exceeds about 15,000 kilometres per year.[1]

Ownership Period

The TCO of electric light commercial vehicles is also very sensitive to the tenure of the ownership period. In general (and assuming no residual value of the battery), the longer the period of ownership, the more the TCO of electric vehicles drops relative to diesel equivalents due to lower running and maintenance costs. As most commercial fleet vehicles are owned for between 8 and 10 years (shorter for mining and other rugged applications), a move towards electrification can often make economic sense based on this element.

However, a complicating factor in practice is the life of the battery. Given that the battery represents the largest input cost for an electric vehicle, if the battery needs to be replaced during the life of the vehicle, this will clearly increase the TCO. If the battery can be rented as opposed to purchased, the equation changes once again. There may even be more than one breakeven point when comparing the TCO of electric and ICE vehicles, e.g., once after 8 years and once after 15 years, if vehicle batteries need to be replaced.[1]

In most cases, the TCO of an electric vehicle can therefore be optimised by using the vehicle at least until the battery has to be replaced. In more rugged operating environments where vehicle life may be limited by significant wear and tear, renting, refurbishing and/or re-using batteries may reduce TCO.

Maintenance and Running Costs

Because electric vehicles have significantly fewer moving parts than ICE vehicles, they generally do not require (or require less intensive) oil and filter changes, encounter reduced temperature stress and generally suffer less wear and tear. Accordingly, the costs of maintaining and running a fleet of electric light commercial vehicles will be unequivocally less than for a fleet of diesel or petrol equivalents.

While maintenance costs for various vehicle types – electric, petrol and diesel – vary across the world, the cost savings for electric vehicle maintenance compared to ICE vehicles persist worldwide. [2]

Regenerative Braking

Regenerative braking is one of the key advantages a fully-electric or hybrid-electric drivetrain has over a purely combustion-powered equivalent, because it enables the vehicle to save and redirect energy that would otherwise be dissipated through braking to generate power that is sent back to the battery. This 'regenerating' of electrical power happens when the same motor that is turning the wheels is temporarily re-deployed as a generator and instead of using power, it produces or 'regenerates' power and the impact slows the car while also adding charge to the batteries. In contrast, ICE vehicles convert kinetic energy to heat during braking, an unwanted and wasted by-product which is especially harmful in underground or other closed environments.

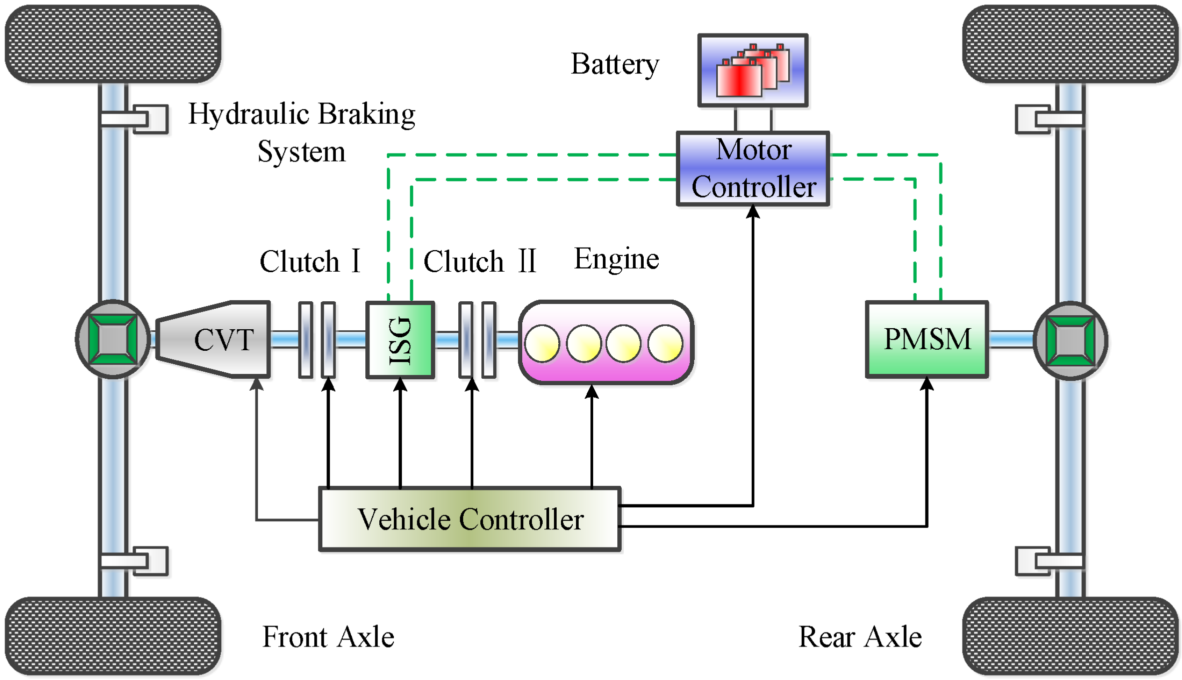

Figure 1. Hybrid braking system. [3]

Empirical studies have shown that an optimised regenerative braking system can increase the energy recovery rate by more than 33%, which then increases the battery power and enables an electric vehicle to drive further distances. This helps to extend the utility of the battery and increase service intervals for the braking system, thereby reducing TCO.

Fixed Payload

Many types of commercial fleets are customised and/or ruggedised. For example, in the mining industry, 'mine-spec' vehicles are customised and ruggedised to meet stringent safety and compliance standards. In a similar context, in the road infrastructure industry, traffic management utility vehicles may have an additional payload of several hundred kilograms or more by virtue of significant customisation needed to meet regulatory standards.

Figure 2. Examples of customised vehicles with increased fixed payloads.

Aside from travel range, the greater the incremental fixed payload, the greater the draw and use of the batteries, which impacts the life of the batteries and, in turn, the TCO equation. This must be compared against the greater diesel fuel requirements for ICE vehicles with higher fixed payloads.

Variable Payload

In addition to fixed payload, variable payload is also a key element to consider. This includes how many people on average are being carried in an electric light commercial vehicle per trip as well as the average weight of what is being transported (for example, boxes for delivery).

As with fixed payload, the greater the incremental variable payload, the greater the draw and use of the batteries, which on average can reduce the life of the batteries, again impacting the TCO equation. This must once again be considered against the increased diesel usage of ICE vehicles hauling larger variable payloads.

Figure 3. Tembo Electric Cruiser with cargo tray to carry variable payload.

Residual Value of the Batteries

As with any vehicle, residual value plays a key role in assessing TCO. Given the battery is the most expensive and important component of an electric vehicle, assumptions regarding the residual value of the battery can have a material effect on the TCO equation. The larger the battery, the more sensitive the TCO results will be to the residual value of the battery.

The most conservative approach is to assume that the battery has no residual value. Traditionally, this has been the default assumption for most electric vehicle TCO calculations. That being said, batteries will typically have a charging capacity of 70-80% of their nameplate capacity once they reach the end of their useful life for automotive use. This means that these batteries can realistically have second life applications. For example, some first-generation Nissan Leaf batteries are now being used to power 7-Eleven stores in Japan. These batteries could also be repurposed for storing energy to power the charging of a corporate owner’s fleet or wider operations via a microgrid. As second life battery applications become more commonplace, the economics of second life battery usage can begin to be factored into the TCO equation. In fact, the global market for second-life batteries is forecast to increase by over 65% from 2019 levels by 2025. [4]

Residual Value of Vehicles

As it is early in the adoption cycle, there is relatively little data on the residual and resale value of electric vehicles, especially in a commercial fleet context.

A recent research study suggests annual depreciation rates of 20.75% on the value of diesel vehicles, 17.27% on petrol vehicles, and 15.24% on electric vehicles. These figures were calculated based on average vehicle residual values after five years as published by ING Economics Department, assuming a constant rate of annual depreciation. [1]

While preliminary, this research suggests that electric light commercial vehicles may hold their value better than their equivalent diesel or petrol counterparts.

Figure 4. Electric light vehicle battery.

Government Incentives

An increasing number of governments globally have introduced incentives to promote electric fleet adoption. These include tax credits, reduced registration fees and accelerated depreciation allowances, among others.

These measures are clearly beneficial towards justifying the business case for transitioning to an electric fleet. The value of any available incentives will accordingly reduce TCO for electric vehicle owners.

Government Taxes

In addition to incentives, countries such as the United Kingdom (UK) have introduced taxes or surcharges on diesel and petrol vehicles including higher road taxes, company car taxes and parking permit surcharges. Furthermore, there will be an outright ban on selling diesel and ICE vehicles in the UK from 2030. Similar schemes have been or are being proposed and adopted in other jurisdictions. Supportive measures such as these clearly contribute to an attractive TCO for electric commercial fleets versus diesel or ICE powered equivalents.

On the other hand, some countries such as Australia have discussed introducing a tax on electric vehicles to compensate for potential loss of fuel excise revenues. Any such taxes imposed on electric vehicles need to be factored into the TCO calculus.

Key Observations

The competitiveness of a light commercial electric vehicle fleet can be improved by optimising the usage of the fleet. By maximising the utilisation intensity of the fleet of vehicles, the TCO of electric vehicles declines at a faster rate than the TCO of conventional ICE vehicles due to lower maintenance and running costs. Range considerations may be a limiting factor on usage. However, for use cases involving limited speed (say 50-70 km/h) and limited range (50-70 km per trip), range limitations are less of an issue. This type of fleet is often customised for local authorities, last mile delivery companies, road infrastructure and utility companies as well as for mining site applications.

Where range limitations constrain the ability to maximise utilisation, ownership tenure is the more relevant factor to be optimised. This is because ownership tenure has a more significant effect on the TCO, especially in the earlier years of vehicle operation. Additionally, sensitivity analyses have shown that battery replacements have a critical impact on the overall TCO of electric vehicles. Accordingly, in order to minimise the TCO of an electrified light vehicle fleet, vehicle ownership should last until the battery has to be replaced. That conclusion is especially true when using the default assumption that used electric vehicle batteries have no residual value. However, if some value can be captured from used batteries, the TCO can be reduced even further, particularly for heavier ruggedised or customised vehicles. [1]

Overall, the economics of converting to an electrified light commercial vehicle fleet vary by business and use case. However, as technology continues to improve, battery prices continue to decline, and governmental policy increasingly incentivises electric vehicles, more and more fleet owners are likely to find that electrification is not just the best solution for the environment, but also for their bottom lines.

Next Steps

If you are a commercial fleet owner seeking to navigate all relevant TCO considerations in a move to electrification, please email us at electrification@vivopower.com and we will contact you to discuss further.