Investigating the development of an analysis tool to support the business case for medium and heavy-duty zero-emission vehicles

EXECUTIVE SUMMARY

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Introduction

Electric powertrains are a promising technology for the propulsion of vehicles with potential to improve air quality and reduce greenhouse gas emissions associated with road transport. Electric powertrains are more efficient than internal combustion engine vehicles (ICEVs) and have zero tailpipe emissions (Sadek, 2012). In addition, the technology can help to mitigate the transport sector's heavy reliance on fossil fuels.

On the flipside, large scale adoption of zero-emission vehicles (ZEVs), specifically electric vehicles (EVs), may require additional electricity generation. While the cost to produce electric vehicles is higher than conventional vehicles due to advanced components, the cost of ownership is generally lower, predominantly due to lower fueling and maintenance costs (Nordelöf & Messagie, 2014). The cost of electricity to charge an EV is lower than the gasoline cost for an ICE vehicle to travel the same distance. In addition, less maintenance is required for an EV as components last longer due to less wear-and-tear from fewer moving parts.

In order to study these costs in more detail, a toolkit was developed by a third-party that used the total cost of ownership (TCO) approach to evaluate comparative costs and savings as vehicles are electrified. This study analyzes the development of this toolkit for medium and heavy-duty electric vehicles (MEV & HEV) in a fleet environment. The TCO approach is used extensively to analyze cost of vehicle operation due to fleet managers being interested in costs of ownership beyond just fuel costs (Yang & Xu, 2018).

Background

In order to develop the analysis toolkit, consultants were engaged in the space of fleet management who had access to real-world ownership cost data for both internal combustion engine (ICE) and electric vehicles (EVs). The purpose of this project was to support the development of this toolkit by verifying and validating the logic of all calculated values and to compare methodology to similarly developed tools. If any differences in methodology were identified, these would be communicated to the consultant to implement suggested changes. The tool was also required to maintain a simple, easy-to-use interface that fleet managers with non-technical backgrounds could comfortably use.

Specifically, a comparison was done with two industry standard calculators:

1) Medium Duty Battery Electric Vehicle: TCO Calculator (Nigro & Quebe, 2019)
2) Fleet Procurement Analysis Tool (North American Council for Freight Efficiency, 2018)

Methodology Analysis

Over the life of a vehicle, the most significant costs of ownership are the annual depreciation, cost of capital, fuelling costs, and maintenance costs (Yang & Xu, 2018), as discussed in the sections below. In the TCO approach, these costs are calculated by using industry-standard values for cost of capital, discount rate, and other metrics as determined by central banks. The toolkit was designed to be able to change these values as needed.

Depreciation Cost

Depreciation cost was modelled as a simple straight-line depreciation between purchase price and salvage value of the vehicle. Other tools such as those developed by NACFE and Atlas Policy follow a polynomial depreciation model that has significant depreciation in the first few years of ownership, after which the rate of depreciation gradually reduces as vehicle life increases. In a fleet environment, a vehicle is seldom sold before it reaches end-of-life, as such it was a reasonable approximation to use straight-line depreciation for simplification purposes.

Cost of Capital

The cost of capital refers to the actual cost of financing a purchase to do business activity. This is the assumed rate of return that could have been earned if the same money were put into a different investment with an equal amount of risk. This was modelled in a similar way across the variety of toolkits.

Fuel Cost

This is the annual cost of fuel for a given annual mileage whether it is gasoline for an ICEV or electricity for an EV.

Maintenance Cost

The annual maintenance costs were calculated from past fleet data over the vehicle life and amortized into an equivalent annual cost for comparison purposes. This is especially useful when you want to get a generalized cost between the two drivetrain types (ICEV and EV).

Outcome

The toolkit used values for fueling and maintenance costs from databases maintained by the consultant, and these values were comparable to those in the industry standard calculators. Values for depreciation and cost of capital followed a model of straight-line depreciation in the toolkit, which varied with other calculators. The industry standard calculators used polynomial depreciation, which accelerated the lost value in the first few years of ownership but ended at a comparable value at vehicle end-of-life (generally ten years). Due to the low probability of decommissioning a vehicle before end-of-life in a fleet environment, straight-line depreciation was an acceptable simplification in order to maintain ease-of-use of the toolkit.

Summary

The methodology used in the analysis toolkit developed presented pertinent information in an easy-to-use, intuitive format that had results comparable to other more sophisticated toolkits. While the toolkit developed does not replace a more comprehensive cost analysis, it is a useful tool to illustrate the benefits of electrifying a fleet of vehicles on a high-level, and serves as a stepping stone to further detailed analysis.

Next Steps

To increase the audience of the toolkit, the next step would be to facilitate a conversion to an online tool that uses the logic from the toolkit developed to illustrate results online such that fleet managers can easily access this data to inform their decisions.

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