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Environmental and techno-economic analysis of electric vans for urban deliveries in the grocery retail industry

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Background

Concerns about climate change and deteriorating urban air quality have caused policymakers, research institutions and industry leaders to amplify their efforts towards decarbonization, pollution control and resource efficiency (World Resources Institute, 2018). In 2016, the transport sector accounted for 25% of the total greenhouse gas (GHG) emissions on a global scale (IEA, 2018) and in 2017, the transport sector was the largest CO_2-emitting industry in the UK (UK BEIS, 2018). Electric vehicles (EVs) are regarded as the most promising solution to these issues. The light commercial vehicle (LCV) sector will experience significantly higher growth rates and contribute larger shares of the total road transport emissions, as can be seen from figure 1 (Tryggestad et al., 2017). A major contributor to this is the rapid rise of urban delivery operations primarily driven by increasing e-commerce demand.

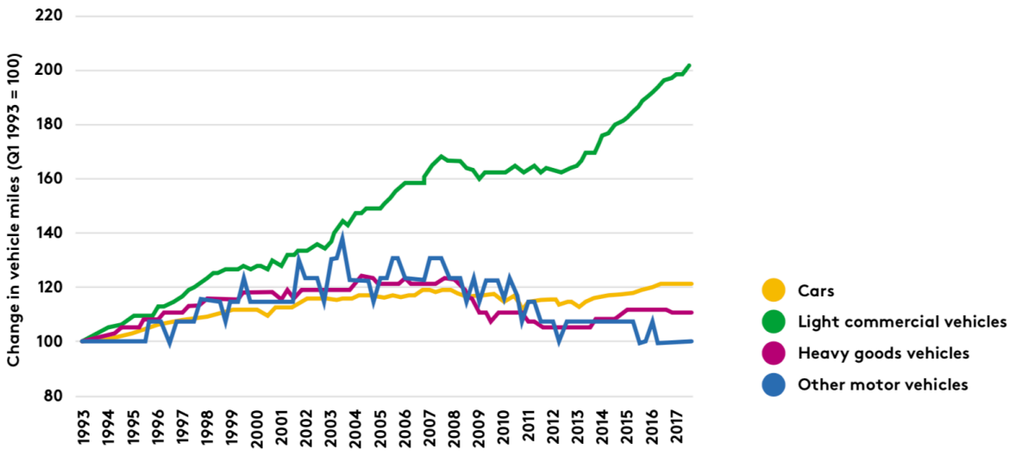

Figure 1: *Change in vehicle miles driven per segment in the UK (UK Government Office for Science, 2019)*

Research Aim

This thesis aims to investigate the economic, technical, operational and environmental feasibility of electric vans as a replacement for diesel vans and to provide a rollout strategy recommendation for a large grocery retail company in the UK.

Methodology

A like-for-like replacement analysis is applied, i.e. it is assumed that a standard diesel fleet vehicle performs the identical operational pattern as the monitored EV. Total cost of ownership and operational compatibility are identified as the key decision-making criteria for fleet operators. Furthermore, a dynamic CO_2 emission evaluation is designed to accurately determine the associated grid emissions of EV utilization. Following a baseline scenario analysis, further parameter sensitivity analyses and three alternative scenario analyses were conducted.

Results

Figure 2: *Breakdown of Electric and Diesel Van TCOs over 4.25 years of ownership*

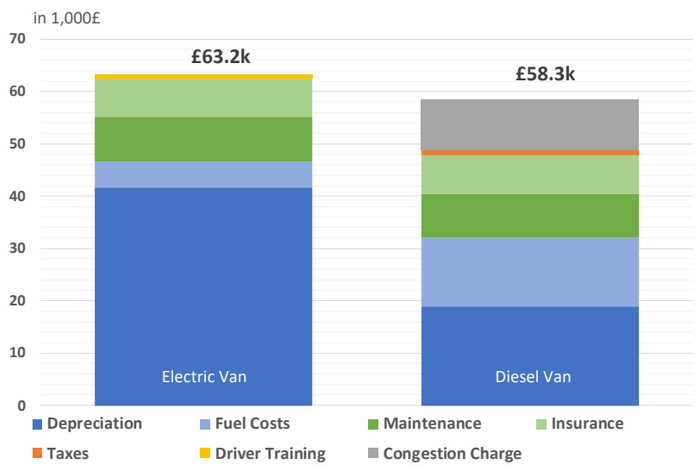

Figure 3: *Total associated Vehicle CO_2 Emissions over 4.25 years*

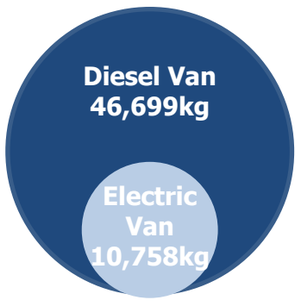

Figure 4: *Electric and Diesel Van TCO as a function of Depreciation Rate*

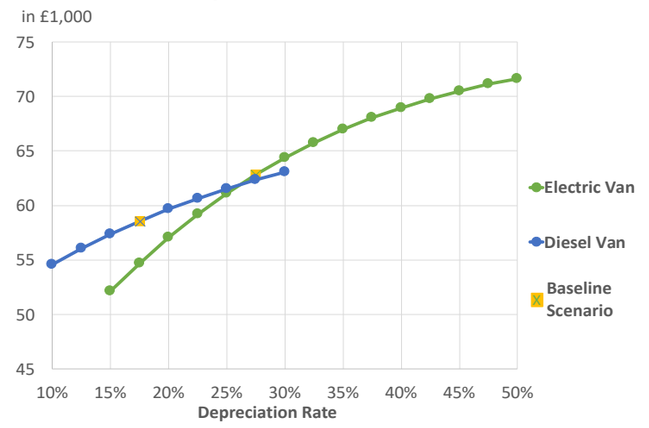

Figure 5: *Electric and Diesel Van TCO as a function of EV Purchase Price*

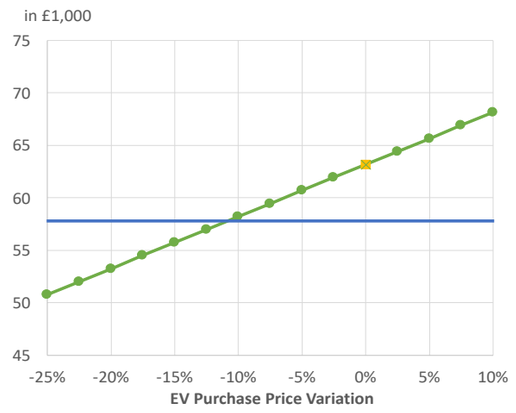

Figure 6: *Electric and Diesel Van TCO as a function of Congestion Charge*

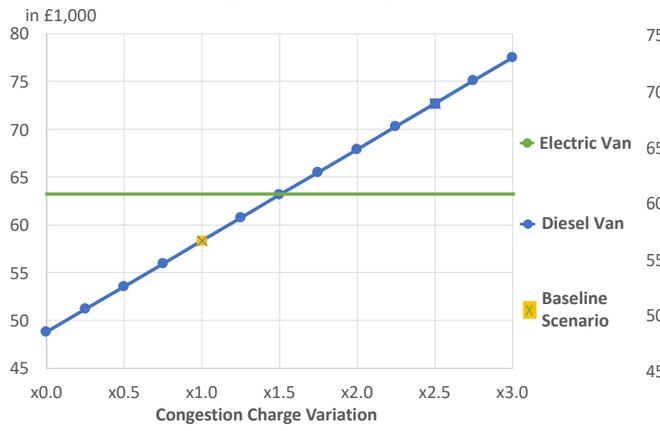

Figure 7: *Electric and Diesel Van TCO as a function of Electric Van Grant*

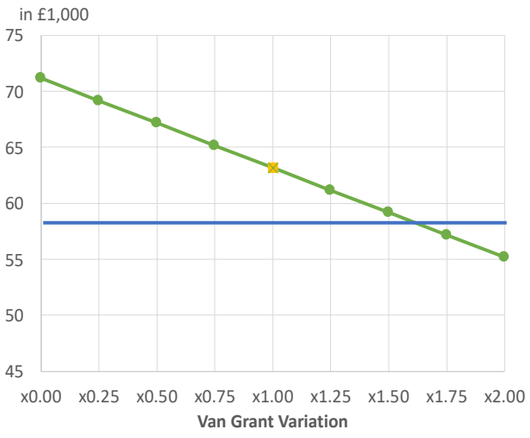

Figure 8: *Electric and Diesel Van TCO as a function of Operational Ownership Period*

Figure 9: *Electric and Diesel Van TCO in various Industry Scenarios*

Conclusions

Over the ownership period of 4.25 years, the replacement of a diesel van with an electric van enables CO_2 emission reductions of ~75% and significantly improves urban air quality. However, electric vans remain between 8% to 16% more expensive than diesel vans on a TCO basis. Operational lifetime, EV purchase price and depreciation effects, and the volume of financial policy support were identified as the key influencing factor to the future development of the electric van market. The results of this study send an affirmative signal to policymakers and industry leaders that electric mobility is an effective solution for addressing climate change and urban air quality.

Electric Van Rollout Strategy Recommendation

Short-Term:
- Continue electric van trial phase with various models
- Implement smart charging management
- Extend ownership period to five to six years

Mid-Term:
- Add electric vans to delivery fleet
- Benefit from first mover advantages
- Update EV charging and electric power infrastructure

Long-Term:
- Consider electric vans as the mainstream solution
- Begin to phase out diesel vans

References

World Resources Institute (2018) Unlocking the inclusive Growth Story Of The 21st Century: Accelerating Climate Action In Urgent Times. [Online]. Available from: www.newclimateeconomy.report

UK BEIS (2018) UK greenhouse gas emissions 2017. [Online]. Available from: https://assets.publishing.service.gov.uk/government

Tryggestad, C., Sharma, N., van de Staaij, J. & Keizer, A. (2017) New reality: electric trucks and their implications on energy demand. [Online]. Available from: doi:10.1111/phen.12113.

UK Government Office for Science (2019) A time of unprecedented change in the transport system - The Future of Mobility. [Online]. Available from: https://assets.publishing.service.gov.uk/government

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