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‘’ Comparing Battery Electric and Fuel Cell Vehicles as replacement for conventional cars in company fleets‘’

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Executive Summary

Some people are convinced that Battery Electric Vehicles (BEV) are our mobility future. Others think that Fuel Cell Vehicles (FCV) will have a big share in the future as well [1]. Stedin from the Netherlands aims to evaluate and experience the feasibility and employment of both BEV’s and FCV’s in daily operation as replacement for the current, conventional fleet.

In this paper, the initial results of a feasibility study conducted as part of the European ICVUE project will be presented including the comparison between a BEV and FCV as replacement for an ICE. The results are based on quantitative research (actual logged and analysed car-data) and qualitative research (interviews with drivers) during a period of 3 months, over different departments.

The main conclusions depend on range capability, impact of infrastructure and some insights on the TCO showing an advantage for BEV’s, but the FCV is less far away than expected.

In order to get an insight of driving an FCV vehicle Stedin decided to set up a pilot including 2 Toyota Mirai vehicle being used as pool vehicles within their fleet between September 2016 and September 2017. This decision was made based on the conclusions of the feasibility study and first results of the pilot are presented in this paper as practical follow up of the feasibility study.

1. Background

I-CVUE aims to reduce CO_2 emissions in urban environments by increasing the number of electric vehicles in large fleets in urban areas. The project will achieve this by mentoring large urban-based pan-European fleet operators, offering them free EV usage assessment and creating a framework that authorities can use to set up tailored fleet incentive programs. As part of the EU funded I-CVUE project [2] EY, FIER and FleetCarma performed an ‘Electric Vehicle Suitability Assessment’ (EVSA) in the fleet of the Dutch grid operator Stedin. Stedin is responsible for the transport of electricity and gas to households and companies in the Randstad region and has the aim to provide every citizen with sustainable energy. Stedin. Stedin has a fleet of total 1.500 vehicles of which 900 are dedicated company cars. The management team of Stedin currently is in a process of setting up a sustainable mobility plan 2020 for their corporate fleet and to be able to make first step decisions and set up a back ground of possibilities for the next years Stedin asked for the EVSA during the fleet mentoring process.

The primary purpose of the EVSA is to demonstrate the potential strategies that can be employed to achieve efficiency savings using Battery Electric Vehicles (BEV) and Fuel Cell Electric Vehicles (FCV) and enhanced management of existing vehicle assets. Efficiency savings include the financial benefits gained through Total Cost of Ownership reductions as well as the corresponding reductions in fuel usage and greenhouse gas (GHG) emissions.

2. Approach

The three organizations together (FIER, FleetCarma, EY) used quantitative and qualitative research methods to be able to give Stedin a representative and detailed overview of their current fleet, the current usage of the fleet and the motivation for typical usage. The EVSA consist of data logging of 30 representative vehicles during 4 weeks, and interviews with 15 drivers. The 30 vehicles and their drivers were a representative sample of the total fleet (975 vehicles) and were a combination of passenger cars, small vans and large vans. The quantitative and qualitative results led to strategic conclusions to advise Stedin in their aim to have a sustainable fleet management strategy 2020.

3. Research

3.1 Quantitative research

The quantitative research process started with collecting route data from data loggers in 30 vehicles within the fleet of Stedin. The 30 vehicles were selected from three main groups of vehicles within the fleet, passenger cars, small vans and large vans. The 30 vehicles were also selected from three different departments to be able to carry out a qualitative research on the route data versus departments and their different responsibilities. The selection process was build up on two phases. The first phase was to set up a representable selection of vehicles (regions and function groups) and in the second phase the selected group was asked for cooperation (dataloggers and interviews).

FleetCarma’s EV modelling software uses the data from the existing fleet vehicles to model and simulate the suitability of BEVs and FCVs in the same drive cycles. Comparison between the current situation and the simulated BEV’s and FCV’s led to a report highlighting the potential reduction in operating costs, emissions and the driving range capabilities of the BEV and FCV related to the real drive cycles.

The route patterns that came out of the dataloggers were being used in the FleetCarma powertrain models which is an independent predictive analytic system with a reliable determination of the amount of fuel and electricity that would be used by the Battery Electric Vehicles and plug-in hybrids compared to the current vehicles. Comparison leads to an anticipation of reduction in operating costs, emissions and the electric driving range capabilities related to the real drive cycles.

Facts and figures quantitative research.

In total 26 vehicles from 30 logged were analyzed based on representative data These 26 vehicles had a daily average utilization of 86 kilometers and average fuel consumption of 10 liters / 100 km’s. average engine-on-hours of the vehicles was 1.7 hours a day and average duty cycle speed was 51 km/h. Fleet efficiency improvements through idle time measures were also identified since the vehicles spent on average 49% of their time idling of the fuel used during this idle time, 72% is wasted fuel and not due to short stops in traffic. Average potential savings per vehicle each month is €11 if using idle-reduction management programs.

There was a clear difference of average fuel economy between the passenger cars (6 liters / 100 km, small vans (8 liters / 100 km) and large vans (14 liters / 100 km), but there was no significant difference between kilometers driven per day with most vehicles between 50 and 150 kilometers per day.

Diving deep into the three groups of different vehicles and compare them in the suitability assessment system of FleetCarma with relevant BEV's and FCEV's we get the figures below. In figure 1 the assessment of the passenger vehicles regarding TCO-calculations. In figure 2 the assessment of small vans and in figure 3 the assessment of large vans.

Current Vehicle	2016 Volkswagen e-Golf	2016 BMW i3	2016 Nissan Leaf - 30kWh	2016 Renault Zoe	2016 Toyota Mirai
09ZND8 Ford Focus	€ 6.492,76	€ 6.796,11	€ 13.182,41	€ 13.035,44	€ -64.729,71
29SRG3 Ford Focus	€ 9.433,02	€ 9.735,33	€ 16.063,91	€ 16.028,26	€ -68.153,69
73SFD4 Ford Focus	€ -3.520,49	€ -3.315,71	€ 3.403,22	€ 3.315,51	€ -69.034,69
HZ363P Toyota Auris	€ -6.859,02	€ -6.667,72	€ 157,14	€ 49,56	€ -70.006,90
JD696Z Toyota Auris	€ -5.961,59	€ -5.806,31	€ 1.038,54	€ 960,93	€ -69.943,32

Figure 1: TCO comparison passenger cars. Red shows best fit from range point of view and CO2, but negative TCO [3], grey shows positive TCO, but no range fit, blue shows best fit in range, CO2 and positive TCO

Current Vehicle	2016 Volkswagen e-Golf	2016 Renault Kangoo ZE	2016 Nissan eNV200	2016 BMW i3	2016 Nissan Leaf - 30kWh	2016 Renault Zoe	2016 Toyota Mirai
5VLG42 Peugeot Expert	€ 7.569,00	€ 12.953,81	€ 12.953,81	€ 7.952,90	€ 14.371,29	€ 14.261,26	€ -65.347,72
6VSP98 Peugeot Expert	€ 8.027,41	€ 14.547,44	€ 14.547,44	€ 8.210,83	€ 15.050,79	€ 14.941,44	€ -54.835,86
VB478X Peugeot Expert	€ 19.043,20	€ 24.268,61	€ 24.268,61	€ 19.255,05	€ 24.938,30	€ 24.868,96	€ -40.492,51
VF163N Ford Transit Connect	€ 934,11	€ 6.689,87	€ 6.689,87	€ 1.227,45	€ 7.635,74	€ 7.555,85	€ -72.077,11
VF270S Peugeot Expert	€ 3.570,83	€ 10.212,93	€ 10.212,93	€ 3.729,68	€ 10.586,22	€ 10.482,76	€ -62.463,22
VF596R Peugeot Expert	€ 14.020,06	€ 20.040,74	€ 20.040,74	€ 14.245,55	€ 20.888,50	€ 20.826,74	€ -54.928,38
VR706X Ford Transit Diesel	€ -11.518,91	€ -4.756,77	€ -4.756,77	€ -11.423,58	€ -4.439,91	€ -4.522,10	€ -78.732,11
VR707X Ford Transit Connect	€ -5.825,46	€ 116,03	€ 116,03	€ -5.503,07	€ 1.073,60	€ 943,81	€ -74.450,17
VR708X Ford Transit Connect	€ -11.501,56	€ -4.853,07	€ -4.853,07	€ -11.404,85	€ -4.451,65	€ -4.520,37	€ -77.907,24

Figure 2: TCO comparison small vans. Red shows best fit from range point of view and CO2, but negative TCO [3], grey shows positive TCO, but no range fit, blue shows best fit in range, CO2 and positive TCO

Current Vehicle	2016 Renault Kangoo ZE	2016 Nissan eNV200
VB463R Ford Transit	€ 28.320,66	€ 28.362,50
VG741F Ford Transit	€ 22.831,82	€ 22.529,54
VH070B Ford Transit	€ 30.944,56	€ 31.039,57
VH071B Ford Transit	€ 31.622,37	€ 31.728,54
VH103X Volkswagen Crafter	€ 33.970,48	€ 34.121,85
VH256Z Volkswagen Crafter	€ 37.624,28	€ 37.984,84
VH480H Volkswagen Crafter	€ 27.867,88	€ 27.833,44
VK908F Ford Transit	€ 28.632,66	€ 28.814,53
VK909F Volkswagen Crafter	€ 30.250,31	€ 30.459,79
VK937V Volkswagen Crafter	€ 32.636,44	€ 32.871,30
VT492H - Ford Transit Connect Diesel	€ 29.330,77	€ 29.285,04
F3128C[1] Volkswagen Crafter	€ 32.709,63	€ 32.850,52

Figure 3: TCO comparison large vans. Red shows best fit from range point of view and CO2, but negative TCO [3], grey shows positive TCO, but no range fit, blue shows best fit in range, CO2 and positive TCO

When considering BEV's and FCV's in representative operational conditions these requirements are useful in the evaluation of replacing for a suitable BEV or FCV in the fleet. Based on these figures, 7 vehicles were selected as suitable for replacement with potential TCO savings (9,3% savings), greenhouse gas emissions (17% reduction) and fuel consumption (19% reduction). After a thorough analyses by FIER and FleetCarma, we concluded that 6 more vehicles were suitable for replacement by a BEV with potential savings in TCO of 6%, GHG reduction of +-8% and fuel reduction of +-8%. In this thorough analysis, we didn't just look at kilometers per day compared to range of the vehicles, but also at the route configurations and possibilities to charge during the day. Based on these analyses per vehicle assessment we concluded that all passenger cars could be a BEV, with a positive TCO and 3 more small vans could be a BEV with a positive TCO.

The FCV appears to be the best replacement car in terms of range but showed a negative TCO in all cases (see red boxes in passenger car and small vans assessments).

Despite the negative TCO of the current FCV vehicles, Stedin decided to invest in 2 Toyota Mirai FCV vehicles in their pool fleet and monitor them for a full year with FleetCarma dataloggers as a pilot and to learn from. In September 2017, we will present the conclusions of these vehicles driven in this year. Figures will give an overview of distance driven, energy consumption, CO2 emissions, FC fuel level, idle time, hard braking and hard acceleration. Currently (July 25, 2017) Mirai 1 has driven 9.007 km and Mirai 2 16.515 km. The average daily distance of Mirai 2 is 98 km and Mirai 1 70 km. Fuel efficiency of both vehicles will be analysed in the next months. The relative low distances per day are due to the fact that there are only 3 fuel stations in The Netherlands and not close to each other. Mirai 1 fuels on average once per 10 working days and Mirai 2 once per 6 working days.

3.2 Qualitative research

To gain a better understanding of the practical challenges and the opportunities that come along with the introduction of BEVs and FCVs, we conducted fifteen interviews with white- and blue collar employees from different departments and regions within The Netherlands.
During the interviews, we gained a better understanding of the story behind the data. The first phase of data logging was of great importance, but the opinion of the mechanics as well. During the interviews, the participants gave us valuable information for further improvements besides the introduction of BEV. Some of the mechanics suggested the concept of van-sharing, placing two or more mechanics on one van to avoid unnecessary commuting. Supply points with materials can also help the mechanics to minimize their traveling and to lower their stock in the vans, resulting in less weight on board of the van and fewer emissions.

During the interviews with the blue-collar employees, they indicated a willingness to drive with alternative fuelled small vans, but only when certain concerns are addressed. For example, understanding the possibilities to charge and fuel their vehicles at home and/or at the offices. For some of the mechanics who are rarely at the office, arrangements would be needed to permit them to charge their vehicles at home.

Another concern that was raised is the cargo capacity of the BEV's and the practical range. With the introduction of BEVs into the fleet, considerations must also be made to account that some blue-collar employees are working at night or are troubleshooting in areas without a possibility to charge.

Longer single trip distances and higher mileages of office staff require another approach. The FCV currently serves the needs for mobility for office staff better when it comes to range compared to a BEV, though FCVs are still in an early phase, require high up-front investments, and there is a lack of infrastructure.

4. Main findings

During the data logging period, it was striking that the idle time was 49%. Based on the output of the interviews, we obtained a legitimate explanation; the mechanics need a running engine to work or charge their equipment and during cold it was used to heat the car to work comfortably in the vans.
Other main findings based on the quantitative and qualitative analyses were the possibility to share vehicles within the fleets. Some of the drivers use their vehicles in the morning of the day and are at their office locations during the afternoon and colleagues are in the office in the morning and use their vehicles in the afternoon. At the moment they have similar own vehicles, but in future sharing of such vehicles must be possible.
Another finding is that some employees are able to use smaller vehicles than they currently drive. Some large vans can be replaced by smaller (electric) vehicles, because they currently use their vehicles partly as storage for materials while they have storage rooms at their premises or simply don't need the space in their vehicle

The comfortable drive of the FCV's during the first months of operation within Stedin, longer range compared to a BEV are experienced as very positive. On the other hand, the larger availability of various BEV vehicle types, increasing battery capacity, growing infrastructure, better TCO's and efficient power usage speaks for itself.

The Stedin management mentioned the importance of a phased implementation of BEV and FCV. An awareness campaign is suggested to change the mind set and behaviour.

5. Conclusion

The overall conclusion is that BEV's are currently the best replacement for ICE cars by having the best TCO and already a range capability that fits for main parts of the fleet. Based on the data of 30 vehicles we recommend a potential suitable replacement of 27% of the Stedin fleet to BEV's, leading to possible TCO savings of 15%, GHG reductions of 25% and fuel consumption reduction of 27%. From the total fleet we concluded that all passenger cars are suitable for replacement by BEV's with a positive TCO. FCV's have a longer range, but are not suitable yet because of a negative TCO compared to ICE's and BEV's and infrastructure that is lacking behind. Which causes high prices and a certain 'range anxiety' for fuel as well.

References

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Authors

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