A study on the electrification of a classic Aston Martin

A feasibility study on the application of hydrogen technology in the electrification of an Aston Martin DB5

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Noble House Classic Cars is specialized in the maintenance and restoration of classic British cars. Their expertise and quality craftsmanship have granted them the title of Aston Martin Heritage Dealer. Clients from all over the world come to Noble House for the maintenance of their classic cars. To be at the front of the developments concerning the energy transition, Noble House wants to be able to offer electric conversions of classic Aston Martins to their customers. This makes sure that Noble House stays relevant in the future and in front of its competitors. An electrified classic Aston Martin makes the preservation of the legacy possible when polluting internal combustion engines are not allowed anymore on the road.

The aim of this research is to continue the research done by the previous researchers (Beusink, & Hofman, 2018). The goal of the research is to investigate the possibility for the conversion of a classic Aston Martin to an electric drive. The previous research has resulted in a strategy (Beusink, 2018) for the conversion of an Aston Martin, with a list of requirements as a result of market research. Based on this list of requirements, a design has been made for a battery-electric driveline (Hofman, 2018). This design also includes a selection of components. With the data acquired from the previous research, the next question had to be answered: is it feasible to convert a classic Aston Martin to a hydrogen electric drive?

This question is answered by firstly researching the theory behind the use of hydrogen in an electric driveline. After that, fuel cell suppliers are compared to see the availability of components on the market. At this point, the research showed that the use of a fuel cell as a range extender for a battery pack, is the best set-up. A driveline for a range extender can be set-up in multiple ways. Therefore, a calculator was built to determine the set-up with the highest range. It is based on the data from a longitudinal simulation ran for the previous research. This calculator can later be used with new components and data. Cardboard models are made to test fit the components in the car according to the Box-Based method.

Figure 1: Cardboard models of the components placed in the car to test their position

The final concept for the drivetrain consists of a battery pack of 22kWh supported by a 15kW fuel cell. The connected fuel tank has a capacity of 1,5kg of hydrogen. Together, these make for a range of 233km; 12% more than a BE driveline. The costs of the conversion are estimated at €135 000; more than double the price of a battery electric driveline. The small gain in range combined with the substantial difference in prices result in a conversion that is only viable for customers that want something unique or for fans of the technology. To determine what's important for the customer, a presentation was made. This presentation explains the changes in regulation and the need for clean mobility. It concludes with a couple of questions to receive feedback from the customer. With this feedback, the development of the project can be tuned to the likings of the end-user.

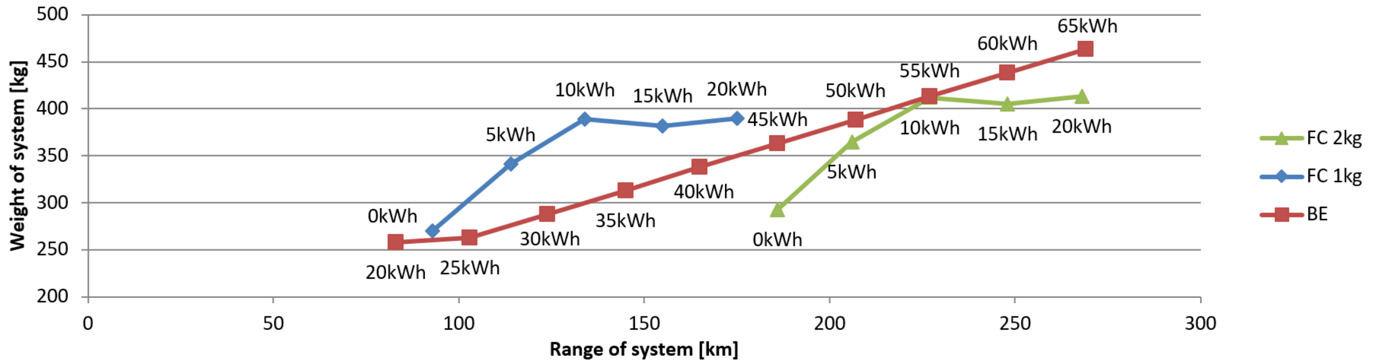

Figure 1: Weight vs range based on the range calculator

In Figure 2, the weight of a set-up can be seen with its corresponding range. It shows the ranges for a battery electric driveline and a fuel cell electric driveline. The latter is shown with a 1kg hydrogen tank and a 2kg hydrogen tank, both with a 15kW fuel cell. The capacities next to the data points represent the size of the battery packs/buffer of the driveline.

Because of the higher energy density of hydrogen, adding a kg of hydrogen (+25kWh and +52kg with tank) has a higher impact on the range (+90km) than adding the equivalent weight in lithium cells (+11kWh for +46km). This only counts for battery packs with a minimum total capacity of 15kWh, as there is a lighter lithium cell available at that capacity.

For now, a customer would be better off by choosing for a battery electric driveline. It's cheaper, the infrastructure is present and less of an investment for Noble House to design. However, if Noble House invests in the use of hydrogen, it is easy to take a step back because of the similarities and design a battery electric driveline.

A way to make a hydrogen conversion more appealing is by changing the requirements. The weight of the driveline is the limiting factor. When using two tanks of 1,5kg the range increases to 347km; 48% more than a battery electric driveline of the same weight.

To validate the data of the calculator, the required power, based on the longitudinal simulation, needs to be verified with a real car. This can be done using a coast down test. Also, a test setup can be built for the Noble House mechanics to practice on. While doing integration testing, the mechanics can experience what problems they can encounter when performing a conversion. It is important for Noble House to keep the project going as times are moving fast and when the energy transition hits the classic cars, they need to be ready.

References

Beusink, J (2018). *Converting Classic Aston Martins to a Cleaner Powertrain [Thesis]*
Hofman, E(2018). *A feasibility study on an electric Aston Martin DB5 [Thesis]*