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Electric vehicle user-centric design for optimised energy efficiency

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DOMUS

Design OptiMisation for efficient electric vehicles based on a USer-centric approach

DOMUS – Deliverable Report

D5.4 - Indicators and Competence Structures for Efficient Driving with a Validated DEB demonstration application

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Publishable summary

The overall objective of the DOMUS project is to increase the driving range of electric vehicles (EVs) by at least 25%. This objective is addressed within the project in several ways. First and foremost the DOMUS project is seeking to improve the vehicle designs as well as the vehicle components to reduce energy consumption which directly translates into a range increase. This work is described in the deliverables of workpackages two through six. Specifically, the DOMUS project investigates methods to increase EV-range such as using novel materials or redesigning the vehicle to reduce the vehicle weight and decrease the energy consumption of non-driving related energy consumers such as heating and cooling, driving style changes. Secondly, and this is the focus of this deliverable, the DOMUS project investigates methods to increase the driving range by improving the driver's driving style through the usage of a Driving Efficiency Booster (DEB) application. The DEB provides information about driving efficiency to the driver and is mounted within the viewing- and interaction range of the driver. A driver's driving style has a significant impact on the energy usage of a vehicle and improving a drivers driving style may help increase the driving range of an EV. The DEB presents information to help the driver increase their competences for efficient driving and information to increase the driver's motivation to drive efficiently.

In this deliverable we describe the analyses and studies that were performed to develop a DEB application that helps the driver to build competences and knowledge about efficient driving as well as motivate the driver to drive more efficiently. The DEB application was running on a tablet mounted at the middle console of a car mockup. In a driving simulator study with 32 participants, we compared the DEB application with other ways to enhance driving efficiency. Thereby, we compared four different conditions (8 participants per condition): (1) Drivers were asked to drive energy efficient without further information, (2) they received a training for energy efficient driving in form of an instructional video before the drive, (3) they were challenged by the DEB application to drive energy efficient, or (4) they were provided both – training and challenges. In a baseline drive beforehand, participants were asked to drive as they would normally do.

The efficiency of the drives was determined by relating the performance in the baseline drive and the instructed drive. The results indicate that energy consumption was mostly reduced with the training video (25.04%), followed by training and use of the DEB app (23.79%), use of the DEB app (18.85%), and no training (15.12%). With the training video, participants thereby achieved a range increase of about 33 %. While the DEB application motivated participants to focus on energy efficient driving behavior, further information about how to drive energy efficient and how to improve needs to be integrated.

While it is possible for drivers to apparently drive efficiently without any difficulties, the question is how they could be brought to do so in the real world in acceptable and comfortable ways. Here the study shows that tutoring and gamification may help. The study also identified several ways for how these methods could be further improved. For example, some participants did not like to compare themselves with others when using the gamification app. Therefore, an adjustable gamification setting could be added to provide feedback in the user-appropriate format. For example, a driver who does not want to compare him or herself with other drivers may receive only driver specific feedback about how to improve their own score. Also, the effectiveness and acceptability of the app could be improved by incorporating the feedback of participants as this study used just a first app prototype.

The main significance of the findings of this study is that one of the best way for increasing the range of electric vehicles is through the hands of the drivers themselves. Enabling drivers to realize the benefits and methods of efficient driving and then help to build their motivation and tools to realize efficient driving, are important steps toward more sustainable mobility.

The work described in this deliverable supports objective 3 "Development of new cabin components, systems and control strategies for energy efficient, safe and comfortable future EVs up to TRL 5/6 (for some potentially up to TRL 7)". Specifically, the described work focuses on driver control strategies toward more efficient driving.

The work described in this deliverable is directly connected to WP 2 (“Advanced Cabin Design and Virtual Assessment Implementation and testing of the different solutions at the full vehicle level”) where the impact of the efficient driving style on overall vehicle efficiency and range are calculated. The work described in this deliverable also relates to WP 6 (“Implementation and testing of the different solutions at the full vehicle level”) where the DEB will be demonstrated within a physical DOMUS prototype.