Submitted by the expert from Germany

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German Statement to GRSG/2023/5 (CLCCR)

Germany would like to thank CLCCR for the submitted document and express its support for the presented concept of assisting driven axles on trailers. Powered trailers increase the traction of the vehicle combination and thus the ability to negotiate gradients even in adverse friction conditions. The ability to distribute and use energy storage more efficiently and to recuperate energy more efficiently is also increased.

This can help to improve traffic flow and energy efficiency. With additional energy storage units installed in the trailer, the range of the combination could also be increased.

The Federal Highway Research Institute (BASt) has investigated the influence that driven trailers can have on the driving dynamics of combinations compared to non-driven trailers. BASt concludes that driven trailers do not have a negative impact on vehicle safety if driven trailers are designed in such a way that the driving forces are distributed equally to both wheels as well as that the trailers do not push the towing vehicle. While other methods (e.g. torque vectoring) bear a strong potential to improve driving dynamics, a functional safety assessment would be required to protect the vehicle combination from adverse effects in failure states.

Further information on the BASt study:

Driving experiments with two prototype trailers (caravans) had been carried out in direct comparisons with active and inactive trailer motors. The experiments focused on possible effects on the handling (double lane change test) and lateral stability (yaw damping test). Additionally, calculations had been carried out to investigate the transferability of the results.

Based on the available data, it was shown that there is no negative impact of the propelled trailer to the stability of the towing vehicle and vehicle combination, provided that there is always a remaining towing force in the towball, and no torque vectoring between the trailer wheels. It was also found that handling benefits from a driven trailer. Theoretical calculations show that when these two conditions are met (=no torque vectoring, no pushing), propelled trailers are safe with regards to driving dynamics.

It is expected that torque vectoring has a potential to even further improve handling and stability, however possible faults of the drive system and control strategy could negatively influence handling and stability.

The study had been carried out with only two prototype vehicles. Calculations checked that the results can be transferred to almost all kinds of trailers. Articulated trailers that have a steering of their own, however, need to be excluded from the conclusions without further research, as well as trailers for single-track vehicles for the time being, given the fundamentally different driving dynamics.

As a conclusion, it has been identified that propelled trailers where a towing force in the coupling remains (=the trailers compensate their driving resistance only partially, they do not

push the towing vehicle) and without torque vectoring do not have negative effects on the stability of the combination and can have possible effects on the handling. This is true for non-articulated trailers, including semi-trailers and central axle trailers, for non-single track vehicles. Regulations could as a next step be adapted, so that the positive effects towards traction and energy efficiency could be demonstrated. Also as a next step, the benefits and possible issues with torque vectoring could be identified.