Aerodynamic and Flexible Trucks for Next Generation of Long Distance Road Transport

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Publishable Executive Summary

As overall objective, AEROFLEX WP2 aims to reduce fuel consumption of EMS vehicles by advanced powertrain technology. A key idea is to combine the combustion engine of the pulling vehicle with electric drives in different vehicle units, thereby creating a distributed hybrid drive. In turn AEROFLEX vehicles would allow a flexible combination of vehicle units which bring their own driveline into the combination. A sophisticated energy and torque management system will allow an efficient operation of this distributed powertrain. This type of powertrain architecture including at least one electric drive in a trailer unit, the sophisticated energy and torque management and a suitable communication interface is referred to as Advanced Energy Management Powertrain (AEMPT).

This report presents requirements to an AEMPT from different aspects: Relevant vehicle portfolio, energy and power demand for reaching efficiency goals, energy management and vehicle dynamics. These requirements will form the basis for concrete technical solutions which will be presented in D.2.2

The portfolio of vehicles which have to be considered as AEMPT relevant has been chosen in line with the findings of the FALCON project. Accordingly, AEMPT vehicles may include up to four trailer units, have a length of up to 36,5 m and a gross combination weight of 91,6 tons.

In order to derive requirements to battery capacity and electric power of AEMPT vehicles, simulations have been conducted using a low detail simulation model. This model allowed to calculate initial fuel saving potentials for different vehicle configurations assuming a simple energy management. The results show that AEMPT vehicles should have a battery capacity of 0,35kWh/ton GCW and an electric power rating of 4kW/ton GCW. These values allow fuel savings of up to 8,5% on typical long haul cycles. A sophisticated energy management may further increase this number.

For the energy management architecture, basic requirements are presented. Based on these findings a functional structure will be set up in the course of the project. In favour of maximum energy efficiency, a decision has been taken toward a centralized structure. A global energy and torque management system will communicate with multiple local system management instances in the trailer units. A suitable communication protocol will ensure the required flexibility in combining vehicle units.

Including a powerful distributed hybrid drive into long haul trucks, in particular EMS vehicles, of course may substantially influence vehicle dynamics. Looking at driveability, a distributed powertrain shows advantages in traction, as more weight is carried by driven axles. Requirements have been derived for electric torque and for power ratings of the electric drives and the combustion engine. For lateral dynamics, electrically driven axles may lead to unwanted behaviour in articulated vehicles. Following the general idea that AEMPT vehicles shall fulfil the same stability criteria as conventional vehicles, reference is made to the Australian Performance Based Standards for high capacity vehicles. However, multibody simulations show that additional criteria are necessary to account for the influence of electric drives.

The performance of AEMPT vehicles will be rated by in total 15 KPIs defined in this document. These KPIs cover efficiency, lateral stability, driveability and manoeuvrability. By adding target values to KPIs, they are also part of a list of 54 requirements to AEMPT vehicles. For vehicle configurations which cannot be rated in real world tests, the KPIs will be calculated in suitable simulations.

1.1.1 Tractor semitrailer

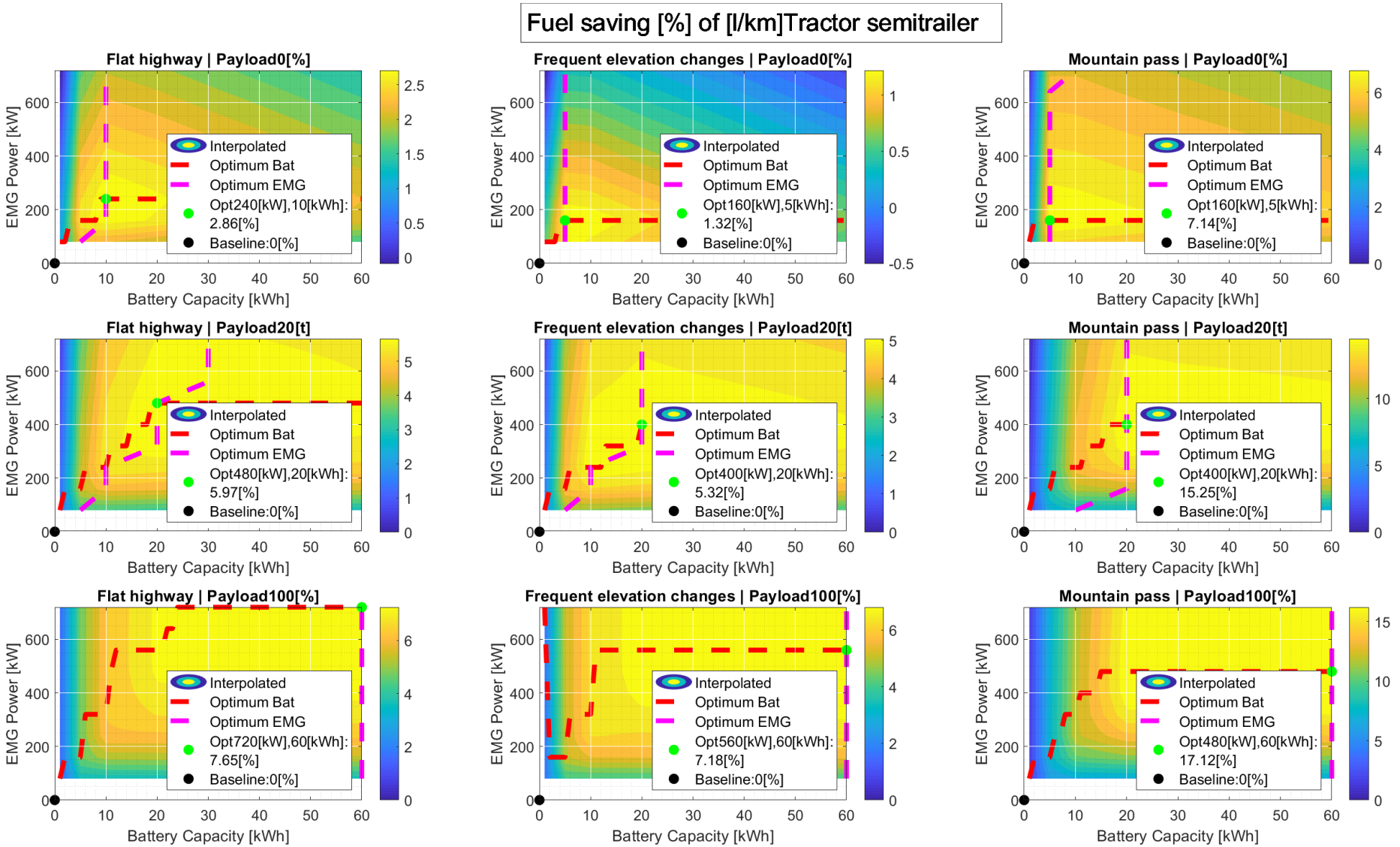

Figure 1 Saving [%] of fuel consumption in [l/km] for tractor semitrailer

1.1.2 EMS1

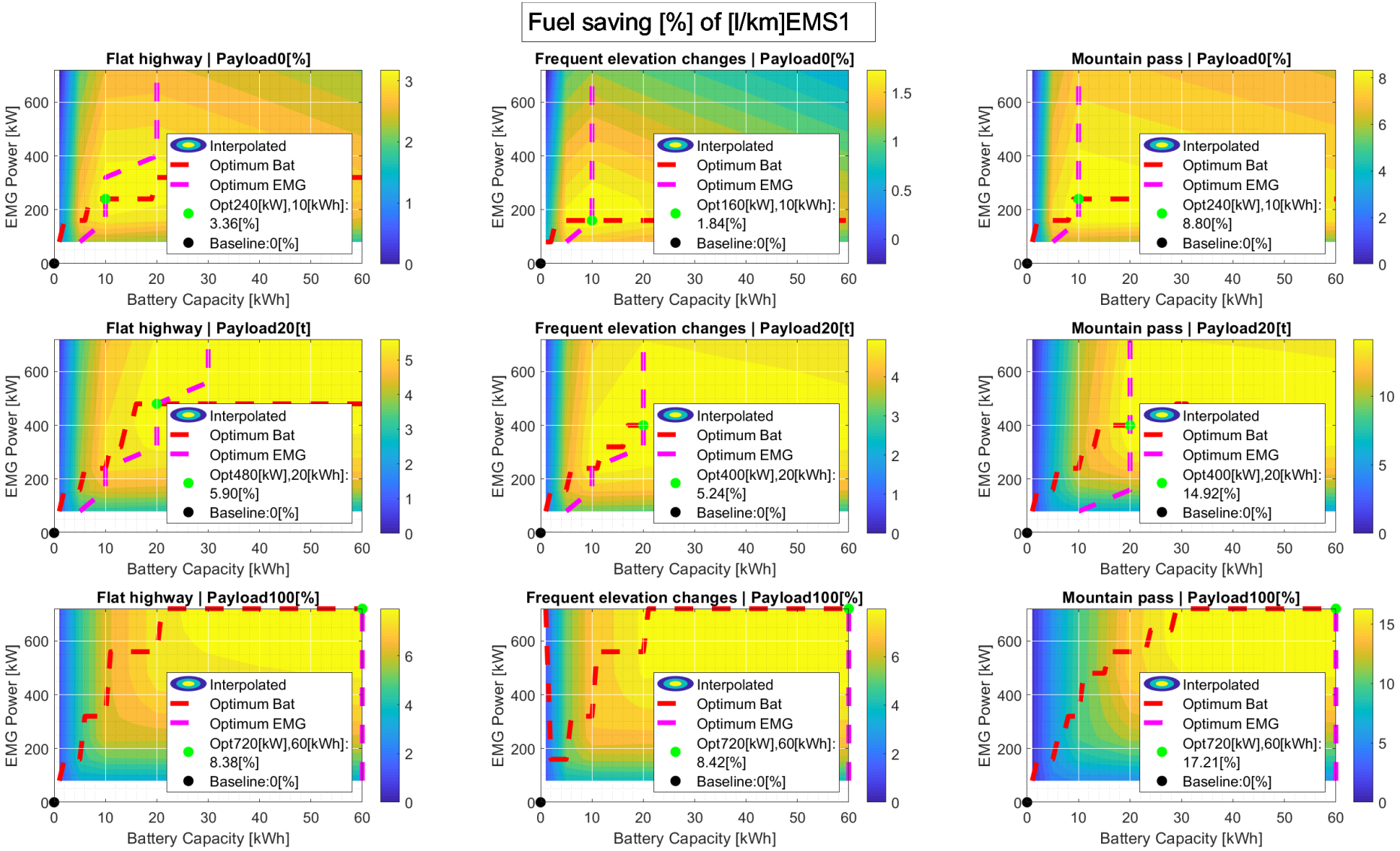

Figure 2 Saving [%] of fuel consumption in [l/km] for EMS1

1.1.3 EMS2

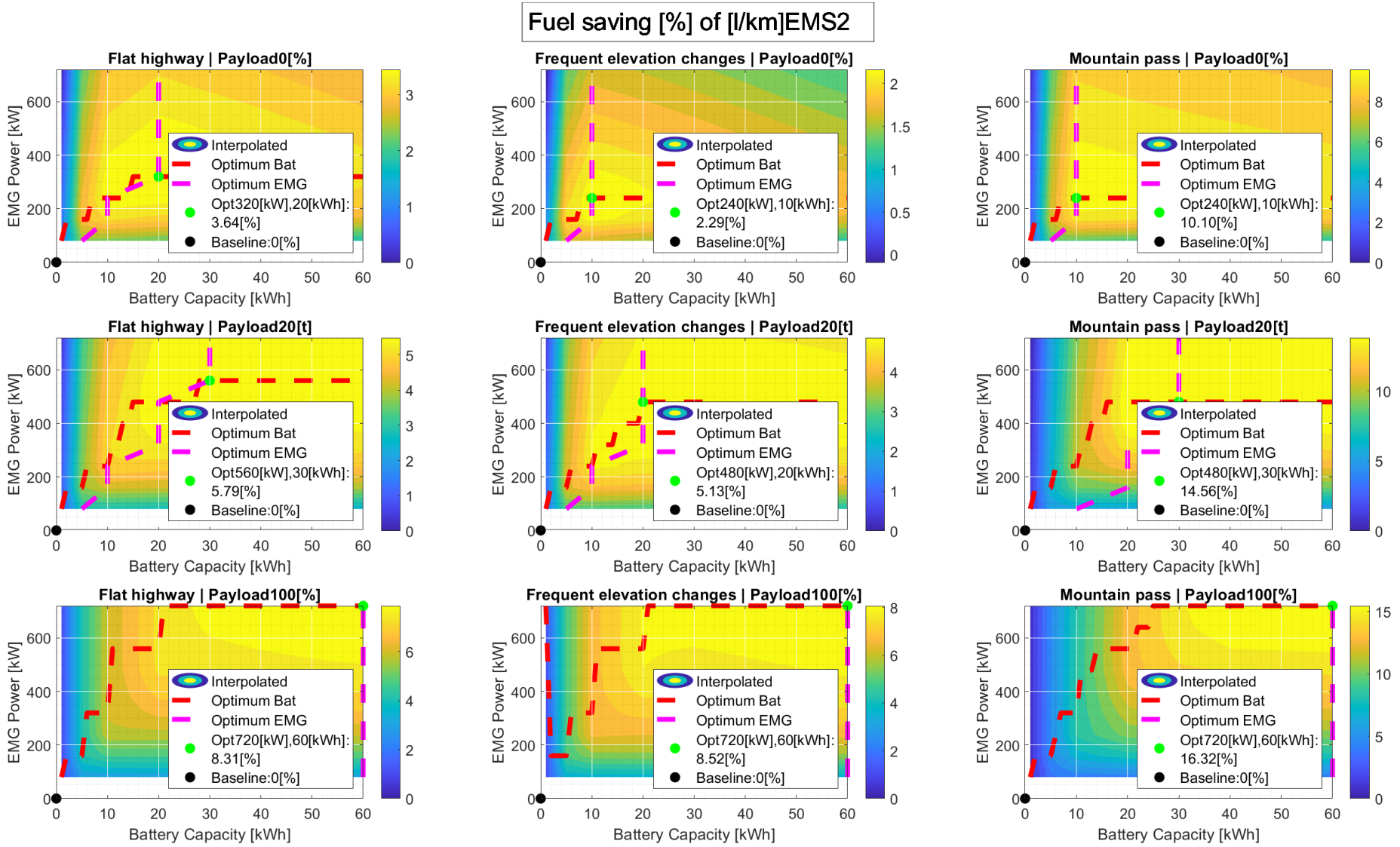

Figure 3 Saving [%] of fuel consumption in [l/km] for EMS2

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D2.1 – Book of Requirements AEMPT and KPIs
