Rare Earth Free e-Drives Featuring Low Cost Manufacturing

ReFreeDrive

Collaborative Project
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Abbreviations

4WD – 4 Wheel Drive

BEV – Battery Electric Vehicle

CAD – Computer Aided Design

DSPWM – Discrete Space vector Pulse Width Modulation

EDU – Electric Drive Unit

EPA – Environmental Protection Agency

FeSynRel – Ferrite assisted Synchronous Reluctance motor

HWFET – Highway Fuel Economy Cycle

IFPEN – IFP Energies Nouvelles

IM – Induction Motor

JLR – Jaguar Land Rover

MDL – Motor Design Ltd.

MOSFET – Metal-Oxide Semiconductor Field Effect Transistor

PMSM – Permanent Magnet Synchronous Motor

SiC – Silicon Carbide

SOC – State Of Charge

SVPWM – Space Vector Pulse Width Modulation

SynRel – Synchronous Reluctance

UAQ – Univeristy of l'Aquila

UDDS – Urban Dynamometer Driving Schedule

WLTP – Worldwide harmonized Light vehicle Test Procedure

1 Executive Summary

This report focusses on the integration of the 200kW high power electric drive units designed within the ReFreeDrive project in a Jaguar Land Rover (JLR) vehicle. The results are based on simulations that rely on datasets which have been provided by Motor Design Limited (MDL) in WP3, IFP Energies Nouvelles (IFPEN) and University of l'Aquila (UAQ) in WP4 and complemented by specific datasets related to mechanical and gearbox losses provided by JLR. As the gearbox development wasn't part of the ReFreeDrive project, JLR has provided a dataset for this specific subcomponent based on the assumed gear ratios and gearbox layout corresponding to the target vehicle with the boundary conditions described previously within WP2. Vehicle performance calculations are generated with a JLR-internal vehicle model. Efficiency calculations are generated by the workflow described in Figure 1.

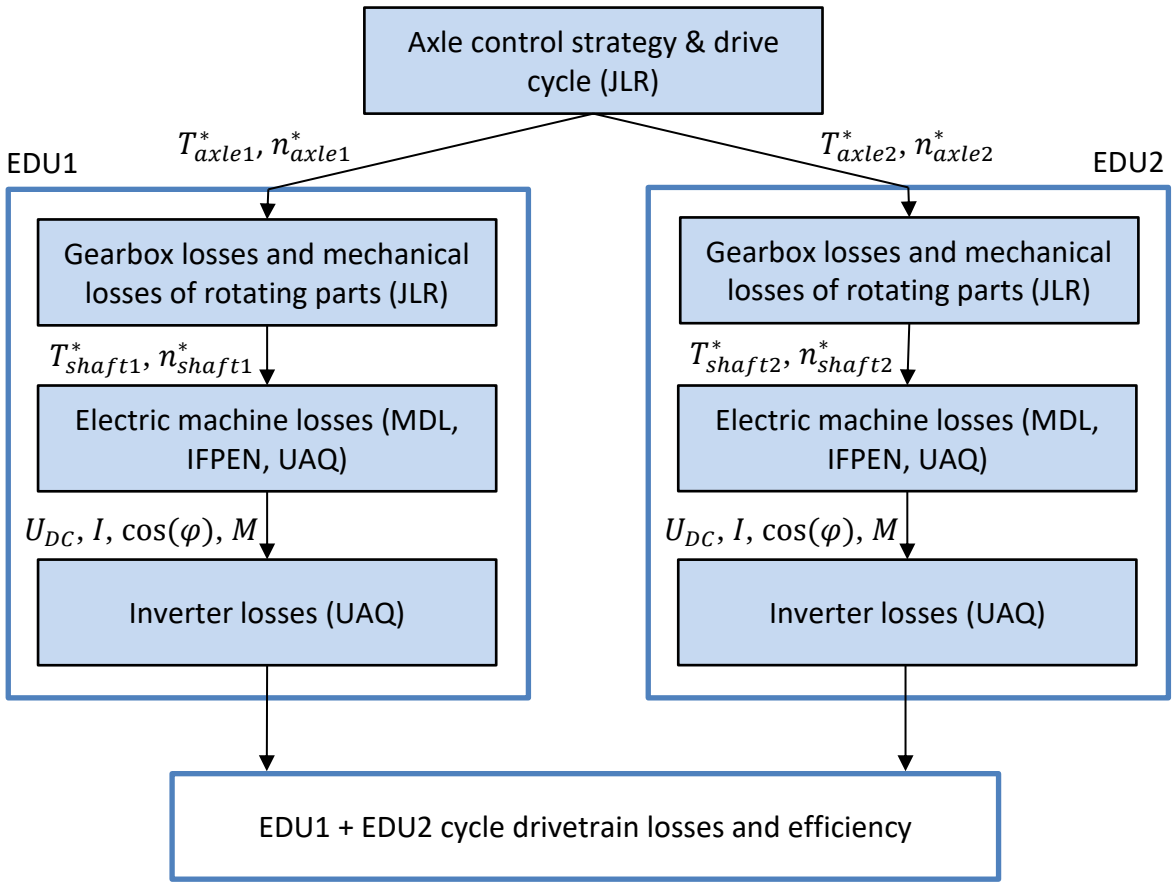

Figure 1: Workflow for generation of drivetrain losses over representative drive cycle and subsequent drive unit efficiency determination

The different outputs will highlight the performance of the three rare-earth free motor topologies at system level when used as dual-axle four Wheel Drive (4WD) propulsion system for high performance Battery Electric Vehicles (BEV) .

The results show that each type of motor technology has a different impact on the behavior of the inverter and the gearbox thus directly impacting the overall system. The ReFreeDrive motors integration potential is described and proven in section **¡Error! No se encuentra el origen de la referencia.**.

In terms of deliverable tracking, delivery month of D5.4 was M24 according to the ReFreeDrive proposal but delivery in M28 was mandatory in order to ensure all design data from the relevant partners was consistent and compliant with the JLR simulation processes. No deviations on content were mandatory to comply with the project proposal and the simulative aspect of the deliverable has been clearly defined previously (no 200kW motor vehicle integration within the project). D5.4 in general will help understand the high-level trade-offs between the different technologies and define a more robust exploitation plan and techno-economic assessment in WP8 as the powertrain efficiencies will directly impact battery cost for a given range.