Brandenburgische Technische Universität Cottbus - Senftenberg

Lehrstuhl Leistungselektronik und Antriebssysteme

Project HELMS

The Project HELMS (Hybrid Electro-Mechanical Shunter) is created with the target to upgrade the existing BR 29X shunting locomotive from a hydraulic transmission to a series parallel hybrid system. The new power train is comprised of a planetary gearbox which facilitates the interconnections between a diesel engine and a generator, two electrical motors and a mechanical shaft to wheels. With this arrangement the locomotive can be operated in a variety of modes either utilizing the mechanical transmission or the electrical transmission or a combination of the two. Two prototyping locomotives are planned to be built and tested in order to obtain the know-how for this concept to enter series production.

The complexity and size of the project necessitate expertise in several fields and strong collaboration between many agents. In the case of HELMS, the involved companies are Deutsche Bahn Systemtechnik and Deutsche Bahn Fahrzeuginstandhaltung, Toshiba, Henschel and several others. Aside of the industrial expertise, the project involves academic proficiency brought in from the Brandenburg University of Technology Cottbus-Senftenberg (BTU). Modules for the locomotive assembly, such as the planetary gearbox from Henschel or the electrical drive train from Toshiba, are brought in Cottbus at the Deutsche Bahn Fahrzeuginstandhaltung facilities where the assembly takes place. The Chair for Power Electronics and Drives (LEA) at the BTU is tasked with:

- Investigation of the electrical drive components like electrical motors, generator, battery and power electronics for the hybrid drive system as well as the control and regulation
- Establishment and verification of the specifications for the Energy Management System (EMS) software
- Implementation and testing of the EMS software
- Preparation and build for the integration tests
- Integration testing of the locomotive
- Preparation and setup of instrumentation for the operational verification stage of the locomotive
- Operational verification phase: Evaluation, Documentation and Improvements

The responsibilities of the LEA as listed above involve support of the consortium during the entire duration of the project, which is anticipated to last 2 years. Since the locomotive is assembled in modular systems developed by different companies, the assistance provided by the LEA will be critical. The investigations about the electrical drive components encompass data gathering and analysis of both electrical and mechanical variables of the locomotive. The investigation should provide early warning about discrepancies in the operation and offer insights into possible issues for the later stages of testing.

The EMS software is planned to optimize the operation of the locomotive in order to reach the planned improvement in efficiency and decrease of CO_2/NO_x emissions. The specifications for this software will depend heavily on the locomotives' technical parameters and once they are established and verified, the EMS software will be implemented at the LEA. This software will later serve in the course of operation of the locomotive.

Integration testing of the locomotive is to be performed in Cottbus, where the LEA is able to assist with any difficulties. For this part, all the necessary measurement instrumentation is to be placed and observed by the LEA, for later analysis and improvement suggestions. The integration testing takes place at the facilities of Deutsche Bahn where LEA has easy access to the instrumentation and data acquisition. Early warning and upgrading options would be provided to the appropriate agent in the consortium.

The last stage of the project involves observation of the locomotive during operation. This is considered to be the operation verification stage of the HELMS concept. The instrumentation of utmost importance would be assembled with the locomotive by the LEA and the vehicle will be deployed into operation. Once in operation, data will still be gathered and uploaded to a server, thus made available to the LEA for operational verification. During this final stage of the project, the LEA will aggregate evaluation reports, write up the documentation and offer further improvements to the complete project.

Close collaboration is imperative due to the complexity of the project. It involves expertise in power electronics and drives, electrical machines combined with data analysis; software development and deployment documentation. The success of this cooperation would result into know-how on extending the lifecycle of the BR 29X for about 16 years and an upgrade of about 400 other shunter locomotives in the same or similar series. This prototyping locomotive, if successful, would enter serial production in about 2020.

Facts and figures:

HELMS BR 29X

- Hybrid type: Series Parallel Hybrid
- Maximum output (at wheel rim): 750 kW
- Maximum operation speed: 80 km/h
- Diesel engine power output: 1.000 kW
- Generator (x1): Asynchronous type (Toshiba)
- Traction motor (x2): Asynchronous type (Toshiba)
- Traction converter (x1): IGBT-type (Toshiba)
- Battery: SCiB (for traction) 92.25 kWh (Toshiba)
- Gearbox: Planetary (Henschel)

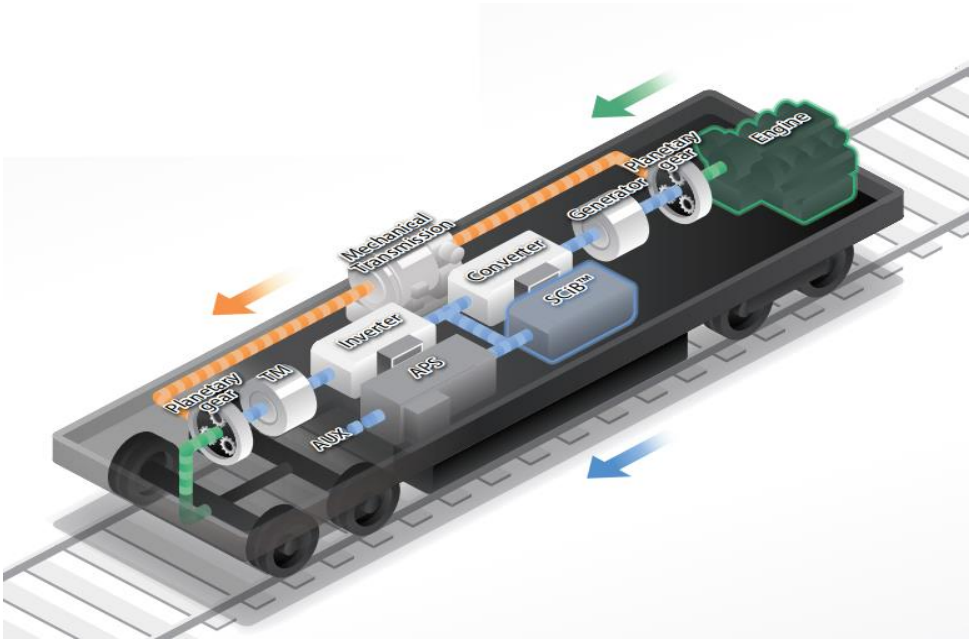

Figure 1. Diagram of the HELMS concept. Wheel rim can be supplied through mechanical and electrical power train

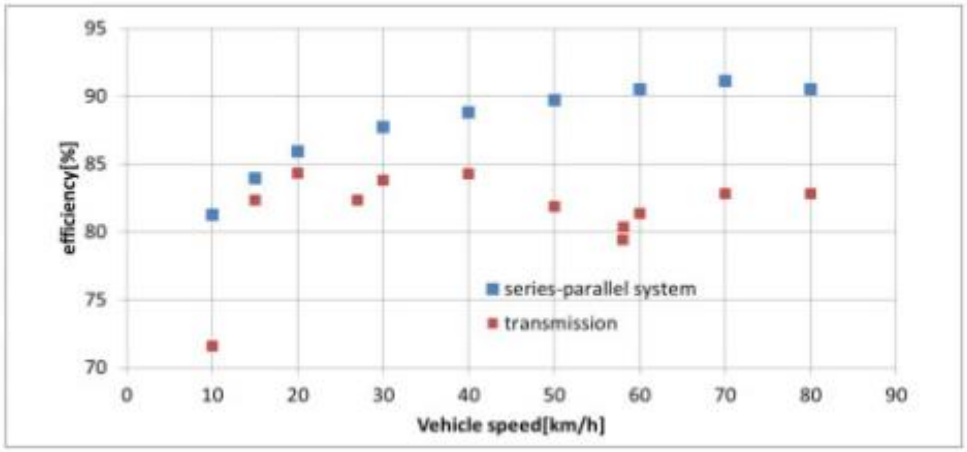

Figure 2. Expected efficiency of the series parallel hybrid versus classical transmission