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The Unimat 09-4x4/4S E³ uses electrical energy from the overhead line not only for electrical traction during transfer travel but also to power the tamping unit electrically

Sustainable track work

A study conducted by the Graz University of Technology and Plasser & Theurer examines the possibility of achieving zero direct emissions during maintenance and construction work on railways

Current track work machinery is predominantly powered by diesel engines. According to the Institute of Railway Engineering and Transport Economy at the Graz University of Technology (TU Graz), track maintenance work on the Austrian Federal Railways amounts to 9,600 tons of CO_2e per year – based on fuel consumption, machinery transport, material transport, and production. This indicates huge potential for mitigating greenhouse gas emissions by switching to alternative drives for track work machinery. It can also be assumed that track work machinery will be subject to more stringent regulations in the near future.

The goal of the Fossil Free Future for Track Work Machinery (FFF) study, conducted by TU Graz in cooperation with Plasser & Theurer, is to analyze different solutions arising from other modes of transport in order to assess their applicability to the railway sector and to track work machinery. This analysis considers market-specific aspects and risk factors. The FFF study recommends alternative solutions for different track work machinery based on the results of market analysis and the outputs of a calculation tool. The market analysis captures the technology trends of different drives in different modes of transport, with a special focus on the rail and construction sector. It evaluates the institutional landscape, such as regulations and the political incentives to be expected. As part of the project, TU Graz developed the CalCAS (Calculation of Comparison for Alternative Solutions) tool using operating data from different kinds of track work machinery.

Cross-industry analysis

The barriers for the market uptake of alternative drives in the transport industry include the technology currently available, a lack of infrastructure, a lack of regulations or incentives, and higher costs due to scalability. The road sector has proved to be the most mature industry in regard to alternative drives. Despite the lack of clear goals and little demand in the rail sector, stakeholders are aware of the need to reduce environmental impacts. In combination with technological progress, this will lead to a further rise in alternative drives in both sectors.

Alternative drives for track work machinery are in their infancy. Research shows that the technological concepts for powertrains and transmissions used in the construction sector might be applicable to track work machinery. Regarding the primary power source, track work machinery is highly influenced by market trends in the rail sector. This is because implementing alternative solutions depends on the infrastructure for supplying energy (e.g., charging or refueling).

In comparison to the rail sector, battery-only technology is much more established in the construction sector and limited to electric construction machinery with cables, handheld equipment, or smaller machines. By contrast, fuel cell technology is at a very early stage of development (with the exception of forklifts). Few models with alternative drives exist for track work machinery (six manufacturers could be identified).

The solutions for track work machinery tend to be hybrid solutions, such as mainly diesel-battery, rather than stand-alone solutions; this is in line with trends in the rail sector as a whole. Smaller and lighter track maintenance tools, such as portable tampers, which work on battery power only, are an exception to the above.

The CalCAS tool

The outputs of CalCAS show that on-board battery technology is the preferred solution for track work machinery that requires less than 300 kWh of energy. By contrast, hydrogen fuel cell technology is suited to machinery that requires more than 800 kWh of energy. For machinery with energy requirements in between, either more advanced battery technology is needed due to weight issues, or the machinery should be equipped with fuel cell technology.

Despite the benefits of alternative drives (such as fewer GHG emissions, less noise pollution, or higher efficiency), it does not automatically equal fossil free nor emission free. Alternative liquid fuels have limited potential (high demand for primary energy, contradictory findings on emissions, concerns regarding synfuels, etc.). Battery and hydrogen applications depend on the electricity mix, as well as on the production process and the end-of-life of their components. Nonetheless, in terms of mitigating environmental impacts, they are considered to have great potential.

The findings of the FFF study have helped Plasser & Theurer assess both alternative drive technologies for track work machinery and the possibilities and risks they offer. The data provided by the study allows for a more effective assessment of future market developments, particularly in the railway and construction sector. Moreover, the calculation tool makes it possible to evaluate the fundamental requirements individual machine types have for alternative drives, and to integrate these requirements into strategic corporate decisions.

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