

## DEEP SLEEP ON A LIGHT EUROPEAN TRAIN: MODULARITY AND LIGHT-WEIGHT AS ENABLERS OF A PROFITABLE NIGHT TRAIN

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**Summary:** Night trains face economic challenges in Europe primarily due to three key issues. Firstly, the rolling stock of sleeping cars is usually outdated and has a narrow loading gauge designed for intra-European journeys. This results in poor acoustics, thermal insulation and dynamic damping and also offers only limited privacy. Secondly, cost efficiency is challenging due to the special and limited scope of use. The interior concept of existing sleeping cars is not economical for daytime transport (higher track access charges with lower possible passenger density). Lastly, greater comfort also means increased weight, as conventional construction methods do not allow the possibility of realising a lightweight structure.

The "AliSa" research project addresses these problems. In AliSa, a sleeping car is being fundamentally redeveloped. The overall concept consists of permanently coupled 3-part car. This makes it possible to create daily demand-dependent configurations of the train system that enable the most efficient utilisation of the entire network. In addition to the modularity of the overall network, the focus here is on the modularity of the interior concept and the overall concept optimised for lightweight construction. The innovative value of the interior lies in the comprehensive implementation of standardised modular compartments that offer a high degree of privacy. Thanks to the modularity and the adapted length of the coach body, the available installation space can be optimally utilised and the passenger density increased through an optimised arrangement of sleeping berths, sanitary facilities and multi-purpose areas. This enables a quick changeover from night to day operation and thus all-day utilisation of the rolling stock, which increases economic efficiency. If the increasing comfort and privacy requirements of passengers are considered, this also raises the mass of the interior concept. In order to counteract this increase in mass and to continue to develop efficiency-optimized and low-emission vehicle concepts in the future, lightweight construction concepts are absolutely essential.

The previously non-load-bearing interior concept of the night train is therefore being integrated into the load-bearing structure using new sustainable materials and material combinations. The innovative linking of the interior concept and mechanical structure avoids double structures and the lightweight design potential can be fully utilised. With the holistic lightweight design approach, the aim is to reduce the mass per metre by 15 % compared to conventional car bodies despite increased comfort and to enable an optimised, offer-differentiated configuration. The mass advantage resulting from the function-integrated multi-material design is utilised to increase passenger density and implement a comfortable, modular interior concept without exceeding the permissible axle load. This increases energy efficiency and at the same time reduces the CO2 footprint in production and operation. As a result, it is possible to use the vehicle economically both during the day and at night, while at the same time increasing the comfort and privacy of individual passengers. The new development as part of the "AliSa" project offers the potential to significantly improve the economic efficiency, sustainability, attractiveness and thus the competitiveness of night trains.