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Is hydrogen suitable for powering railway vehicles in the Czech Republic?

Jiří Krejčí[1], Lukáš Týfa[2]

1 Czech Technical University in Prague, Faculty of Transportation Sciences, Prague, Czech Republic
2 Czech Technical University in Prague, Faculty of Transportation Sciences, Prague, Czech Republic

INTRODUCTION

The aim of our society is to transform various industries, particularly the transport sector, to make them more environmentally friendly and help protect our planet. Our primary goal is to promote sustainable development by reducing carbon dioxide emissions, a major contributor to global warming.

Rail transport is considered one of the most environmentally friendly forms of public and cargo transportation. However, emissions can still be reduced. The main source of these emissions comes from independently powered vehicles that rely on fossil fuels for propulsion.

The solution is to replace them with vehicles that use alternative propulsion, such as battery-powered and hydrogen units. The goal of this paper is to assess the feasibility of operating hydrogen-powered vehicles within the conditions of our country's railway system.

MATERIALS, METHODS & IMPLEMENTATION

This paper focuses on hydrogen-powered rail vehicles, specifically HMUs (Hydrogen Multiple Units) and HEMUs (Hydrogen Electric Multiple Units), assessing their suitability for the railway network in the Czech Republic. It also compares them with alternative propulsion systems, such as BEMUs (Battery Electric Multiple Units). The authors conducted a comprehensive analysis based on available literature, including scientific studies, technical reports, and real-world case studies, to ensure a thorough comparison of these technologies.

RESULTS

The study compared hydrogen-powered rail vehicles, specifically Hydrogen Multiple Units (HMU) and Hydrogen Electric Multiple Units (HEMU), with alternative propulsion systems such as Battery Electric Multiple Units (BEMU) to evaluate their suitability for the Czech railway network. The analysis focused on key factors, including energy efficiency, operational range, infrastructure requirements, environmental impact, and economic considerations.

Energy efficiency
BEMU are more suitable on shorter routes, while hydrogen units are more suitable for longer and non-electrified routes.

Range and infractructure
Hydrogen units offer a longer range but require extensive infrastructure for hydrogen production, storage, and distribution, which may pose economic and logistical challenges.

Environmental impact
Both technologies reduce carbon dioxide emissions, but their overall environmental benefits depend on the energy source for electricity or hydrogen production.

Economic considerations
BEMU represents a cost-effective alternative for railway lines where charging infrastructure can be effectively integrated into the existing system or is already built. Hydrogen propulsion is showing promise for lines with limited electrification, but the initial investment and subsequent operation of these vehicles seems to be very expensive, so regular vehicle operations are not widely adopted.

CONCLUSION & IMPLEMENTATION PATH

Both battery and hydrogen propulsion systems have unique advantages and challenges, making their selection dependent on factors such as route length, infrastructure availability, and sustainability goals. Battery-powered trains are more suitable for shorter routes with established charging infrastructure. They offer lower operating costs and higher energy efficiency. In contrast, hydrogen trains are better suited for longer, non-electrified routes. They provide greater flexibility but require significant investment in hydrogen production and distribution infrastructure.

For the successful use of these technologies in railway transport, further research and investment in renewable energy sources, energy storage systems, and hydrogen production are essential. Strategic planning and policy support will also play a key role in ensuring a sustainable and efficient transition to alternative propulsion systems

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