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Fuel Cells Not Only for Cars: Technological Development in Railways

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Abstract : Railway vehicles are divided into two groups: traction (powered) vehicles and wagons. The traction vehicles include locomotives (line and shunting), railcars (sometimes referred to as railbuses), and multiple units (electric and diesel), consisting of several or a dozen carriages. In vehicles with diesel traction, fuel energy (petrol, diesel, or compressed gas) is converted into mechanical energy directly in the internal combustion engine or via electricity. In the latter case, the combustion engine generator produces electricity that is then used to drive the vehicle (diesel-electric drive or electric transmission). In Poland, such a solution dominates both in heavy linear and shunting locomotives. The classic diesel drive is available for the lightest shunting locomotives, railcars, and passenger diesel multiple units. Vehicles with electric traction do not have their own source of energy -they use pantographs to obtain electricity from the traction network. To determine the competitiveness of the hydrogen propulsion system, it is essential to understand how it works. The basic elements of the construction of a railway vehicle drive system that uses hydrogen as a source of traction force are fuel cells, batteries, fuel tanks, traction motors as well as main and auxiliary converters. The compressed hydrogen is stored in tanks usually located on the roof of the vehicle. This resource is supplemented with the use of specialized infrastructure while the vehicle is stationary. Hydrogen is supplied to the fuel cell, where it oxidizes. The effect of this chemical reaction is electricity and water (in two forms -liquid and water vapor). Electricity is stored in batteries (so far, lithium-ion batteries are used). Electricity stored in this way is used to drive traction motors and supply onboard equipment. The current generated by the fuel cell passes through the main converter, whose task is to adjust it to the values required by the consumers, i.e., batteries and the traction motor. The work will attempt to construct a fuel cell with unique electrodes. This research is a trend that connects industry with science. The first goal will be to obtain hydrogen on a large scale in tube furnaces, to thoroughly analyze the obtained structures (IR), and to apply the method in fuel cells. The second goal is to create low-energy energy storage and distribution station for hydrogen and electric vehicles. The scope of the research includes obtaining a carbon variety and obtaining oxide systems on a large scale using a tubular furnace and then supplying vehicles. Acknowledgments: This work is supported by the Polish Ministry of Science and Education, project "The best of the best! 4.0", number 0911/MNSW/4968 – M.P. and grant 0911/SBAD/2102—B.K.

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