



A Research Project at the Federal Institute for  
Vocational Education and Training (BIBB)

# H<sub>2</sub>PRO

Hydrogen – a future-oriented topic for vocational  
education and training with regard to energy transition

## Hydrogen in the Mobility and Transportation Sector: Additional Training Needs for Skilled Workers in Workshops

The transition to emission-free propulsion technologies is a central focus of the energy transition. According to the German Federal Environment Agency, emissions from the transportation sector in 2022 amounted to 148 million tons of CO<sub>2</sub> equivalent, which accounts for 20% of the total emissions. Hydrogen can play an important role in emission reduction where battery-powered vehicles cannot meet high energy demands and specific usage requirements. Therefore, application potentials are primarily seen in the commercial vehicle sector. Legislative requirements, procurement measures, and manufacturer strategies indicate an increase in fuel cell commercial vehicles in the coming years.

### Relevant training occupations

Occupations geared towards working on vehicle drives include “Automotive Mechatronics Technician”, “Body and Vehicle Construction Mechanic”, and “Agricultural and Construction Machinery Mechatronics Technician”. Additionally, there are other automotive-related occupations such as “Vehicle Painter” or “Vehicle Interior Mechanic”, but their occupational profiles do not entail maintenance work on propulsion systems.

### Work tasks and skills requirements

Fuel cell vehicles are electric vehicles where the propulsion energy is not supplied through external battery charging, but rather through the conversion of hydrogen into electricity within the fuel cell. Because the electric drive system of a fuel cell vehicle is structured similarly to that of a battery-powered vehicle, regular workshop tasks of electromobility also apply to fuel cell vehicles (e.g. establish voltage-free state, diagnostic and measurement procedures, component replacement).

Electromobility signifies a significant shift in work tasks and required skills for professionals in workshops. Mechanical activities are becoming less relevant, while electrical and measurement-related skills take center stage. A central area of focus in electromobility is the safe handling of high-voltage systems.

Additional work tasks arising from fuel cell propulsion include the inspection of hydrogen sensors, valves, and connections, purging and flushing of the gas system, leak and integrity testing, extra fault-finding and diagnostic procedures, as well as the removal and installation of components within the fuel cell and tank systems. Work processes primarily involve the hydrogen distribution system, cooling, and air supply. Fuel cell stacks and hydrogen tanks are not opened in service workshops but are only replaced.

New skills requirements for working on fuel cell and tank systems revolve not only around understanding their functionality and system interconnections but also focus on occupational health and safety. Potential hazards arise from hydrogen's flammability, high pressures within the lines, and high voltages. While these risks are manageable, they demand competencies in hazard avoidance, such as handling components of the gas system under pressure (e.g. valves and screw connections) and understanding hydrogen's substance behavior (e.g. ignition limits, volatility, odorlessness, colorless combustion). Even though the fuel cell isn't opened in service workshops, a basic understanding of its structure and the processes occurring within should be present.

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## Qualifications and training regulations

Professionals working on fuel cell vehicles need to be qualified for high-voltage and gas systems. The required qualification depends on the job tasks and associated risk assessments. In practice, the professionals typically receive training in high-voltage technology and gas propulsion from a professional training provider, along with product-specific training provided by the vehicle manufacturer.

The Professional Association for Wood and Metal has introduced qualification levels that typically serve as the basis for the provided training courses and certifications. These qualification levels refer to development/production (E-levels) and service/after-sales (S-levels). Training for the E-levels is more extensive due to higher safety requirements.

Level	High Voltage (HV)	Gas
E/S	<b>Sensitised Person</b> Operating HV vehicles	Operating vehicles with gas propulsion
1E/1S	<b>Expertly Instructed Person</b> General work on the vehicle	General work on the vehicle (excluding the gas system)
2E/2S	<b>Skilled Person</b> Working on HV systems in a voltage-free state	Working on the gas system
3E/3S	<b>Skilled Person</b> Working on live HV components	Construction and modification (3E) or retrofitting of gas systems (3S)

Table: Qualification levels according to DGV 209-093 and DGV FBHM-099.

The training occupation of “Automotive Mechatronics Technician” was restructured in 2013, establishing working on high-voltage systems in a voltage-free state as a minimum standard in the training, and integrating work on live high-voltage systems within the focus area of “High-Voltage and System Technology”. In 2023, a codified additional qualification for working on live high-voltage systems was integrated into the occupation of “Body and Vehicle Construction Mechanic”.

In the course of future restructurings, it should be examined whether corresponding qualifications regarding gas systems and hydrogen need to be added to the regulatory framework.

## Hydrogen in vocational schools and in inter-company training

In vocational schools, the topic of hydrogen has not yet been widely adopted. However, individual schools are working on integrating hydrogen-related content into their education. In some cases, schools collaborate with regional hydrogen networks and training providers for this purpose.

To foster skill development, more cross-regional networking is necessary. Flagship projects that already offer hydrogen qualifications can share their experiences and support other vocational schools as multipliers.

Beyond task-related knowledge, the topic of hydrogen provides an excellent opportunity to address societal and technological aspects of the energy transition, thereby enhancing students' overall sustainability competency.

Following the restructuring of the occupation “Automotive Mechatronics Technician”, a high-voltage training course was developed for inter-company training. Here, too, it should be examined whether and how hydrogen-related qualifications should be complemented.

## Raising awareness for future technologies and sectoral changes

Once professionals are qualified to work on electric drives, it's a close step towards working on fuel cell vehicles. Electromobility remains a challenge in vocational training, partly because electric vehicles are not yet part of the daily work routine in many (smaller) workshop operations, leading apprentices to often lack hands-on experience. Beyond the topic of alternative propulsion systems, it's becoming increasingly important to sensitise apprentices early on to future technologies and forthcoming changes in the automotive sector.



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