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 **STANDARDIZATION ROADMAP
FOR HYDROGEN TECHNOLOGIES**

MANAGEMENT SUMMARY: STANDARDIZATION ROADMAP HYDROGEN TECHNOLOGIES 2024

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Management summary of the Standardization Roadmap Hydrogen Technologies 2024

On behalf of the Federal Ministry for Economic Affairs and Climate Action, work on the first edition of the Standardization Roadmap Hydrogen Technologies began in January 2023 under the leadership of the seven project partners DIN, DKE, DVGW, NWB, VDA, VDI and VDMA. With the broad participation and involvement of more than 600 experts from industry, science, the public sector and civil society, the strategic roadmap for hydrogen technology standardization was thus developed. This work is coordinated and supported by a high-level steering group.

The Standardization Roadmap addresses the importance of uniform standards for the development of a hydrogen infrastructure, which is also emphasized in the German National Hydrogen Strategy and its update.

The publication of the first version of the Standardization Roadmap Hydrogen Technologies issued in July 2024 presents the status quo of the analyses of existing and required standards and technical rules in the field of hydrogen technologies. The results of these analyses serve as a coordinated roadmap and uniform standardization strategy for Germany's hydrogen economy. These results are also to be seen as tools for successfully representing German interests at the European and international level.

The publication of the Standardization Roadmap Hydrogen Technologies lays an important foundation for the further development of the technical rules for hydrogen technologies. A comprehensive network of experts has been established, and diverse German opinions have emerged for future technical rule-setting projects. In the course of work, it became apparent that the various subject areas are at significantly different stages of development. While the technical rules for grid-bound infrastructures are already almost complete and in some cases are being revised, other areas are in the coordination and initiation phase. For example, there are still many gaps that need to be closed in the areas of aviation and shipping, alternative types of hydrogen production or the offshore sector.

The Roadmap results are broken down into the following five fields of action along the hydrogen value chain:

- Production
- Infrastructure
- Application
- Quality infrastructure
- Further training, certification and safety

The Roadmap outlines the results of the work and discussions along the entire value chain and provides a comprehensive overview of the status quo, current challenges, needs for action and the specific steps required in the development of technical rules.

With over 850 entries, the publicly available standards database for hydrogen technologies) maps the current technical rules already available and/or applicable to hydrogen; the database is maintained and continuously updated. The more than 180 needs identified so far, which have been made official recommendations for action in the Roadmap, provide a strategic guide to the development and revision of the technical rules for hydrogen. In addition, the Standardization Roadmap for Hydrogen Technologies enables the rapid and efficient implementation of high-priority needs through financial support.

Overview of the status quo and identified gaps in standardization



Production

PRODUCTION PLANTS

The level of maturity of the existing technical rules for the production of hydrogen by water electrolysis is relatively advanced. However, there are still gaps in terms of uniform evaluation criteria and international harmonization. Other types of production of hydrogen, such as through biological fermentation, or photosynthetic or thermochemical processes, are still in the early stages of development and no corresponding standards exist.

TOTAL SYSTEM INTEGRATION

Existing technical rules can be applied for total system integration – the economically efficient and grid-friendly interaction of the electricity, heat and gas infrastructures. However, the collection of technical rules must now be expanded, for example by implementing uniform communication standards to ensure a fluid, cross-sectoral exchange of data and to enable the integration of hydrogen production and utilization facilities into the existing energy system.

HYDROGEN QUALITY

The core standards for specifying the quality and composition of hydrogen (blends) for applications are available. At national level, the same applies to transmission - although these standards still need to be raised to European or international level in order to ensure international connectivity. There are many specific requirements in the area of verification and sustainability aspects, but these have not yet been harmonized with the regulations.



Infrastructure

TRANSMISSION AND DISTRIBUTION GRIDS

An almost complete set of technical rules is available for the grid-based supply of hydrogen. The gaps, for example the adaptation of operating processes to hydrogen or the harmonization and specification of uniform training content for handling the medium hydrogen by employees, were identified as part of the standardization roadmap and will now be closed in a timely manner. Some of the technical rules are already entering the next iteration of revision in order to further develop the state of the art with findings from research projects.

STORAGE

A large number of technical rules exist for stationary and mobile pressure vessels, some of which need to be adapted to the new requirements of a mass market. New technologies must also be accompanied by standards and technical rules, which must be developed for better market access, thereby taking into account safety, economic efficiency and technological openness. In the area of underground gas storage facilities, an existing set of technical rules for the natural gas sector can be used as a basis. The technical rules need to be expanded in line with the requirements for hydrogen applications, and the conditions specific to underground gas storage facilities need to be taken into account.

LIQUEFIED HYDROGEN AND HYDROGEN DERIVATIVES

Based on their use as chemical products, a large number of standards and technical rules exist for liquid, cryogenic hydrogen (LH₂) and hydrogen derivatives (e.g. NH₃, methanol, LOHC). New regulations must be developed to meet the requirements for wider use as an energy source and storage medium. Successful market ramp-up requires more pre-normative research and uniform, publicly accessible standardization.



Application

POWER SUPPLY AND REVERSIBLE FUEL CELLS

The topic of fuel cell energy systems is well covered by standards, many of which are already available in a revised version. For thermal power plants, the existing technical rules need to be expanded to include the specific requirements for hydrogen applications., e.g. in the area of combustion technology.

INDUSTRY

Many power plant and industrial hydrogen applications are already operational and state of the art. The majority of existing standards usually require little or no adaptation in order to integrate safety requirements and other influences of the market ramp-up, such as new or improved technologies, into existing standards.

HEAT

In the field of heat supply already many safety and product standards exist dealing with appliance components. Many national certification schemes make it possible to bring technologies onto the market. For equipment technology, the current standards at European level and the installation and application technical rules still need to be adapted.

MOBILITY

In the area of mobility, the level of normative coverage varies greatly.

A large number of standards already exist for filling systems, but there are still some gaps to be filled in order to develop all the necessary filling system standards for safe hydrogen mobility.

In shipping, the existing DIN, EN and ISO standards and ship-related technical rules for inland and maritime shipping are being reviewed, supplemented and further developed to include hydrogen and its derivatives for use as a fuel.

In addition to the use of hydrogen as an on-board fuel, the ship-shore interface and ship-side storage for transportation are also taken into account.

The use of hydrogen in road transport is well covered by standards, and there are only a few gaps in standardization and technical rule-setting.

The first technical rules in the electrotechnical sector have been issued for rail vehicles. In addition, reference is made to standards from other sectors because they are interface technologies. Rail-specific requirements for refuelling, storage and safety aspects are currently being focused on. As currently hardly any standards and technical rules exist in the aviation sector, there is a need for standardization in several areas, such as refuelling, test methods and cleanliness of the hydrogen used.

Existing technical rules can be applied for special vehicles; the challenge here is to work out specific standardization needs, as further developments with respect to future fields of application are still unclear.



Quality Infrastructure

MEASUREMENT TECHNOLOGY

In the field of measurement technology, a large number of applicable technical rules for analysis, measurement and billing already exist. Relevant analysis, measuring device and metering standards are currently being developed or revised. Procedures for calibration, verification of precision and online gas analysis also need to be adapted in order to comply with the guidelines and specifications of the calibration and measurement regulations.

MATERIALS

For metallic materials, composites and plastics, existing technical rules must be partially revised for the use of hydrogen, and identified gaps must be closed, in particular the definition and validation of test methods and measurement technology, and the description of material behaviour when exposed to hydrogen.

COMPONENTS

The collection of technical rules for the use of components in infrastructure is almost complete. The gaps are currently being closed with the support of the Standardization Roadmap. In the area of applications and technologies, many national certification schemes already exist that make it possible to place products on the market on the basis of EU regulations. The remaining gaps will be closed in the near future and the existing national technical rules must be harmonized at European level in the next steps.



Training, certification and safety

SAFETY/SECURITY

For safety- and security-related aspects, including cyber security a large number of technical rules already exist which define requirements for specific fields of application. The new and broader application of hydrogen technologies results in additions and changes to the relevant safety standards and technical rules, including for operational explosion protection, the handling of cryogenic hydrogen and the evaluation of safety concepts for manufacturers, operators and licensing authorities.

PRODUCT CERTIFICATION

Already a large number of standards exist making it possible to certify products that use hydrogen. For plant technology and production international standards are available. There are also already a large number of certification schemes that can be applied nationally in order to meet the European legal requirements for the approval of products until the corresponding European Standards for hydrogen have been revised. Nevertheless, there are still considerable gaps that need to be closed in the coming years in order to accelerate the market ramp-up and standardize approval.

FURTHER TRAINING

Qualified personnel are needed for the market ramp-up of hydrogen. The necessary knowledge can be imparted on the basis of existing technical rules. Hereby, it is essential that the qualification requirements are adapted to hydrogen. What is particularly important is to break down the historically evolved and non-transparent legal framework in order to clearly define the necessary qualifications for the specific field of work. The requirements must be set sufficiently high without creating market barriers.

Implementation projects

As part of the Standardization Roadmap Hydrogen Technologies, high-priority technical standardization projects based on the recommendations of the Standardization Roadmap bodies are financially supported.

In summer 2023, the proposals for the first implementation projects in the areas of hydrogen transmission, storage, components and rail transport were evaluated. Nine implementation projects were funded by the Federal Ministry for Economic Affairs and Climate Action (BMWK). The focus of this first initiation round was on the important and urgent technical rule-setting projects that are being driven forward at national, European and international level and that have been developed to such an extent that they could be initiated as early as summer 2023.

In the second initiation round in autumn 2023, 14 implementation projects were supported. These were new projects at national and European level in the areas of production, industry, quality infrastructure, heat and hydrogen quality.

Looking ahead

The joint project will further specify and consolidate the existing Roadmap in order to further advance the development of the quality infrastructure for hydrogen. Over the next few years, there will also be more results from various research projects and practical experience that will enable the technical rules to be adapted and expanded. Here too, the Roadmap will support the implementation of the technical rules with its network of experts. Furthermore, the progress of standardization activities and technical rule-setting activities at national, European and international level will be closely monitored and taken into account accordingly.

These developments and the further elaboration of recommendations for action to close existing gaps, particularly in areas that are currently still at a low level of development, will be presented in the second version of the Standardization Roadmap Hydrogen Technologies. The final version of the Roadmap will be published at the end of 2025. There will also be three further initiation rounds for implementation projects during the course of the project.

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