H_2 Readiness

Consulting & Engineering for Infrastructure and Plants

Hydrogen is considered a central pillar of the energy transition and an important driver of defossilisation. The energy carrier, ideally in its green form, has the potential to support the revolution in the energy sector. Hydrogen will take over an important role in the energy mix: by long-term storage and transport over long distances, hydrogen fills the gap between energy production and reliable power supply and, thus facilitating the necessary sector coupling. A successful energy transition with a focus on national and international climate targets requires a combination of security of supply, affordability and environmental compatibility with innovative and sustainable climate protection. To achieve this, new infrastructures and applications must be H_2 ready, i.e. they must be able to operate with 100% hydrogen.

We split H_2 readiness into 3 levels. <u>H_2 ready:</u> Operation with H_2 possible immediately, <u>H_2 ready to adjust:</u> Operation possible after conversion and <u>Unfit for H2:</u> Conversion impossible or not reasonable.

HydroHub offers **consulting** and **engineering services** on multiple aspects of **H_2 readiness.** Experts from various operational units* of TÜV NORD GROUP are available with their comprehensive expertise to support you in the construction of new infrastructures and plants or the retrofitting of your existing ones: **starting with a basic assessment and feasibility study, to subsidy and investment advice to system integration as well as plant construction and EPC/M**. We divide our analysis of the H_2 readiness of your projects for the **use** of hydrogen into three levels: The **technical level** refers to all installations – their individual suitability and interactions. The **regulatory level** ranges from permit management to authority engineering. The third level comprises the **economic considerations,** such as feasibility studies, investments, fundings, operational cost or ROIs.

Technical Considerations

<u>Materials:</u> Hydrogen as an energy carrier entails special challenges on construction materials. For example, hydrogen embrittlement in steel can lead to premature failure of components. This risk can be minimised by selective decision on suitable materials, such as steels, plastics or sealing materials. For existing components, the remaining service life can be estimated by fracture mechanics assessments.

<u>Processing:</u> Selected materials need processing and treatment according to the desired application. For hydrogen systems, for instance, it implies sufficient weld seam classes, heat treatment or non-destructive testing.

<u>Hydrogen purity:</u> Each application has different requirements for its fuel quality. For example, fuel cells are sensitive to impurities and therefore require high-quality hydrogen. Combustion processes, on the other hand, have a higher tolerance. Here, technical requirements must be harmonised with the supply conditions.

<u>Conformity:</u> Hydrogen systems, like other industrial systems, are subject to applicable directives, such as the Machinery Directive or the Pressure Equipment Directive. The highly volatile and explosive hydrogen poses an increased risk potential, which needs to be taken into account when retrofitting existing systems.

<u>Fire and explosion protection:</u> Individual solutions for fire and explosion protection are necessary for each plant. If hydrogen is used, special focus is placed on explosion protection, as H_2 is classified in explosion group IIC. This results in requirements for the components used and the necessary protection zones, which, in turn, impacts the creation and validation of fire and explosion protection concepts as well as hazard assessments.

<u>Fittings:</u> Components such as seals or valves need to be made of suitable materials and equipped with appropriate seals to be resistant to hydrogen-induced damage. Simultaneously, their design needs to be in accordance with explosion group IIC within the protection zones.

<u>Pressure piping and tanks:</u> As shown by the previous components, the materials are essential for their hydrogen compatibility just as the number of permissible pressure load cycles.

<u>Sensors and metrology:</u> Material suitability and explosion protection classes with corresponding functionality also affect installed sensors. For example, the measuring range of sensors may change compared to a natural gas application. Optical flame detectors, for example, must have their sensitivity maximum in the ultraviolet emission spectrum, depending on the hydrogen purity.

* e.g. companies such as DMT GROUP, EE ENERGY ENGINEERS GmbH or ENCOS GmbH

<u>Emissions during combustion:</u> The resulting exhaust gas from combustion processes using hydrogen contains significantly higher levels of NO_x and water compared to natural gas combustion. As a consequence, purification systems e.g. in the form of SCR (selective catalytic reduction) are required. On an industrial scale, it is possible that gas and steam power plants could operate using hydrogen. Additionally, the aforementioned combination of high NO_x and water vapour contents in the exhaust gas caused by combustion can lead to acid formation. The latter might influence the design and choice of materials, especially for gas turbines and waste heat boilers.

The HydroHub experts are pleased to support with the above-mentioned overarching and specific aspects of technical consideration – with specialist expertise in the evaluation and design of suitable components and plant components.

Regulatory Considerations

In many cases, approval procedures are not yet specialised in hydrogen applications. Standardised approval procedures and legal issues are still limited. Therefore, project-specific decisions on an individual basis are often necessary to identify and prepare the required approval procedures. Our experts identify individual decisions in permit management and prepare them accordingly. In addition, we are pleased to provide support in operator obligation management and risk assessments to increase the level of legal certainty.

Economical Considerations

The economic viability of infrastructures and plants is mainly dependent on application-related framework conditions. Possible reasons for deciding in favour of hydrogen-based plants, for instance, are – in addition to securing supply and climate benefits – energy autonomy as well as economical benefits. Furthermore, factors such as the availability of hydrogen and its (projected) price as well as the degree of technological maturity, possible alternative technologies and required investment costs need to be taken into account within the holistic decision making process for the design and construction of H_2-ready infrastructures and plants.

HydroHub combines consulting, engineering and services and is pleased to provide you with its comprehensive expertise. Regardless of whether you have technical, regulatory or economic questions about your H_2 infrastructure and plant. Get in touch with us!

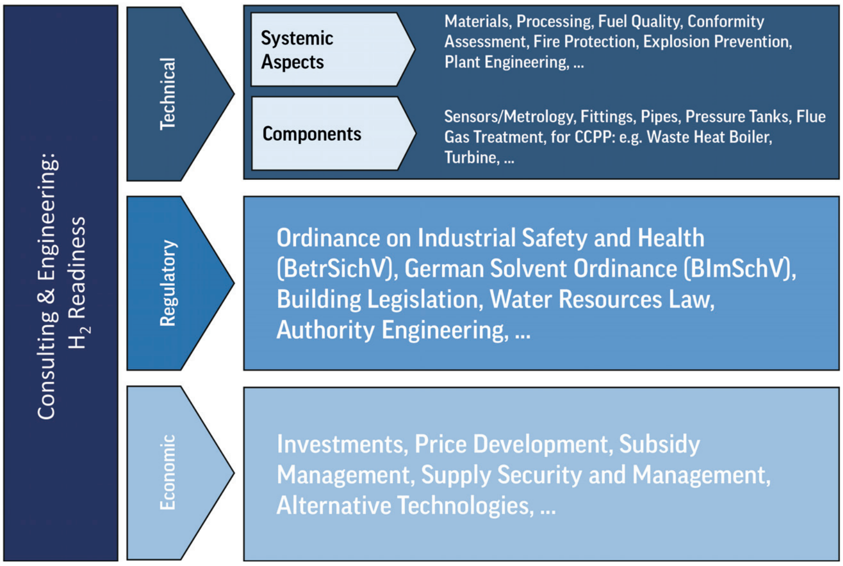

Figure: The **three modular levels of consideration for H_2 readiness consulting and engineering**, comprising technical, regulatory and economic issues.

An initiative of TÜV NORD GROUP companies.

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