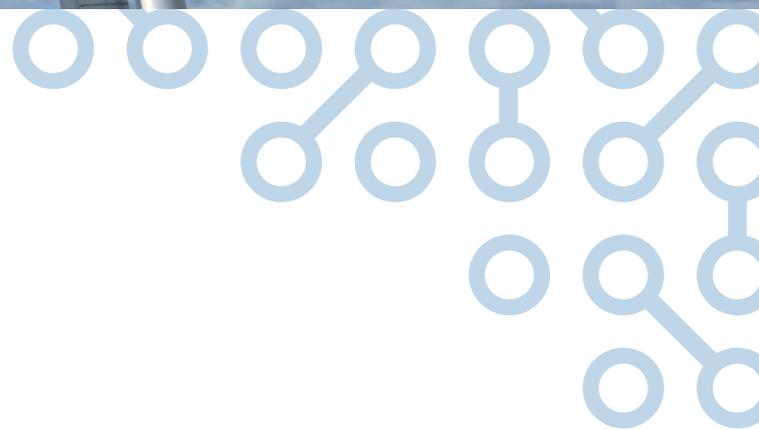




Services along the hydrogen value chain

**Distribution/transport:**  
**Pipelines**



# H<sub>2</sub> competence @ HydroHub

Our services run along the entire value chain in the hydrogen industry - from generation through transport and storage to use in various fields of application.

## Energy generation

Renewables  
(e.g. wind, solar)

Conventional power plants

Geothermal

## H<sub>2</sub> generation

Electrolysis  
Seawater  
desalination plants

Reforming processes

Methane pyrolysis

## Distribution/transport

Electrical grid  
Pipelines  
District heating

Intelligent networks  
Refuelling stations/  
filling systems

Tankers  
(lorry, train, ship)

## Storage

Battery storage  
Gas tanks

Cavern storage  
(H<sub>2</sub> and CO<sub>2</sub>)

Pressure vessels  
H<sub>2</sub> hydride storage

## Consumption/use

Fuel cell system  
Methanol synthesis unit

Carbon capture and utilisation  
Mobility (e.g. e-fuels)  
Reconversion to electricity

Power to gas (gas, heat, liquid)  
Industrial applications  
(e.g. refinery)

# H<sub>2</sub> competence @ HydroHub

We give comprehensive support to hydrogen projects and offer a broad spectrum of services in the concept/planning, production, operation and decommissioning/disposal phases.



## Concept/planning

We support you from the start with research and project planning measures and specific tasks. Already at the conception phase, we are there at your side with feasibility studies, strategic and financial consultation and a broad range of organisational and technical services. Alongside concept creation with consideration for legal, technical and economic conditions, we take on the task of analysing the requirements and support you in the process of determining feasibility through basic and design planning all the way to the approval process.



## Production

For over 150 years, it has been one of our tasks to analyse and manage technical sources of risk. With our wide range of specific services, we are thus able to offer you competent help in the integration of hydrogen technologies into the industrial value chain. Our range of services runs from fact-finding and construction through project management, administering documentation and operator's obligations, basic and detailed process engineering all the way to project support through geological, environmental and engineering services during the production process.



## Operation

We support frictionless operation with our extensive range of services and our primary goal of optimising operational reliability and preventing damage. Our services support you in the implementation of your operating strategies and in the accompanying optimisation, maintenance and upkeep concepts. Our safety-oriented process with operational monitoring and the creation of damage-limitation concepts contributes, in the final account, to establishing hydrogen in the popular conception as a safe and controllable technology.



## Decommissioning/disposal

Just as we are there for you in the first concept phase, we are also at your side at the decommissioning phase, providing all the required services for dismantling and disposal – including project management and comprehensive services to handle your operational obligations. We create concepts to the current legal requirements, standards and regulations and support you in identifying, analysing and avoiding the potential risks of your intervention.

# Natural gas pipelines and their potential for hydrogen

The planned expansion of production capacities for green hydrogen is making solutions for storage and transport urgently necessary. In this regard, Germany's gas infrastructure offers the greatest potential. Alongside setting up a dedicated hydrogen network, the use and conversion of existing gas pipelines is the subject of intensive research, dealing with the suitability of materials and the development of proper standards, safety regulations and national and international directives. We can foresee a phase where the existing gas network makes ever greater contributions to decarbonisation and the successful coupling of the industry, mobility and heating sectors.

We are your experienced partner for the energy transition in the gas network – both in the development of new networks and with a view to the testing and use of existing systems. With the most modern analytical methods, measurement processes and competent specialists, we are at your side to carry out your project safely and successfully, and to help you benefit from subsidies as available. Do get in touch.



# Connecting industrial consumers

Pipelines allow the transportation of large quantities of gaseous hydrogen. For industrial consumers who largely draw their energy from natural gas, such as the steel and chemicals industry, the connection to a hydrogen network offers the possibility of withdrawing from fossil energy media.

In the Ruhr and central Germany's "Chemical Triangle", larger hydrogen networks have existed for decades and are today part of plans to set up model regions for a green hydrogen economy – from production through storage and transport to use by various sectors.

## A powerful transport and storage medium

Alongside functioning as a transport system, gas pipelines offer the advantage of providing flexible storage. Unlike electrical grids, where the quantity of energy fed in and out is always constant, gas networks can buffer large

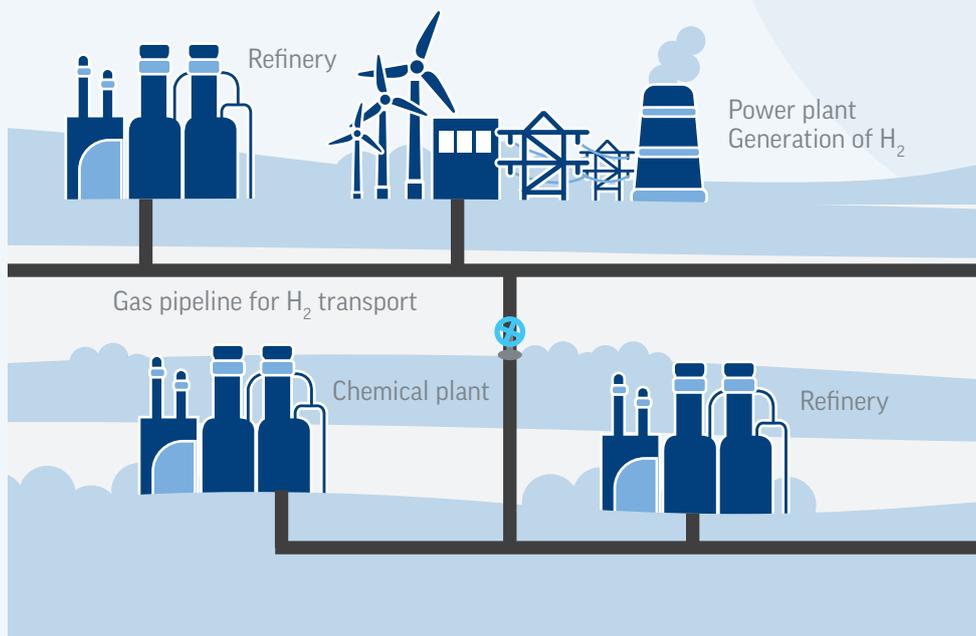
quantities of energy. Thanks to the range of pressures at which pipelines can be operated, overcapacity can be returned to the network and recovered when needed.



# Use of existing gas networks

The development of a dedicated hydrogen network is connected with high investment costs. One option to reduce these is to use or convert existing gas pipelines. The suitability of pipelines, compressors, valve stations etc. for the transportation of gas containing a high proportion of hydrogen is currently the subject of studies regarding, say, hydrogen embrittlement, fracture toughness, corrosion and the alteration of ex-protected zones. The knowledge gained is used to derive maintenance and safety concepts. Together with standards and regulatory frameworks to be newly developed, they will allow the operation of converted gas pipelines.

The idea of developing the future hydrogen network from the existing gas one arose from the conversion from L-gas to H-gas in north-west Germany, to take place by 2030. This makes it possible to modify lines previously used for the transport of L-gas and lay the foundations, with them, for a hydrogen network which allows not only the internal transportation of green hydrogen but also its importation from abroad, say, from the Netherlands. To help drive forward this development of the hydrogen network, the HydroHub is aiding the conversion of a natural gas pipeline located in the Ruhr to operation with hydrogen.



# On the path towards a new gas infrastructure

Already today, Germany's gas networks are carrying biomethane and hydrogen as additives at varying levels by region. Against the backdrop of the goal of achieving greenhouse gas neutrality by 2045, the entire German gas network is involved in a process of transformation, in which fossil natural gas is to be almost completely

replaced and a new gas infrastructure created as part of the National Hydrogen Strategy – for green hydrogen, synthetic methane and biogas.



# Our services

We will support you from the start in considering the underlying legal and technical conditions and will be there for you from designing and executing feasibility studies all the way to managing the project. To this end, we offer you comprehensive services in the fields of consulting, engineering and training - in all phases of the project at hand:

	 Concept/ Planning	 Production	 Operation	 Decommissioning/ Disposal
Creation of concepts to current legal requirements, standards and regulations	●			●
Creating requirements specifications	●			●
Creating technical specifications	●			●
Creating commissioning and periodic inspection concepts	●			
Weak-point analysis, identification and analysis of potential risks	●			●
Creation, consultation on staggered power system protection plans, protection tests	●			●
Conception and consultation (commissioning, periodic inspection) of isolated networks including the incorporation of e.g. decentralised generator units, electrolysers and any necessary storage facilities (on and offshore)	●			
Creation of risk analyses to determine the potential risk of intervention	●			●
Creation of risk analysis and hazard assessments	●			●
Creation of safeguarding concepts	●			●
Consultation on and evaluation of electrical and mechanical safeguarding systems	●			●
Consultation, evaluation on installation and operation of alarm receiving stations	●			●

	 Concept/ Planning	 Production	 Operation	 Decommissioning/ Disposal
Consultation, evaluation on determination of intervention measures by guarding/security company or police	●			●
Consultation, evaluation on determination of administrative security measures	●			●
Technical advisory services	●			
Project management and document administration	●	●	●	●
Feasibility studies: conception and arrangement of the design parameters for the technical process, evaluation of the technical process, simulation of the technical process; determination of capital expenditure (CAPEX), operating expenditure (OPEX), emissions	●			
Civil engineering	●			
Investigation of the plant and process safety: executing HAZOP process analyses, risk assessments (work area/process-related), TRBS inspections by authorised personnel (vapour and pressure), safeguarding reporting, functional safety, SIL (safety integrity level) calculations, fire and explosion protection, safety and failure concepts, smart inspection and monitoring, revision cycle extension, legally compliant documentation	●		●	
Computer verification/structural mechanical simulations in plant construction: static and dynamic verifications to national and international regulations, analytical calculations and finite-element simulations (FEM), static/dynamic load models, mechanical models, calculation of loads (stresses), comparison with material properties for load capacity of the component, evaluation and documentation of the results as a report, damage assessment and analysis	●	●	●	
operator obligation management: conception of operator obligation management system, development of plant registers in the field of pressure vessels incl. determining test deadlines (hazardous materials), energy audits to EDL-G, introduction of energy management systems (EnMS), compliance analyses	●	●	●	●
Fire protection: Creation of fire safety concepts and assessments, specialist construction management for fire protection, fire risk assessments, fire and explosion cause determinations, risk avoidance plans	●	●	●	●

	 Concept/ Planning	 Production	 Operation	 Decommissioning/ Disposal
Explosion protection: determining the safety parameters, explosion and fire protection assessment, explosion and fire protection for machines, for operators, tests on plants requiring monitoring	●	●	●	●
Route engineering: feasibility studies, design, approval and execution planning, planning and calculation of special buildings, valve stations, creation of tendering documents, collaboration on awarding tender, site management, construction monitoring, planning and support for pigging, pipeline accounting	●	●	●	
Acquiring rights: land acquisition, acquisition of private easements, planning permission, access rights, repurposing of pipelines, crossing request management, authority management, construction rights of way, damage compensation on the route	●	●	●	
Geotechnical/foundation engineering subsoil assessments, field and lab tests of soil mechanics, excavation plans, soil science support, compaction tests	●	●	●	
Hydrogeology: water table drawdowns, groundwater usage, hydrogeological investigations, requests for water rights, company officer for the water authorities	●	●	●	
Environmental technology: hazardous material assessments, contaminated site investigation and cleanup planning, renaturation planning, inspections of heaped aggregates, risk assessment under BBodSchV, waste evaluation and declaration, initial condition reports, A+S plans	●	●	●	
Geoinformation: CAD-GIS treatment, 3D modelling, database and app development, data and structural analyses, programming, BIM)	●	●	●	
Engineering surveys: route measurement, construction and inventory surveying, control surveying, 3D laser scanning and tracking, pipe location, 3D ground radar	●	●	●	
Basic engineering for the technical process: Planning process technology, i.e. creating mass flow diagrams, piping and instrumentation diagrams (P&IDs), mechanical drawings of tanks, columns etc., EI&C technology, concrete construction, 3D steel and piping design, HAZOP, fire and explosion protection etc.		●		
Detailed engineering for the technical process: Detailing of the basic engineering		●		

	 Concept/ Planning	 Production	 Operation	 Decommissioning/ Disposal
Plant construction: acquiring equipment and subcontractors, monitoring production and delivery, monitoring assembly (concrete construction, steelwork and piping, containers, EI&C etc.), construction supervision, commissioning, training the operating personnel, performance tests, documentation		●		
Damage assessments and analyses of the causes of damage, creation of avoidance concepts			●	
Analysis and evaluation of damages and measures to prevent comparable faults			●	
Maintenance of breakdown statistics to assess operational reliability in comparable plants/components			●	
Analysis of electrical grids: e.g. short circuit, load flow calculations, efficiency and optimisation assessments			●	
Operational optimisation of a process plan: modelling relevant chemical and physical processes for the design of reactor concepts (kinetics, heat transfer, hydrodynamic system behaviour, dispersion effects). targeted process simulation for an energy-optimised mode of operation (Linnhoff/pinch analysis), design and application of thermal and mechanical separation procedures in the distillation/rectification sectors, gas scrubbing/absorption, stripping/desorption, vacuum drying, separation, classification and sorting processes, consultation, troubleshooting, energy efficiency and optimisation			●	





## HydroHub

An initiative of TÜV NORD GROUP  
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