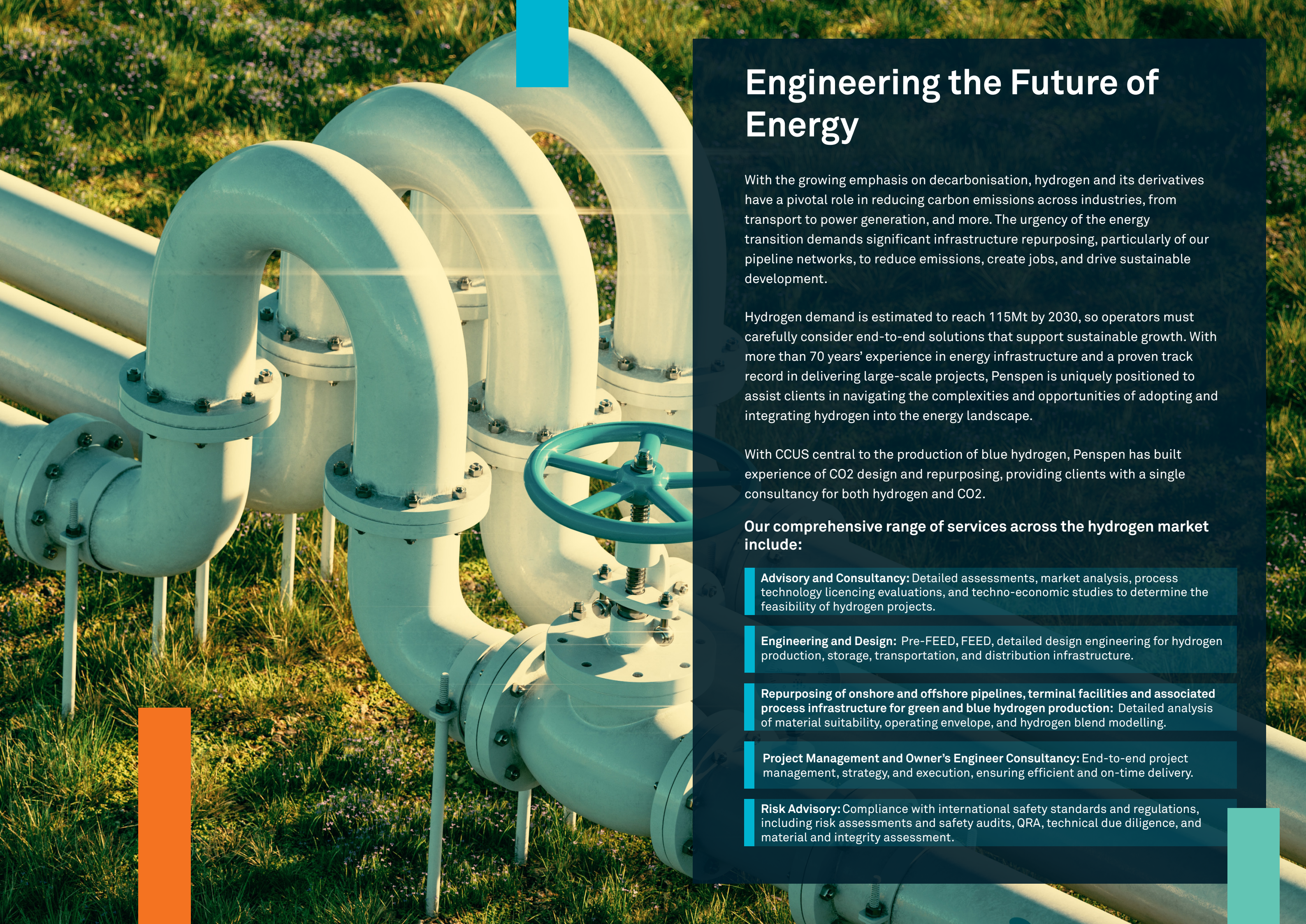




Hydrogen Solutions for a Sustainable Future

SERVICE OVERVIEW





Engineering the Future of Energy

With the growing emphasis on decarbonisation, hydrogen and its derivatives have a pivotal role in reducing carbon emissions across industries, from transport to power generation, and more. The urgency of the energy transition demands significant infrastructure repurposing, particularly of our pipeline networks, to reduce emissions, create jobs, and drive sustainable development.

Hydrogen demand is estimated to reach 115Mt by 2030, so operators must carefully consider end-to-end solutions that support sustainable growth. With more than 70 years' experience in energy infrastructure and a proven track record in delivering large-scale projects, Penspen is uniquely positioned to assist clients in navigating the complexities and opportunities of adopting and integrating hydrogen into the energy landscape.

With CCUS central to the production of blue hydrogen, Penspen has built experience of CO₂ design and repurposing, providing clients with a single consultancy for both hydrogen and CO₂.

Our comprehensive range of services across the hydrogen market include:

Advisory and Consultancy: Detailed assessments, market analysis, process technology licencing evaluations, and techno-economic studies to determine the feasibility of hydrogen projects.

Engineering and Design: Pre-FEED, FEED, detailed design engineering for hydrogen production, storage, transportation, and distribution infrastructure.

Repurposing of onshore and offshore pipelines, terminal facilities and associated process infrastructure for green and blue hydrogen production: Detailed analysis of material suitability, operating envelope, and hydrogen blend modelling.

Project Management and Owner's Engineer Consultancy: End-to-end project management, strategy, and execution, ensuring efficient and on-time delivery.

Risk Advisory: Compliance with international safety standards and regulations, including risk assessments and safety audits, QRA, technical due diligence, and material and integrity assessment.

Unlocking Hydrogen's Potential

No longer a nascent industry, operators and offtakers need a partner with deep engineering expertise and a thorough understanding of delivering hydrogen power at scale. Penspen supports customers with engineering, project management and technical services at all stages of the hydrogen value chain.

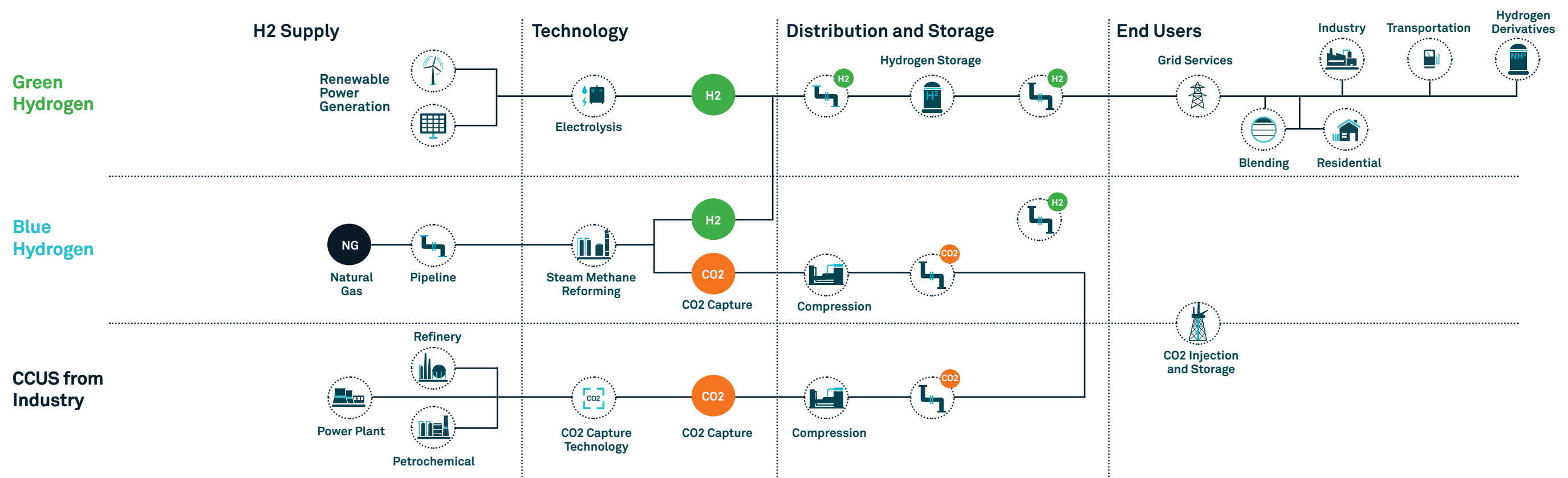
With an international presence and extensive local knowledge, our teams understand regional challenges and regulatory frameworks, enabling Penspen to develop tailored solutions for our customers.

Our reputation is built on deep technical expertise, collaborative industry relationships, and a customer-centric approach. Our global consultancy brings together specialists from across the energy sector, ensuring that every aspect of your hydrogen project – from planning to commissioning – is handled with precision and efficiency.

Penspen is proud to collaborate with leading industry partners to deliver innovative, large-scale hydrogen projects that contribute to a sustainable energy future.



The Hydrogen Economy



HYDROGEN REPURPOSING ASSESSMENT, REN-GASODUTOS

A first of its kind in Europe, this project leads the way for European national transmission companies to develop their own hydrogen blending and decarbonisation projects.

As one of the first countries in the world to set 2050 carbon neutrality goals, Portugal has made impressive progress regarding energy transition. The national gas transmission systems operator, REN, is mandated to incorporate renewable gases, mainly hydrogen, in order to comply with the requirements of the decree-law 62/2020.

REN engaged Penspen as part of a long-term collaborative relationship to provide engineering services for the assessment and gap analysis of the natural gas network to certify the hydrogen readiness of its transmission system.

Our engineers provided assessment studies and gap analysis for the system and related assets for hydrogen blending of up to 10% (first stage) and then 100% (second stage).



- Feasibility Study for H2 and NG mix (10% and 100%)
- Gap Analysis and Validation
- Technical Documentation
- Regulatory Compliance
- Budget and Schedule Valuation
- Concept Review
- Basic Design / FEED
- Investment Support
- Formal Training
- Validation of outputs from EPC contracts

BLENDING FACILITY DESIGN & ASSESSMENT, REN-GASODUTOS

Comprehensive system assessments and design of new H2 blending stations to comply with Portugese regulatory requirements.

In addition to the repurposing assessment, REN engaged Penspen to deliver engineering services to establish the concept and feed of future H2 blending stations used to inject and blend hydrogen into the natural gas systems, assessing how the pipeline and infrastructure responds to hydrogen, with safety in focus.

The resulting case enabled REN to develop the basic engineering for nine different classes of blending station differentiated according to its hydrogen flow capacities.

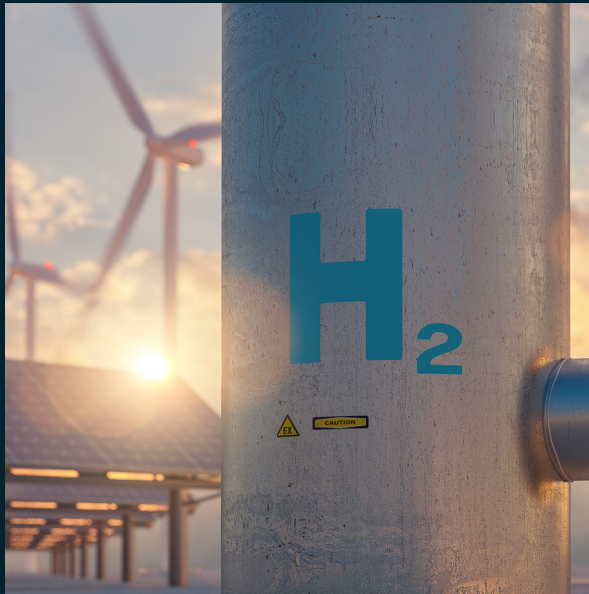
The basic engineering defined the process scheme, its control philosophy, the main equipment, the overall plot plan and the architecture of control and emergency systems, as well as all technical documents required for detailed engineering/EPC.

BLENDING FEASIBILITY, CONEXUS BALTIC GRID

Contributing to Latvia’s decarbonisation strategy by safely optimising existing gas infrastructure.

Conexus Baltic Grid appointed Penspen to complete a comprehensive analysis of its existing gas network for hydrogen introduction. The evaluation included analysis of the potential interactions between hydrogen and existing pipeline defects to identify any integrity threats and assess their impact on structural integrity, as well as recommendations for repair or mitigation measures for any identified defects that may be incompatible with the proposed hydrogen blends.

Penspen also conducted a review of applicable national and international codes and regulations related to hydrogen integration, ensuring all methodologies for defect assessment and integrity management are aligned with industry standards.



- Hydrogen Blending
- Asset Integrity
- Material Testing
- Regulatory Compliance



- Hydrogen Gap Analysis
- Desktop Review of AGIs, BVs & CSs
- Hydrogen Blending
- Asset Integrity
- Regulatory Compliance

Image copyright: Trans Adriatic Pipeline AG

HYDROGEN REPURPOSING ASSESSMENT, TAP AG

Supporting Europe’s energy security and diversifying its energy supply.

Trans Adriatic Pipeline AG (TAP), appointed Penspen to conduct hydrogen gap analysis services in order to evaluate the the readiness of ITS infrastructure to integrate hydrogen. Stretching 877km, TAP is a natural gas pipeline that connects the Trans Anatolian Pipeline (TANAP) at the Greek-Turkish border, crosses Albania and the Adriatic Sea, and links to gas networks in southern Italy.

Penspen performed a comprehensive desktop and field assessment review of TAP’s above ground installations (AGIs), block valves (BVs) and compressor stations (CSs). This evaluation assessed the feasibility of introducing hydrogen blends to the existing gas pipeline, supporting TAP’s strategy of capacity expansion for new volumes of hydrogen and other renewable gases to foster long-term sustainability and decarbonisation in the region.



Energy Transition Courses

Penspen's experts have developed dedicated training courses for those involved in the conception, planning, design, construction, and commissioning of assets used for hydrogen or CO2 capture and transmission. Delivered from our London headquarters, our courses provide practical advice regarding the priorities and resources required for your next project.

Repurposing Pipelines for Hydrogen

- Legislation, codes, standards
- Establishing energy capacity
- Deleterious effects of hydrogen (embrittlement, fatigue)
- Achieving an equivalent maximum allowable operating pressure
- Materials testing
- Assessing hazardous zones and ATEX requirements
- QRA and land use planning
- Protection requirements
- New venting and purging requirements
- Future inspection requirements
- Operator competencies
- First responder training
- Timing and cost expectations

CO2 Capture and Transmission

- CO2 capture technology
- Petrogenic and anthropogenic sources of CO2
- Steady-state and transient conditions
- CO2 phase equilibria and effect of contamination
- Designing CO2 pipelines (fracture management)
- Managing contamination
- Legislation, codes and standards
- Quantitative Risk Assessment (QRA)
- Protection requirements
- Venting and purging requirements
- Seals and connections
- Future inspection requirements
- Operator competencies & first responder training
- Timing and cost expectations

🖱 Book online or get in touch with our dedicated training team for more information on any of our courses: contact@penspen.com

Digital Solutions: Hydrogen Toolkit

THEIA

Penspen's cloud-based digital pipeline integrity management solution, THEIA, features a hydrogen toolkit to provide critical insights into the influence of hydrogen on pipeline systems. THEIA implements multiple modules to empower engineering teams to assess the impact of hydrogen on new or existing infrastructure.

PIPELINE ENERGY CAPACITY

Assess the energy capacity of a pipeline based on new or repurposed infrastructure and the impact of revised operating pressures and velocity restrictions.

MAXIMUM ALLOWABLE OPERATING PRESSURES

Calculate wall thickness or maximum allowable operating pressures based on hydrogen-compatible materials and location class.

RISK ASSESSMENT

Assess the impact on societal and individual risks and compare these with natural gas operations.

TECHNICAL LIBRARY / E-LEARNING

Keep your team up-to-date with the latest hydrogen-related standards and test their knowledge with e-learning materials developed by Penspen's experts.

Why THEIA?

THEIA is a flexible and intuitive platform that enables users to quickly centralise, visualise and analyse their pipeline data. Data agnostic, THEIA provides operators with the critical pipeline integrity insights required to optimise performance of their assets.

- Extract value from historical data and real-time data
- Accelerate the assessment and decision-making process
- Increase value by optimising asset performance
- Build confidence in asset compliance and regulatory requirements
- Enhance integrity engineering and continuous improvement

🖱 Request a demonstration on our website, or e-mail us: contact@penspen.com



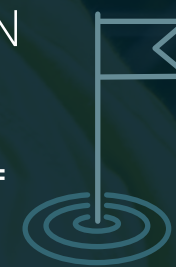
Who We Are

Since our inception over 70 years ago, our vision has remained the same – to improve access to secure and sustainable energy for communities worldwide.

Penspen is a leading international energy consultancy. Our teams design, maintain and optimise energy infrastructure, and we've delivered more than 15,000 projects across over 100 countries.

Part of the Sidara Collaborative, our people bring their specialist knowledge to projects globally, providing a wide range of services including engineering, project management, asset management, asset integrity, digital solutions, and knowledge & training.

FOUNDED IN
1954



12+
GLOBAL
OFFICES



70+ YEARS IN
INDUSTRY

1,100



GLOBAL
EMPLOYEES

COUNTRIES
WORKED IN

100+



GLOBAL
PROJECTS



15,000+



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