

**Expertise and integrated solution support
for your hydrogen blending applications**



h₂

Hydrogen – Natural Gas Blending Solutions

Proven expertise in engineered solutions to help you overcome your toughest challenges with hydrogen for over 60+ years



How do you ensure safe and consistent blending of hydrogen with the natural gas network?

Sustainability and decarbonization have become an integral part of discussions around energy security and securing economic growth. With the aim of net zero emissions by 2050, many countries have introduced legislation with subsidies, along with public and private investment to encourage the use of renewable energy in place of traditional fossil fuels. For natural gas utilities, the blending of hydrogen in the existing distribution network is accelerating the transition to a carbon neutral energy supply.

Pipeline operators and project developers face unique challenges with hydrogen applications. Working within limitations of uncertain blending guidelines, evolving testing standards and product certifications under development, there is a need for well researched and tested solutions. This alleviates concerns related to efficient transport of blended fuels and end user application challenges that use existing infrastructure safely and reliably.

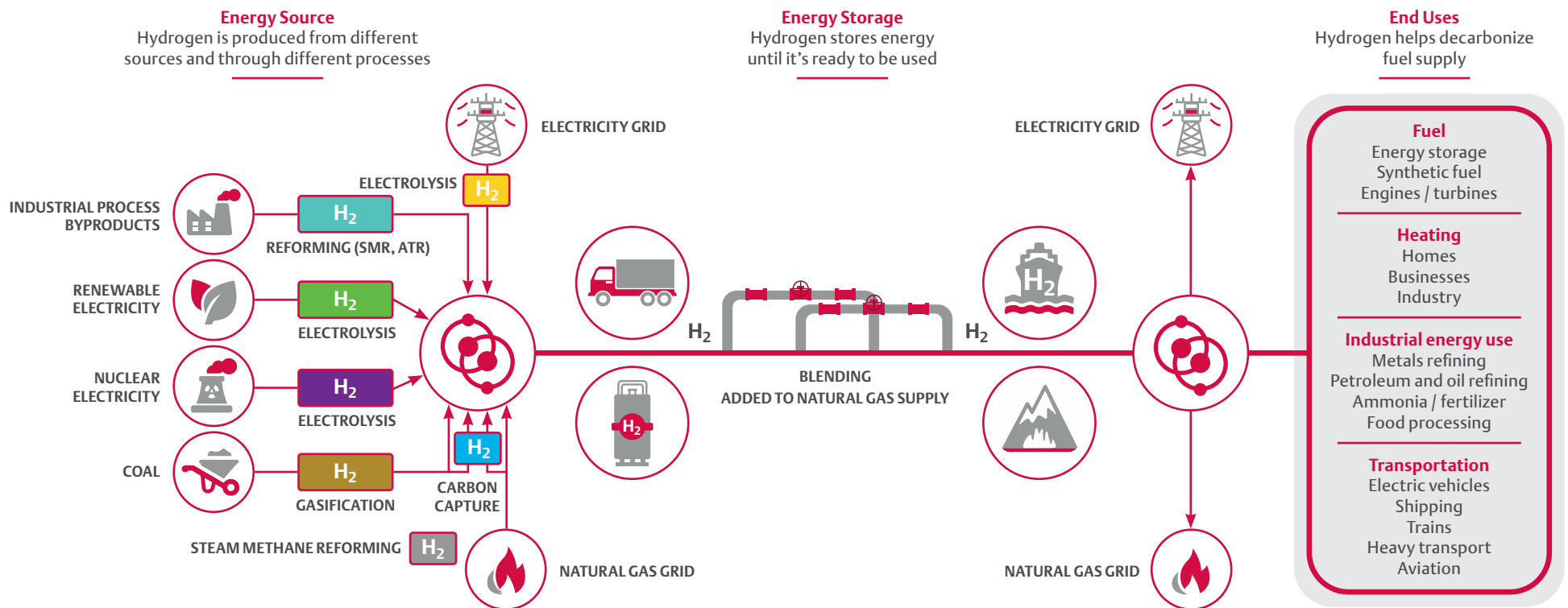
“Global demand for green hydrogen could reach about 530 Mt by 2050, displacing roughly 10.4 billion barrels of oil equivalent (~37% of pre-pandemic global production).”
 – The Dawn of Green Hydrogen, Strategy&, 2020.



“At the beginning of 2021, 30+ countries have released H2 roadmaps, 200 H2 projects have been announced and governments have committed \$70B+ in public funding.”
 – Hydrogen Insights, February 2021.



“In an ambitious scenario, Hydrogen is expected to meet 31% of final natural gas heating demand in the US by 2050.”
 – Road Map to a US Hydrogen Economy, FCHEA, October 2020.



Emerson's expertise in hydrogen solutions and applications

Emerson's extensive portfolio of measurement, gas analysis, pressure regulation and automation systems solutions are designed to address the quality and performance needs required by customers within the growing renewable energies market. With our solutions, you can expect innovative, extensively tested, precise and reliable products designed for the most demanding hydrogen applications.

Across the entire hydrogen fuel value chain, Emerson's global technologies are backed by industry experts who understand customer expectations relating to reliability, safety and cost. Our components are being used in electrolyzers, fueling stations, fuel cells and in industrial applications using hydrogen. In natural gas distribution, our product brands such as ASCO™, Bettis™, Fisher™, Micro Motion™ and Rosemount™ have consistently exceeded industry standards for minimizing risks and providing best-in-class performance.



Leading pressure control, measurement, electrical and automation systems technologies

- Explore the industry's most complete portfolio of high-performing components suited for hydrogen applications
- Partner with Emerson to identify products or integrated solutions to suit specific natural gas / hydrogen blended applications
- Eliminate supplier inefficiencies by partnering with a global leader that provides the complete solution



Application experts around the globe

- Work with experts backed by over 100 years of experience in measurement, pressure control and electrical equipment in hazardous areas
- Consult with engineering technologists, metallurgists and R&D personnel to select the right solution for your application
- Apply innovative technologies that can provide real-time insight, operational certainty and assured safety
- Globally recognized R&D facilities, testing centers and manufacturing facilities that design and deliver exceptional solutions



Engineered solutions and services

- Obtain application consultation to help optimize the performance of the product
- Network of support specialists available for product lifecycle management
- Upskill personnel through tailored training options and lifecycle services

Hydrogen blending with natural gas

Hydrogen vs. natural gas facts

While hydrogen in traditional natural gas applications is becoming more accepted, it is important to recognize the differences in their attributes.

| Attribute | Hydrogen | Natural Gas | Attribute | Hydrogen | Natural Gas |
|--------------------------|-----------------------------|-----------------------------|-----------------------------|---|---|
| Density | 0.0696 sg | 0.60 sg | LEL (Lower Explosion Limit) | 4% with air | 5% with air |
| Gas group classification | B | D | UEL (Upper Explosion Limit) | 75% with air | 15% with air |
| Toxicity | Non-toxic but an asphyxiant | Non-toxic but an asphyxiant | Heating value per scf | 324 BTUs | ≈ 1000 BTUs |
| Molecular weight | 2.02 | 16.04 | Joule Thompson effect | Varies but warms up during pressure drop at room temp | ≈ 7°F cooling per 100 psi drop |
| Wobbe index ratio* | 91.6% | 100% | Odorization | Odorless / colorless. Studies ongoing to study effects of various odorants in hydrogen - natural gas blends | Odorless / colorless odorants are widely used |

*The Wobbe Index (WI) or Wobbe number is an indicator of the interchangeability of fuel gases such as natural gas, Liquefied Petroleum Gas (LPG) and town gas

Challenges of using natural gas products in hydrogen service

Hydrogen Embrittlement

- Exposure to hydrogen gas reduces the strength and ductility of many metallic materials
- The level of embrittlement depends on service conditions like pressure temperature and hydrogen concentration, material properties and stress
- High strength steels and cold worked parts are most susceptible to hydrogen embrittlement, but other materials can also be affected
- Wetted trim materials must be carefully selected to mitigate the risk of embrittlement

Leakage and Permeation

- The small size of hydrogen molecules allows a higher leak rate than other fluids
- It is estimated that the low density of hydrogen allows it to leak 3x more than methane through the same size leak path
- The high mobility of hydrogen in elastomeric materials allows it to permeate faster through o-rings, gaskets and diaphragms than other gases
- Leakage at valve seats, diaphragms and gasketed joints must be evaluated in a state of the art laboratory and tested to industry standards
- Risk management and leak detection systems should be put in place, especially for confined spaces



Emerson's El Campo testing facility

Research and development focus

Material Compatibility

- Assess hydrogen embrittlement risk of standard materials of construction and determine appropriate material substitutions
- In-house metallurgist ensures materials meet customer requirements and Emerson's own guidelines, meeting or exceeding industry standards

Additive Manufacturing

- Produce complex parts from hydrogen compatible materials without tooling
- Partner with customers for custom solutions to their unique applications

Test and evaluation facilities

Hydrogen Laboratory

- Evaluate the sealing performance of valve seats, o-rings, gaskets and diaphragms in hydrogen gas
- Validate the long-term performance of products in hydrogen service
- Ensure product performance, efficiency, environmental compliance, life span and safety

Materials Laboratory

- Study the influence of pressure, hydrogen concentration and material properties on various metallurgies
- Evaluate the compatibility of elastomers in high pressure hydrogen gas
- Analyze permeation to prevent explosive decompression

Hydrogen blending in distribution network – integrated solutions

Emerson offers a **complete portfolio of solutions** that address the challenges of hydrogen service and blending hydrogen in natural gas pipelines.

Through an **extensive sales and support network** and in-house design and fabrication facilities, **we can support** you from the concept design phase through the lifetime of the asset.

- Built with products backed by Emerson’s thorough and well documented testing procedures
- Fully engineered to federal / local codes as a plug and play solution
- PE stamped engineers designing systems to meet ASME, ANSI, CSA, UL and CEN standards
- Complete traceability and documentation package
- Start-up services and long-term support strategy

Odorant Injection

- New technologies ensure ease of use, reduced maintenance and remote access / control
- Higher accuracy, almost infinite turn-down
- Automatic calibration
- Configurable alarms
- Direct or SCADA access



Pressure Regulation

- Portfolio with both “Axial Flow” and “Top Entry” technology
- Whisper Trim™ technology for noise reduction
- Innovative no-bleed technology to eliminate gas emissions
- Overpressure protection methods : Monitors, Relief Valves, Slamshuts



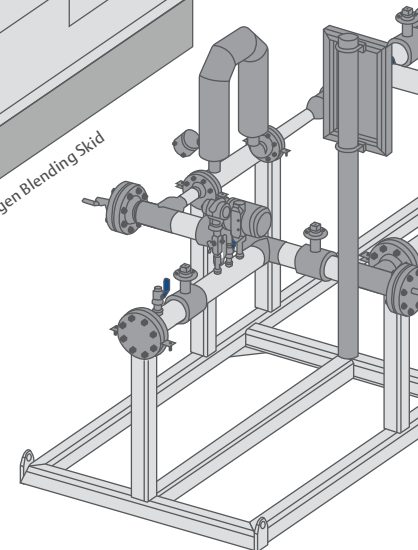
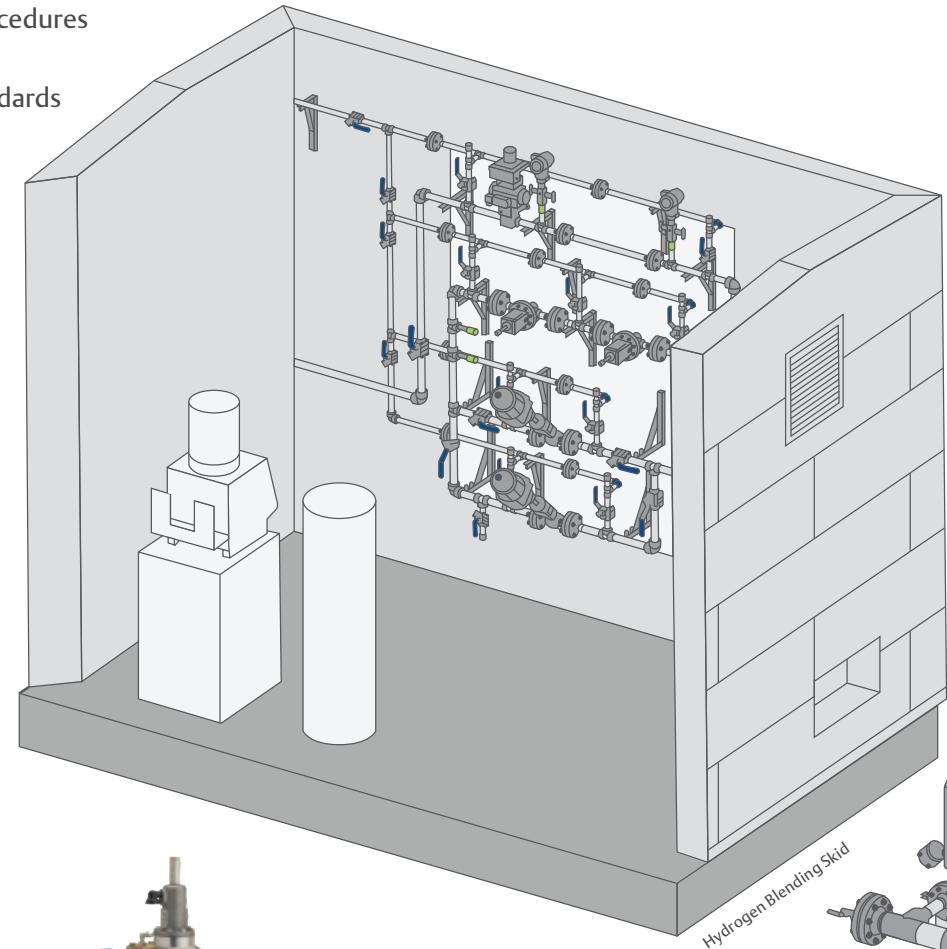
Pressure Relief Valves

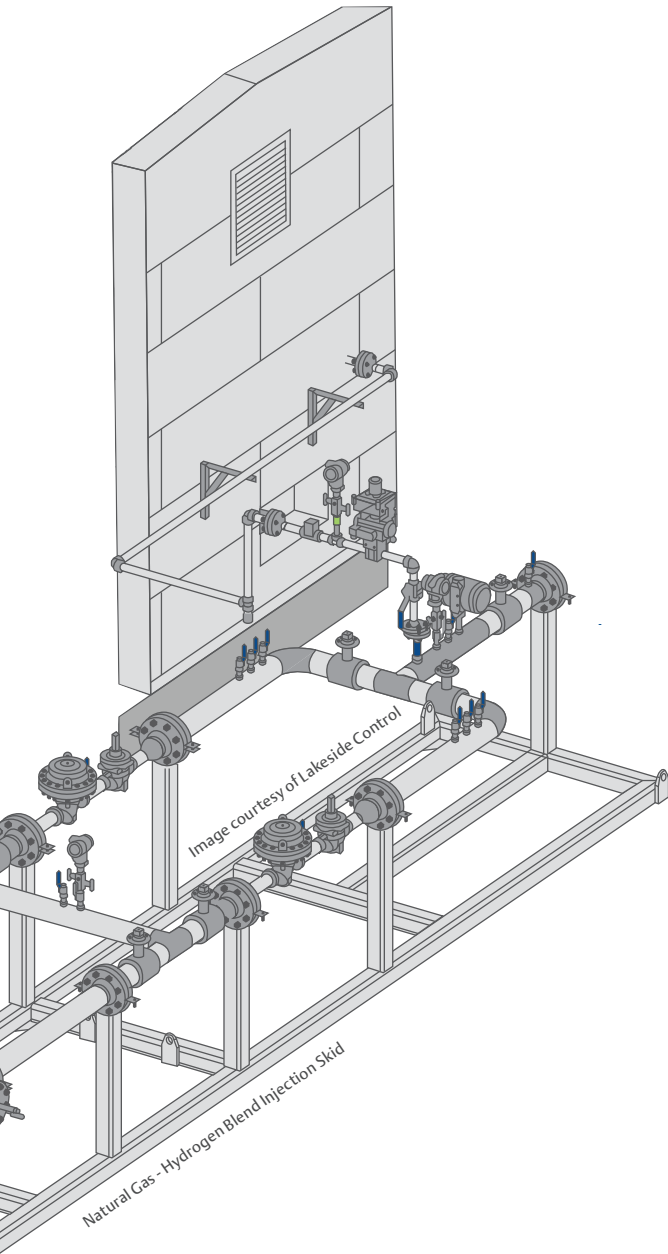
- True modulating pilot-operated safety valve proven on hydrogen services
- Perfectly proportional from zero to full lift to reduce waste and noise
- Soft seats and top entry for ease of maintenance and improved tightness up to 98% of set
- Can be fitted with full remote monitoring (open / close, mass flow)



Flow Control

- Fisher™ easy-e™ and Vee-Ball™ control valves offer a wide variety of flow characteristics and trim materials in easy-to-handle control valve packages
- Fisher FIELDVUE™ DVC6200 provides accurate control and valve diagnostic capabilities
- Minimize fugitive emissions with ENVIRO-SEAL™ live loaded packing





Automation and Custody Transfer System

- Single platform for measurement and control
- Easy-to-use configuration tools
- Fully programmable IEC 61131 suite
- Multiple communication options
- Configurable I/O



Gas Chromatographs

700XA Gas Chromatograph

- Unique capability of measuring both BTU and sulfur content in one single analyzer
- Ideal for trace contaminant monitoring



370XA Gas Chromatograph

- Economical, compact, easy to use
- Can be paired with a H²S analyzer
- Field mountable and offers low installation and operational costs



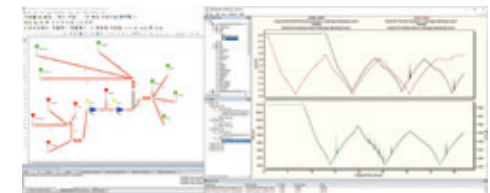
Flow Meters

- No flow conditioning or piping requirements
 - Eliminate errors due to flow profile disturbances and cost of monitoring for them
- No errors caused by pulsations and noise from flow regulation
- No over-registration or damage due to flow surges
- Water calibration transfers to gas
 - Reduced meter flow calibration and verification costs
 - +/- 0.10% accuracy with optional gas calibration and PWL



Energy Solutions

- PipelineStudio® and PipelineManager® accurately model the hydraulics of new blended gas qualities
- Industry standard equations of state are employed to determine fluid properties, either in offline analysis or real-time operational management
- Using PipelineTransporter®, the delivered quality of injected gas blends can be recognized for customer billing



Solving the hydrogen industry's challenges with consistent results and differentiated solutions



Emerson delivers time-tested and innovative overpressure protection solutions for your natural gas distribution systems. Contact us now for world-class technologies and services that can help you protect your customers and assets and gain oversight of your distribution systems.

Visit [Emerson.com](https://www.emerson.com)

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