

LEADING THE ENERGY TRANSITION WITH HYDROGEN

Solution from Honeywell to
support the energy revolution



Honeywell

HYDROGEN IS THE FUEL OF THE FUTURE

Hydrogen is the fuel of the future. As a carrier of clean renewable energy, it will be essential to meeting global goals to decarbonize the economy. Governments in more than a dozen countries worldwide have already adopted formal hydrogen strategies. Dozens more are preparing theirs or in policy discussions.

For powering heavy transport, as a feedstock for industrial processes, and, in the future, heating homes and buildings, hydrogen is versatile and could be plentiful. It can power combustion processes, provide energy via fuel cells, or be blended into natural gas. Hydrogen offers the potential to transform the energy value chain in both industrial and residential uses and will rapidly accelerate the move to low carbon economies.

Hydrogen can further be transformed into Ammonia or Methanol, both as proxies for Green Hydrogen, for practical and logistical reasons. It also presents significant challenges for safety, measurement and storage, requiring new processes, technologies, materials and expertise to facilitate massive and rapid change across a complex value chain:

- From renewable sources such as wind, solar, hydroelectric and tidal energy with intermittent and fluctuating energy production
- To electrolyzers and ancillary processing with requirements to quickly scale hydrogen production as demand increases
- To high pressure storage, cryogenic liquid product movements and grid injection and blending
- To end users, ensuring safe storage, fueling, and utilization
- To ensure safe operations with gas detection solutions

Across both the new and traditional energy infrastructure, industries and transport, operators require hydrogen-ready solutions and partners to operate safely, scale effectively and operate efficiently.

HYDROGEN CHALLENGES

Physical properties:

- Colorless, odorless and tasteless, hydrogen is undetectable to human senses and burns with a pale blue flame that is difficult to detect
- With a low density, it diffuses quickly through porous materials and has a higher risk of leaking
- In certain high-pressure conditions, it can cause carbon steel embrittlement to threaten the integrity of the pipeline and other wetted parts and assets
- Mixed with air or pure oxygen, it is highly explosive
- Lower densities and higher sound velocities can impair accuracy in some meter technologies.

WE'RE READY. ARE YOU?

Honeywell's solutions and expertise cover the entire hydrogen value chain. Across production and conversion, transmission and storage, and distribution and use, our solutions can help operators and OEMs operate more safely and profitably.



PRODUCTION AND CONVERSION

Honeywell technology is field-proven in solar, wind and hydroelectric power; in industrial processes; and for electrolysis. Our automation and control systems, security and safety solutions, and flow and quality metering solutions optimize processes and support safe, reliable and profitable production. Honeywell's simulation and digitization solutions are widely in hydrogen, ammonia and methanol production. Honeywell provides processes, technology and units for the production and purification of Hydrogen including technology for electrolysis.



TRANSMISSION, STORAGE AND DISTRIBUTION

Honeywell brings its decades of experience with natural gas to help with hydrogen solutions across processing and purification, grid injection and blending, controls and instrumentation, compression and pressure control, and flow and quality metering. Honeywell units can also deblend or purify Hydrogen that is mixed in Natural Gas or Town Gas pipelines. Honeywell is also an expert in ammonia, a useful proxy for hydrogen. Our expertise includes controls for ammonia plants as well as terminal gauges and solutions.



DOMESTIC AND INDUSTRIAL END USE AND BURNERS

Honeywell is a leader in industrial and domestic flow metering and residential and commercial gas metering, as well as burner controls. In the home, offices and industry, Honeywell's solutions support accurate measurement of flows for custody transfer, optimized control of processes and safe operations in domestic and hazardous industrial environments.



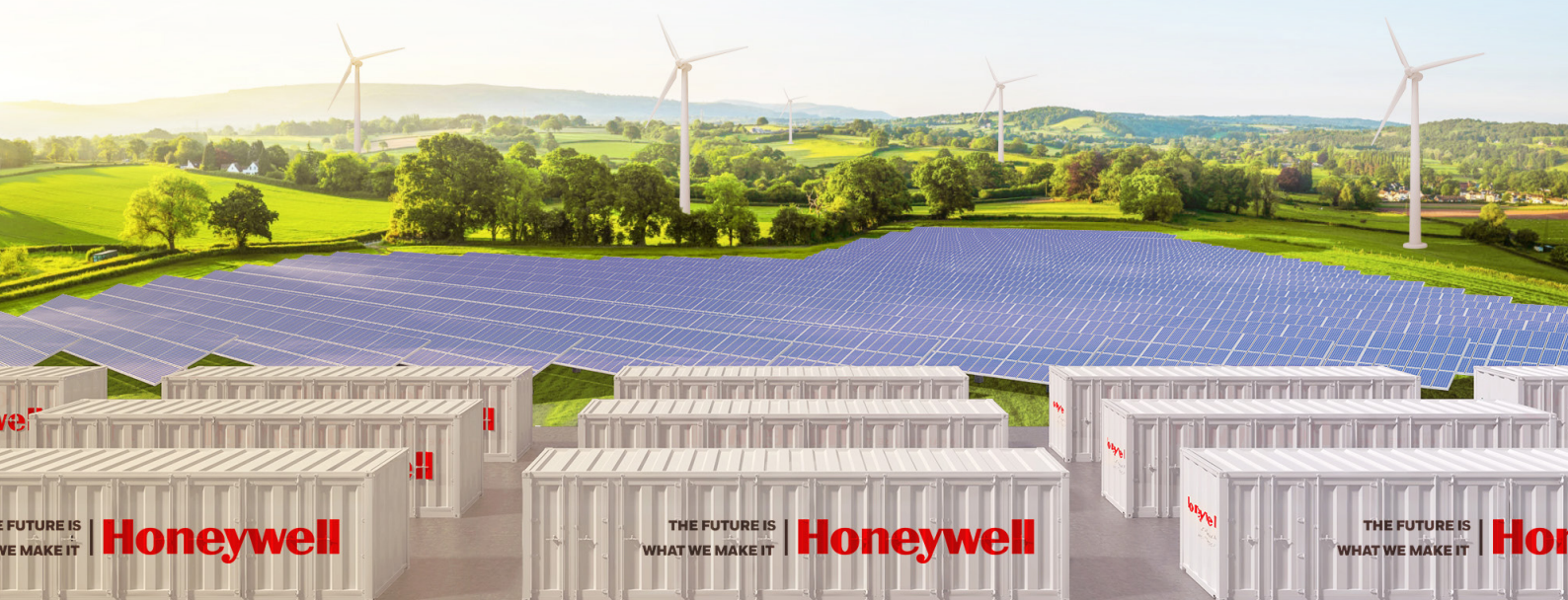
THE BROADEST PORTFOLIO

Honeywell's hydrogen-ready systems, instruments and software support a wide range of applications. From modular systems for local production to industrial control solutions for large plants, as well as extensive portfolio for hydrogen combustion, we have a hydrogen solution to help.

SOLUTION HIGHLIGHTS

PLANT AUTOMATION AND CONTROL

- **Experion®** process automation and controls provides a complete platform for hydrogen automation and management. It offers innovative software that manage, monitor and control operations, second by second. Experion also brings the scalability and modularity for rapid, seamless grow with increasing plant capacity, allowing simple duplication of control elements across multiple units such as electrolyzers and rectifiers. Safety Manager SC meanwhile delivers all the functionality and SIL3 protection needed to aid safe operations, from responses to detected hydrogen gas, to emergency shutdown sequences and interlocks.
- Our **ControlEdge™ PLC**, dramatically reduces configuration, integration, and support costs while decreasing risk with embedded cybersecurity. Combined with Experion® PKS, it minimizes downtime through unified support and lowers the total cost of ownership through the extended system lifecycle.



SCALABLE CONTROL SOLUTIONS

Honeywell's scalable control systems provide an excellent modular, flexible solutions for small and medium-scale hydrogen production, distribution and use. Whether for water treatment, electrolyzers, compressors, fueling stations or hydrogen turbines, we help lower costs and improve control. Our range of flexible solutions to meet the need of many operations include:

- Experion® HS, a powerful software platform incorporating innovative applications for HMI and SCADA.
- ControlEdge™ PLC, providing secure connectivity and tight integration to devices from multiple vendors.
- MasterLogic PLC, a compact and versatile PLC solution optimized for high-speed logic applications.
- ControlEdge™ HC900 SIL2, ideal for unit process applications that require a combination of analog process control functions and safety critical control actions.
- Experion® Panel PC, industrial grade touch panel PC that extends the proven Experion user experience to local field operations.
- Honeywell Low voltage variable frequency drives with advanced control capabilities for improved asset performance and energy savings.

CONNECTED OEM

- Connected OEM combines Honeywell's industrial Internet platform, cloud historian and visualizations and analytics in one simple, subscription-based service. It gives original equipment manufacturers everything needed to remotely monitor and support their assets installed across end customers and dispersed sites.
- With Connected OEM, manufacturers have the visibility required to support customers better, resolve problems faster, and eliminate site visits. It gives users access to the data they need to maintain performance, cut maintenance and service costs and extend equipment life, as well as driving up overall equipment effectiveness.

MEASUREMENT AND INSTRUMENTATION

Honeywell is making sure its customers and partners are hydrogen ready. Our gas metering portfolio, including the Q.Sonic ultrasonic meters that provides accurate readings or more, and we're committed to this standard for the whole portfolio by the end of 2021. We're also a leader in gas quality measurement. Honeywell's EnCal 3000 state-of-the-art gas chromatograph provides accurate energy content for streams.

Finally, SmartLine® transmitters are used worldwide for highly accurate pressure and temperature measurement, including in high-end custody transfer applications. With MID approvals, they deliver fast response time, predictable linear stability and features such as advanced diagnostics and tamper alerts.

INJECTION, BLENDING, DEBLENDING AND GAS TRAINS

Honeywell's Gas Valve Units (GVUs) provide users with gas regulating units to supply fuel to gas engines. GVUs include accessories for filtration, safety, automatic shut-off, pressure control and gas volume metering in a single, compact, cost-effective package. Drawing on our expertise in biomethane grid injection, Honeywell also offers complete, standardized Hydrogen Grid Injection and Blending Units. Pre-built solutions using hydrogen-appropriate materials include:

- Flow metering
- Pressure control
- Blending control
- Gas quality control
- RTU and control systems
- Compliance with all relevant national and international regulations

Through Honeywell UOP PSA and membrane technology, we also provide efficient and proven solutions for deblending to re-extract hydrogen out of a combined flow with natural gas. We help provide safe, reliable continuous supplies for customers unable to accept hydrogen blends.



SOLUTIONS FOR HYDROGEN COMBUSTION

Honeywell Thermal Solutions is ready to meet hydrogen-related combustion needs today and into the future. We provide hydrogen-ready and hydrogen-capable burner and supporting components needed for a complete hydrogen combustion system, including fuel trains, controls and burner management systems.

For your software needs, meanwhile, Honeywell's Thermal IQ™ turns thermal process data into actionable information to help users optimize their thermal process systems. Honeywell is also a leading supplier of services for combustion systems, ranging from commissioning to application testing. From individual components to turn-key fully engineered systems, no other supplier can match the breadth and depth of Honeywell's portfolio for hydrogen combustion.

SOLUTIONS FOR TRANSFORMING HYDROGEN

The hydrogen value chain includes transformation to ammonia or methanol, as potential marine fuel, or even liquefaction for long distance transport. Honeywell has extensive global experience in ammonia, methanol production and terminals.

Much of existing ammonia and methanol production already uses Honeywell controls and technology. For projects looking to liquefy hydrogen, Honeywell brings broad experience in similar cryogenic operations in many LNG liquefaction plants and terminals. Honeywell Terminal Manager software integrates with the Experion® platform to provide a complete terminal automation solution. Increasing efficiency, productivity and safety through greater automation, it offers users the flexibility to scale as required. ENRAF Servo technology tank gauges provide accurate and stable gauging for custody transfer and inventory

control, including for demanding chemical applications like ammonia and methanol., provide accurate, reliable and stable gauging for custody transfer and inventory control. Servo technology is particularly important for ammonia levels since they cannot be measured with high level accuracy using radar gauges. Whether loading hydrogen into horizontal cylinders for trucks or whole tube-skids, Terminal Manager captures the load transaction and handles all terminal interactions with drivers.

SAFETY EQUIPMENT – GAS DETECTION

Honeywell offers a wide range of personal monitors, sensors, leakage and gas detection for across hydrogen applications. From production, through distribution and use, these solutions provide accurate, robust and reliable protection against risks from hydrogen, ammonia, natural gas and other potentially hazardous materials. We offer a wide range of both mobile and fixed gas detection solutions:

- Honeywell BW™ portable solutions for single and multiple gas detection, featuring advanced sensor technology, long battery lives and remote connectivity for real-time reading and gas analysis
- Sensepoint fixed detectors and explosion-proof transmitters for monitoring flammable and toxic gases; easy to install, simple to use and intrinsically safe
- Searchzone Sonik™ fast, reliable ultrasonic gas leak detector, suitable for even noisy and harsh environments
- FSX Plus™ flame detector for rapid detection of hydrocarbon and non-hydrocarbon fuel fires, combining H2 and HC (liquid and gas) detection in a single device

SOFTWARE AND DATA ANALYTICS

Honeywell Forge™ Enterprise Performance Management software encompasses decades' expertise in asset and process control technology. System and hardware independent, it transforms data from equipment, processes and people into intuitive, actionable insights. Honeywell Forge's predictive analytics help identify maintenance issues before they happen. It enables workers to be more productive, proficient and safe, reduces costs and increases productivity.

Our capability with UNISIM® design helps to analyze the data and predicts what needs to be done in the process with remote operations capability. Honeywell analytics brings users value across the hydrogen value by:

- Enhancing monitoring and optimizing processes to maximize membrane life in electrolyzer applications using our market leading Forge APM for Asset Performance Management, real time diagnostics
- Simulating the process and performance of Electrolyzers in UniSim
- Improving control, monitoring and maintenance of compressors
- Optimizing grid balancing for renewable electricity, helping support more profitable operations by determining when to sell electricity and when to power electrolysis to create hydrogen



H₂



WHY HONEYWELL?

At Honeywell, we combine leading technology with global expertise and relevant experience to provide the support operators and OEMs need in a fast-changing marketplace. We don't just offer a broad and growing portfolio of hydrogen-ready solutions, we draw on real experience and from our wider group to provide confident answers to your challenges over entire lifetime.

- Honeywell is a leader in hydrogen process technology, with over 1,000 hydrogen successful purification projects completed worldwide. We're an expert in Blue hydrogen production by reforming (SMR and ATR), by partial oxidation (POX), or by gasification with CO₂ capture. We provide H₂ purification for hydrogen production and for debinding from blends such as Town Gas, Syngas and Natural Gas networks. We have technology used in hydrogen electrolysis. Our Callidus burners are Hydrogen ready. We also have a full portfolio of solvent, membrane, adsorbent, and cryogenic process technologies for CO₂ capture
- We're in biomethane injection market with more than 200 Honeywell renewable injection systems operating across Europe. That includes more than 100 of our compact biomethane injection systems for GRDF, the leading distributor of natural gas in France and the EU.
- Honeywell solutions have cybersecurity as standard. Honeywell Experion DCS, Safety Manager and ControlEdge PLC have embedded cybersecurity capabilities that are ISASecure certified. We enable users to enjoy the benefits of remote connectivity, the industrial internet platform and the cloud while retaining the security they need when dealing with sensitive data, hazardous process and connections to critical infrastructure.
- Honeywell has extensive experience in large-scale and multi-phase projects as a main automation contractor. Our remote solutions capability means projects are engineered in the cloud, implemented with an onsite presence, and supported in real time in operation from remote control centres or remote engineering excellence centres. Our leading virtualization capability, universal IO and marshalling and Experion HIVE technology accelerate engineering and make it easy to adapt to changes.
- Honeywell's 50 years expertise in Chlor-Alkali automation and LNG shipping help our customers to build their end-to-end solutions.
- Honeywell's digitization platform Honeywell Forge provides broad capabilities to track performance of Process, packaged unit operations, Assets and People.

When looking to your hydrogen future, consider our past. Honeywell brings decades of experience in gas and liquid automation, control and metering, and proven solutions that are relied on for critical and complex applications worldwide. We offer global scale and a network of local support to combine innovative technology with strong execution capabilities and unrivaled service.

To discuss your needs, contact us today.

For More Information

To learn more about how Honeywell can optimize your energy operations, visit www.hwl.co/RenewableEnergy or contact your Honeywell Account Manager.

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**THE
FUTURE
IS
WHAT
WE
MAKE IT**

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