ABU DHABI SUSTAINABILITY WEEK

WORLD FUTURE ENERGY SUMMIT

ADSW ADVISORY COMMITTEE INSIGHTS REPORT

GREEN HYDROGEN AND FUTURE FUELS

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Contents

Foreword

The push for hydrogen and clean fuels has moved from concept to concrete action, with dozens of countries adopting a national hydrogen strategy and more looking to announce theirs imminently. Speed is of the essence – green hydrogen has the potential to deliver rapid progress on net-zero targets. Nations that develop their ability to produce, store, transport and trade green hydrogen will deliver not just environmental benefits, but economic ones in the form of a highly valuable energy commodity, skilled jobs, advanced infrastructure, and greater energy security.

Current demand for hydrogen is overwhelmingly in the form of "grey" hydrogen (developed from fossil fuels) with "green" representing less than 1% of global supply.[1] Difficulties in bringing more green hydrogen to market include high production prices, a lack of offtakers, uncertain regulatory requirements, and cautious investors who are mostly waiting for more stability and clarity to emerge. As the industry stands at a crossroads, how are its varying groups of stakeholders reacting to the rapid changes in the road ahead? What are their priorities and objectives? Most importantly, what do they believe needs to happen next to drive the development of green hydrogen and future fuels forward?

Abu Dhabi Sustainability Week (ADSW) – hosted by Masdar – recognizes that making hydrogen a meaningful part of the energy systems transformation will require unprecedented collaboration. Every stakeholder, from government ministries and energy giants to startup innovators and investors, has a role to play and a unique perspective to contribute.

Each year, Masdar convenes a series of ADSW Advisory Committees on key sustainability topics. In 2025, the ADSW Advisory Committee on Green Hydrogen & Future Fuels brought together experts from around the world for an open, candid dialogue on these questions. Under the Chatham House Rule, leaders from business, government, and academia shared their on-the-ground experiences – what is happening in the hydrogen space today, what obstacles they face, and what breakthroughs they believe are needed next.

This Insights Report summarizes their discussion, grouping them into thematic sections spanning global hydrogen trade, technology and supply chains, demand creation, investment and finance, infrastructure, and the importance of sound regulatory support. This provides a snapshot of where we stand in 2025 on the road to a hydrogen-powered future and a roadmap to accelerate progress.

Global Green Hydrogen Trade

Green hydrogen is in an early stage of its development journey, with all the characteristics of any industry that has vast potential but plenty of complex challenges to overcome. Inconsistent regulatory standards and high technological barriers are key factors that currently keep its production and trade volumes low.

According to the Advisory Committee members changing the green hydrogen landscape will take innovation and cooperation. While technological barriers can be overcome, the diplomatic barriers can be even more time-consuming to solve. As its very first consideration, the committee discussed the prospect of free trade agreements as an enabler of green hydrogen trade, and the prospect of bigger, more integrated markets pushing producers to move faster on scaling up their solutions.

"Free trade agreements could be a key enabler," one expert on the committee observed. "A deal between the UAE and the EU with hydrogen on the agenda seems a logical place to start. The Middle East is best placed to use its renewable energy to create green hydrogen at scale, and Europe is always looking to secure new sources of reliable clean energy."

However, there are diplomatic difficulties involved in such an agreement, stemming from stark differences in reporting standards, specifically on indirect CO_2 emissions. A simple, clear-cut trade deal on hydrogen is unlikely to materialize any time soon.

The UAE and the rest of the region are looking east as well as west. India and China hold ambitions to quickly ramp up their ability to produce and export green hydrogen. India aims to produce 5 million metric tonnes annually by 2030, supported by a 125 GW renewable energy capacity.[3] China is set to move even faster, setting targets to produce 100,000 to 200,000 tonnes annually by the end of 2025. Recent analysis suggests that it is already on track to greatly exceed this capacity target.[4]

> **China is moving with tremendous speed – they already have about 120 companies all racing to the bottom on unit price, which is driving technological experimentation and capacity expansion. In a couple of years, they will be able to offer export deals at scale. Europe and other economies have to ask themselves where their focus lies; do they want to build production facilities at home, or do they just want green hydrogen as cheaply as possible? If it's the latter, then that puts China and maybe India in a very strong position.**

While some of the key players in green hydrogen production are starting to emerge, it remains to be seen who can mobilize the political capital and logistical muscle needed to secure their place as the world's premier hub for its trade and shipping. Current political tensions make cooperation on emerging commodities like green hydrogen difficult, but not impossible. The benefit of standardizing regulations and opening up avenues for collaboration on hydrogen technology deployment is that if countries enter into multilateral agreements to share hydrogen technologies and build centers of excellence together, it could alleviate fears of any one power dominating the market, internationalizing the hydrogen value chain without immediately invoking trade disputes.

Regardless of who the early movers and main market leaders turn out to be, every leading economy must consider the crucial trade-off: is it better to focus on securing cheaper hydrogen via imports, or to build domestic hydrogen industries even if costs are higher? While there is no one-size-fits-all answer, a fair and level playing field in the green hydrogen trade is essential for global stability as well as climate action. International bodies like IRENA, the Hydrogen Council, and the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) are platforms that can advance standardization and share best practices to facilitate global hydrogen commerce in an equitable manner.

More broadly, harmonizing standards has become a critical piece of the puzzle. Without alignment on what qualifies as "green" or "low-carbon" hydrogen, international trade will be hampered by uncertainty. Trade negotiations and forums like the G7/G20 and Clean Energy Ministerial can be used to push for mutual recognition of certification schemes and more flexible approaches that still ensure climate integrity. In the meantime, national and regional certification schemes are increasing in number, underscoring the need for a common language of hydrogen standards.

Unlocking the global hydrogen trade is challenging but necessary. Common standards, certification interoperability, and supportive trade policies will be the linchpins. Early bilateral deals (such as the EU's hydrogen import partnerships or Japan's hydrogen supply agreements with Australia and the UAE) have already provided useful precedents for others to follow.[2] The next phase of the market's development will depend on where the main production hubs emerge, and who can best navigate the diplomatic subtleties to secure optimal trade conditions.

The Supply Side – Technology Development and Supply Chain Resilience

While supportive policies and cooperative trade deals are vital for letting green hydrogen flow across the world, there are still immense technological and industrial challenges to overcome. Accelerating innovation and ensuring resilient supply chains go hand in hand. Overreliance on a single producer of green hydrogen, or the key technologies it requires, invites vulnerabilities similar to Europe's dependence on cheap natural gas piped from Russia prior to the Ukrainian conflict. Moreover, any trade disruption could derail projects worldwide, making supply chain resilience a priority.

Regional partnerships are a viable path towards strong, resilient green hydrogen hubs; for instance, Middle Eastern firms partnering with European or Asian technology providers to establish local factories. Policymakers can also incentivize diversification, for example by including requirements in hydrogen project tenders for local capacity building or knowledge transfer, spreading the technical and physical resources and ensuring that no single nation establishes an unassailable lead.

On the technology innovation front, many hydrogen solutions are still evolving. Continued R&D is needed to improve efficiency and reduce costs, from electrolyzers (e.g. scaling up solid-oxide or Anion Exchange Membrane (AEM) electrolyzer designs) to fuel carriers (like novel liquid organic hydrogen carriers) and end-use applications (e.g., hydrogen turbines, high-temperature fuel cells for industry). Shared learning and demonstration are an important part of this. "Forums like ADSW can act as conveners of consortia to pilot new technologies," one committee member noted, "creating a "center of excellence" for hydrogen that brings together innovators could accelerate progress."

There is also a need for clear performance guarantees and standards for hydrogen equipment. Early project developers face uncertainty: "If you build a first-of-a-kind hydrogen plant combining new electrolyzers, new compression and pipeline tech, and new fuel cells, who guarantees the system will perform?" asked one committee member. Traditional project contracts often rely on big engineering, procurement, and construction (EPC) firms to wrap project performance guarantees. But with hydrogen, multiple novel components may each come with their own warranties.

No entity yet provides an end-to-end performance guarantee for an entire hydrogen system – a gap that can make financiers nervous. Tackling this issue may require collaboration between OEMs (original equipment manufacturers), insurers, and perhaps public entities to share risk for the first wave of projects. Developing standards for equipment interoperability and safety is another enabler. Work is underway in organizations like the International Organization for Standardization (ISO) and national standards bodies, but this needs to keep pace with deployment.

> **"Around 60% of the value of green hydrogen comes from the end use technologies, 25% from production and about 15% in the middle. There's a big opportunity for local value creation, using those end use technologies to create domestic demand. Racing for 10GW facilities is not viable for everyone; you have to start with 10MW, prove the business model, build the supply chain, and scale up from there. That's why the technology and expertise element is so important."**

Critical green hydrogen technologies are progressing at pace, but severe bottlenecks could emerge if the local manufacturing capacities and supply chain elements are lacking. By broadening participation in the hydrogen industry and planning for resilience, the risk of delays due to trade friction or monopolies can be minimized. With the right strategies and a healthy amount of international cooperation, the coming years could see the green hydrogen market rapidly mature into full commercial readiness, following a similar development path to wind and solar.

The Demand Side – Mandates and Consumer Innovation

"One cannot grow the supply without the demand" – observed a member of the committee, citing an adage that applies to green hydrogen as much as any other industry. More specifically, the lack of bankable offtake agreements is killing many viable hydrogen projects before they can achieve full financing backing and begin construction. Working with different industries to secure reliable demand is essential for giving investors the confidence to back production projects and upscale green hydrogen supply flows overall.

Policy mandates and quotas can be used to stimulate initial demand. Governments can play a pivotal role by requiring the use of green hydrogen or its derivatives in certain applications. For instance, India has mandated that fertilizer plants must ensure that 5% of its hydrogen demand is green hydrogen, rising to 20% within five years' time. Similarly, Indian oil refineries need 10% green hydrogen in their hydrogen mix from 2024, increasing to 25% by 2028.5 This has created a guaranteed market for green hydrogen producers, allowing projects to launch knowing there is a buyer waiting to offtake. These "green hydrogen consumption obligations" can be combined with incentives such as tax credits to give industry players both "push and pull" factors to lead them towards greater consumption of green hydrogen.

Beyond mandates, aggregating demand through clustering and hubs was discussed. One idea is the development of "hydrogen valleys" or industrial clusters where multiple hydrogen off-takers are co-located near production. Ammonia fertilizer plants, oil refineries, and steel mills can be located in the same industrial zone as a large electrolyzer installation, possibly adjacent to a renewable energy park. By bundling demand together in a logistically sensible manner, hydrogen supply can be shared efficiently via dedicated pipelines or infrastructure, improving utilization and efficiency.

> **"Green hydrogen is still just too expensive for a lot of applications. While the price will come down as the technology advances, governments can do a lot to bridge the gap between producers and consumers in the meantime. They can mandate consumption quotas and help make up the price difference with subsidies. They still need to drive demand to some extent."**

Innovative market mechanisms can also connect hydrogen supply and demand. One notable example is Germany's H2Global program, essentially a double-auction system where the government entity contracts to buy green hydrogen (or derivatives like green ammonia) from producers at a fixed price and sell to consumers via auction, covering the price gap. This acts as a contract-for-difference (CfD), making projects bankable by guaranteeing a price. Such models for broader adoption effectively aggregate demand at the national or regional level and provide a cushion for the "green premium" until costs fall.6

While price sensitivity is still prompting large industrial sectors to wait and see how green hydrogen technologies develop before rushing to establish supply chains, larger budgets and looser margins could turn them into early adopters. Defense industries and space sectors are two prime candidates. Both are often backed strongly by government institutions and are given leeway to invest beyond what market norms might otherwise dictate. They are also vital strategic sectors that tie into national security and long-term economic planning, making them even less vulnerable to price shocks and supply chain disruptions. Again, their participation could send strong signals to green hydrogen producers that there is a growing guaranteed market waiting for them to satisfy.

Without these clear signals, many hydrogen projects will continue to stall at the concept stage. But with consumption mandates forming in India and Europe, offtake aggregators like H2Global, industrial clusters coalescing, and coalitions of buyers pledging early adoption, demand is slowly broadening and deepening. Each region will have different demand drivers, but all regions benefit from a larger global market that drives scale and lowers costs.

The Technical Side – Infrastructure and Regulatory Frameworks

The foundation required to build a hydrogen economy consists of both infrastructure and regulation. If hydrogen is to move from focusing mostly on industrial parks to global energy trading, a whole new network of pipelines, ports, storage sites, and fuelling stations must be built or repurposed – and the rules to govern them must be put in place. Planning for infrastructure and updating regulatory frameworks must begin well ahead of any hydrogen demand buildup. Without such rigorous preparation, bottlenecks are all but guaranteed.

If countries plan infrastructure in isolation, they risk foreclosing future options for efficient hydrogen trade. Some coordination is already underway – for instance, the European Hydrogen Backbone initiative involves dozens of gas TSOs (Transmission System Operators) planning a dedicated hydrogen pipeline network across Europe by repurposing existing gas pipelines. Similar concepts are being explored in other regions, e.g., a Gulf hydrogen pipeline network in the Middle East, or hydrogen corridors in Southeast Asia). Countries should integrate hydrogen into national infrastructure plans, identifying which pipelines could be converted, where new ones are needed, and how to connect hydrogen production hubs with consumption centers. Given the long lead times involved, these decisions must be made soon if nations are to meet their 2030 targets on green hydrogen.

Regulatory frameworks are equally crucial. It is crucial to have clear codes and standards to work with. Safety standards for hydrogen handling, transport, and use need to be finalized, while permitting processes should be streamlined. Some countries, such as the UAE, have already updated gas regulations to include hydrogen blending and set hydrogen pipeline regulations. The Abu Dhabi Department of Energy developed a Low Carbon Hydrogen Policy and Strategy in 2021 and is now working on implementation including updating codes and standards so that hydrogen projects can proceed. The government's role is to "enable, not push" the development of the sector by creating the right policies and incentives and then allow the private sector to drive projects.

One often overlooked piece of infrastructure is storage. Hydrogen's physical characteristics make storage a challenge, but one that needs to be solved to properly balance supply and demand.

Regulatory frameworks should therefore address storage site development, safety buffers, and integration into energy systems. Without storage, a renewable-based hydrogen system will struggle to provide the reliability industries need, so this must be planned alongside production facilities.

Grid integration is another area of concern. Some countries are exploring blending hydrogen into natural gas pipelines (typically up to 5-20%) as an interim step to use existing pipelines. Others plan to build dedicated hydrogen pipelines from the start. Both setups prompt questions around pipeline tariffs for hydrogen, third-party access, and certification of the gas quality. Clarity on these technical issues will bolster investor confidence and drive investment.

Enabling infrastructure and suitable regulatory frameworks may grab fewer headlines than technological breakthroughs and the greenlighting of large-scale production facilities, but this less glamorous work needs to happen now. The next 2-3 years are critical: many countries will finalize their hydrogen strategies and start implementing pilot infrastructure. If they do so with an eye to future interoperability and plausible international connections, it will pay dividends later. Policymakers need to think ahead to plan the hydrogen highways, ports, and storage of the future today, even if initial usage is low. Doing so will shorten the timeline to full commercialization and avoid any bottlenecks on the infrastructure side. This approach needs to be paired with clear, effective regulatory measures that encourage cooperation and flexibility on pricing, demand bundling, and guaranteed levels of consumption that give producers and their backers the confidence to forge ahead with new projects.

> **“The work on infrastructure needs to start now, we can’t wait until demand has matured. The onus is on governments to set the tone with national strategies, setting out their stall for the market to see both the supply and demand implications. If enough economies do this, it will drive impetus for quality infrastructure that forms suitable networks that can handle more supply as it comes online.”**

The Financial Side – Scaling Investment Models and Project Finance Tools

Financing is a make-or-break element in the hydrogen equation. The capital requirements to build a hydrogen economy are enormous – from electrolysis plants and renewable energy farms to pipelines, tankers, and conversion of factories. Traditional project finance models, honed on predictable infrastructure like power plants or pipelines, are struggling to adapt to hydrogen's new risks and uncertainties. Investment models can evolve to mobilize the trillions in investment needed through 2030 and beyond.

One committee member noted that their organization had been analyzing hydrogen project bankability and found the situation reminiscent of the early renewable energy days: projects are often not bankable without some form of support or offtake guarantee. The fundamental problem is the mismatch between the cost of producing green hydrogen and the price consumers are willing to pay for it. Until that gap closes, the revenue streams of hydrogen projects are uncertain, making private lenders and investors cautious.

Much like demand stimulation, financial de-risking mechanisms are required. If governments can take on the market price risk (paying the difference between production cost and market price), then hydrogen projects can secure debt financing much more easily. With renewable energy, long-term power purchase agreements (PPAs) or feed-in tariffs underpinned wind and solar investments for decades. Green hydrogen needs a similar financial structure, whether it's long-term offtake contracts, CfDs, or regulated asset models.

Clarity in policy and regulation was repeatedly cited as a prerequisite for greater investment, which will not flow unless investors see a stable policy environment that lasts for the entirety of the project's lifetime. Governments should publish detailed hydrogen roadmaps that include regulatory frameworks, permitting processes, and support schemes, so that investors have a line of sight to the future hydrogen landscape and decide where they best fit into it. Many announced projects are effectively on hold as they are "waiting for policy clarity," and that gaining such clarity would remove hesitancy in the minds of investors.

The cost of capital itself is a concern, especially in developing markets where interest rates can be high. Green hydrogen projects, with their high upfront cost and initially slim margins, are very sensitive to the cost of financing. This is where green finance and ESG investing trends might help – if hydrogen projects can be labelled as green bonds or attract sustainability-linked loans, they might secure lower rates. There are early signs that banks and institutional investors are keen to support flagship hydrogen ventures as part of their climate finance commitments.

Key Takeaways

Global standards will unlock trade: Harmonizing standards, certifications, and regulations for green hydrogen is essential to enable a global market. Aligning definitions across major markets will reduce barriers and allow hydrogen to be traded like other commodities. Conversely, fragmented rules and protectionism could severely slow progress.

Demand signals are as important as supply: The green hydrogen economy won't scale on supply-side enthusiasm alone – governments must mandate minimum consumption levels, future targets and procurement requirements. Policies such as blending quotas, green product mandates, and buyer coalitions can assure investors that markets will exist for green hydrogen, prompting new projects. Think big, start small: Realizing grand hydrogen visions (global trade routes, gigawatt projects) will take time, but momentum can be built now by starting with pragmatic, regional hydrogen hubs and clusters. Co-locating production with industrial and transportation uses in hub projects allows infrastructure to develop efficiently and matches supply with demand incrementally. These successes will demonstrate viability, build investor confidence, and serve as building blocks for later expansion and interconnection.

Secure and diversify the supply chain: Depending on any single country for green hydrogen production and critical technologies is a recipe for market imbalances and disruption. Stakeholders should invest in diverse, resilient supply chains and share technology expertise globally. This means encouraging multiple manufacturing centers to avoid bottlenecks, standardizing components, and fostering collaboration on R&D.

Match solutions to contexts: Green hydrogen is not one-size-fits-all. Its most impactful roles will differ depending on the sector, country, and regional context involved. Strategies should be tailored to each sector's needs and timelines, setting specific goals. Tailored strategies will meet buyers' needs, prompting them to offtake more confidently and fuelling sustainable demand that will accelerate innovation and investment in green hydrogen ecosystems.

About the ADSW Advisory Committees

The committees are designed to foster candid discussions that break down silos between sectors and regions. Participants include CEOs and senior executives of international companies, government policymakers, leading researchers, and technology innovators. This diversity ensures a wide range of perspectives. In closed-door sessions, members share insights, highlight key challenges, and propose actionable solutions and areas for collaboration. Discussions are held under the Chatham House Rule, allowing participants to speak openly about successes and setbacks, learn from one another, and identify common ground. The dialogue is intentionally forward-looking and focused on practical outcomes.

Insights from the committees help shape ADSW's content, direction, and related initiatives. Recommendations are distilled into official reports such as this one and shared with a broader audience to inspire continued dialogue and action. These findings often inform the agendas of ADSW summits, panels, and workshops, and may guide Masdar and its partners in developing new initiatives or advancing policy advocacy aligned with the committee's conclusions. In past years, the committees have contributed to meaningful outcomes, from catalyzing cross-border partnerships to introducing new topics into global forums such as the World Future Energy Summit.

Advisory Committee Members

Naveen Ahlawat
Head-Power to X
Jindal Steel and Power

Dr. Eng. Adnan AlHosani
Director Of Electricity &
Energy Trade
Ministry of Energy and
Infrastructure

Jeffrey Beyer
Founder and Managing
Director
Zest Associates

Andreas Bieringer
Director of Green Hydrogen
Business Development
Masdar

Jorgo Chatzimarkakis
CEO
Hydrogen Europe

Veronica Constantin
Vice President, Global
Strategic Sales
Emerson

Manuel Kuehn
VP, Sustainable
Energy Systems
Siemens Energy

Sergio Lopez
Head of Energy
Transition and Markets
Department of Energy
Abu Dhabi

Cornelius Matthes
CEO
Dii Desert Energy

Hasan Shafi
Partner
EY-Parthenon

Amir Sharifi
Chief Investment Officer /
Executive Committee Member
Hy24

Alexander Tancock
CEO
InterContinental Energy

James Walker
Team Lead - Renewable
Gases
IRENA

Frank Wouters
Chairman
MENA Hydrogen Alliance

Meeting Co-Chairs

Valerie Peyre
Director, Abu Dhabi
Sustainability Week
Masdar

Oisin Commane
Head, Thought Leadership and
Programming Abu Dhabi
Sustainability Week
Masdar

ABU DHABI SUSTAINABILITY WEEK

About Abu Dhabi Sustainability Week

Abu Dhabi Sustainability Week (ADSW) is a global platform supported by the UAE and its clean energy leader, Masdar, to address the world's most pressing sustainability challenges through crucial conversations accelerating responsible development and fostering inclusive economic, social and environmental progress.

For more than 15 years, ADSW has convened decision-makers from governments, the private sector and civil society to advance the global sustainability agenda through dialogue, cross-sector collaboration and impactful solutions. Throughout the year, ADSW conversations and initiatives facilitate knowledge sharing and collective action that will ensure a sustainable world for future generations.

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WORLD FUTURE ENERGY SUMMIT

About the World Future Energy Summit

The World Future Energy Summit is the leading global event for clean energy and sustainability, bringing together innovators, business leaders, policymakers, and investors to turn ambition into action.

Over three days, the international exhibition and conference addresses the most pressing challenges of our time—clean energy, climate change, sustainable cities, water security, waste management, green finance, and the transformative power of artificial intelligence.

By uniting almost 42,000 attendees from public, private, and non-profit sectors, it serves as a critical bridge between bold policy and real-world solutions.

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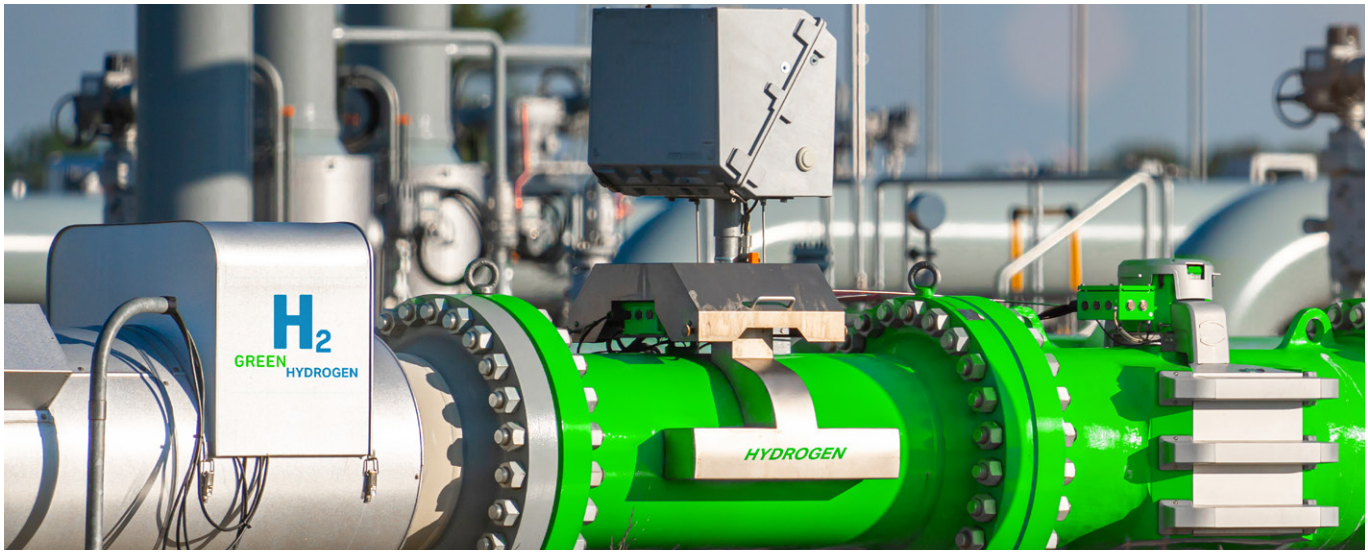

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