

# GLOBAL HYDROGEN MARKET LANDSCAPE REPORT

ASSESSING STRATEGIC  
ECONOMIES



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# Foreword

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The global clean hydrogen market has been on a roller-coaster in recent years, with sentiment shifting from widespread enthusiasm to concern and pessimism as the difficulties of bringing hydrogen technologies to scale became more apparent. Today, analysts are seeing green shoots: projects are advancing globally as companies focus on the best clean hydrogen use-cases and technology innovations arrive to accelerate growth. Still, clean hydrogen markets are almost always policy-driven, making stable and coordinated policy that creates predictable conditions to support long-term investments the most important factor to market growth. As this report shows, while some countries are pulling back on hydrogen policy (and climate policy more broadly), countries with stable policy and clear goals are becoming hubs for clean hydrogen project development today.

A mature global hydrogen market will also require credible data frameworks that enable transparent emissions accounting with well-defined boundaries. Accurate emissions measurement and reporting builds trust and allows stakeholders to make informed decisions. Clear frameworks help delineate the roles and responsibilities of various market participants, providing the necessary guidance for industries to make long-term strategic decisions with confidence. Together, these elements are fundamental for the hydrogen market to thrive and fulfill its promise as a cornerstone of a sustainable energy future. The Open Hydrogen Initiative's hydrogen carbon footprint tool is a major step toward trustworthy, cross-border emissions accounting. The following report relies on market data and analysis to highlight the most exciting areas of hydrogen technology and market development, which can be accelerated through future investment unlocked by clear emissions accounting using tools from OHI.

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# Executive Summary

Global hydrogen markets are entering a period of differentiation, consolidation, and strategic positioning. After an initial wave of enthusiasm, the last several years have revealed the structural realities shaping hydrogen deployment: fragmented policy environments, variable technology readiness, rising capital costs, evolving emissions accounting frameworks, and uncertain demand formation. Yet despite these constraints, momentum continues. As of late 2025, seventy countries have published hydrogen strategies, over 400 projects have reached final investment decision, and 444 offtake agreements, including 96 binding commitments, have been signed. This is a clear signal that governments and industries are beginning to anchor long-horizon supply chains.

This report assesses hydrogen market readiness across seventeen countries that together represent the full spectrum of global hydrogen development: demand-driven industrial economies, resource-rich exporters, technology leaders, and countries pursuing hybrid or transitional pathways. Using a six-pillar analytic framework, the report evaluates national performance across policy and regulatory conditions, geographic and logistical positioning, offtake development, economic viability, technology and innovation ecosystems, and social license and stakeholder alignment.

**The central finding is that hydrogen development is advancing, but not uniformly.**

Rather than converging toward a single global model, countries are evolving along differentiated strategic roles that reflect their structural advantages, policy priorities, and industrial orientation. These roles are emerging through two primary drivers: (1) whether hydrogen is pursued mainly for domestic industrial decarbonization, and (2) whether countries seek to become export-oriented supply hubs in future hydrogen trade.

Countries such as Germany, Japan, South Korea, and the Netherlands have embedded hydrogen within long-term decarbonization and energy security strategies, relying on procurement frameworks, clearly articulated certification rules, and structured offtake mechanisms. Their market influence comes not from low production costs, but from their role as stable demand anchors capable of furnishing long-term purchase commitments. In contrast, Australia, Chile, Morocco, Namibia, Saudi Arabia, and the United Arab Emirates are developing hydrogen as an export-oriented industry, leveraging renewable resources or fossil-based feedstock combined with CCS to compete in emerging green and low-carbon fuels markets. The United States, India, China, Portugal, Spain, Norway, and Colombia exhibit hybrid trajectories where domestic and export interests coexist, often unevenly, across sectors and regions.

This differentiation is reinforced by the challenges countries themselves identify. Drawing on comparative analysis of national hydrogen roadmaps, the report finds that the most frequently cited barriers relate not to technology cost curves, but to institutional capacity: infrastructure planning, market coordination, certification alignment, and workforce readiness. These findings mirror the patterns observed in the seventeen countries assessed here, underscoring that hydrogen markets are constrained more by governance, regulatory stability, and contracting frameworks than by technological feasibility.

Across all regions, three cross-cutting conditions exert outsized influence on market readiness:

**1. Policy durability and institutional stability.**

Hydrogen investments operate on 15–25-year time horizons, making durable policy architecture more important than short-term incentives. Markets with stable institutional frameworks, such as Japan, South Korea, Germany, the Netherlands, and Spain, are moving more consistently toward deployment.

**2. Offtake certainty and market coordination.**

The primary barrier to bankability is the lack of predictable, long-term demand signals. Government-backed contracts, buyer aggregation mechanisms, and standardized emissions-based pricing are proving more influential than production subsidies alone.

**3. Infrastructure, land/water integration, and workforce capacity.**

Hydrogen is not a standalone technology; it is a system requiring synchronized development across power, water, storage, ports, pipelines, and skilled labor. Countries that coordinate these simultaneously (Saudi Arabia, UAE, Norway, the Netherlands) are advancing faster than those treating them as sequential phases.

The report's Regional Comparison section highlights how these factors manifest differently across Europe, Asia-Pacific, the Americas, and the Middle East and North Africa (MENA). Europe is characterized by regulatory clarity and demand-side coordination; Asia divides into import-driven demand anchors and export-oriented suppliers; the Americas show strong resource endowment but uneven policy certainty; and MENA countries leverage state-led planning to accelerate vertically integrated export hubs.

Finally, the report identifies **five emerging global roles** in the hydrogen economy:

- **Demand Anchors** (Germany, Japan, South Korea) shaping certification and procurement norms
- **Export Supply Hubs** (Chile, Saudi Arabia, Morocco, UAE, Australia) building large-scale production

- **Technology & Components Leaders** (China, United States, Norway) driving cost and manufacturing trends
- **Certification & Logistics Gateways** (Netherlands, Spain, Portugal) enabling cross-border market function
- **Hybrid Strategies** (India, Colombia, U.S. regional clusters) navigating domestic vs. export orientations

**These roles are not fixed**, but early movers in standard-setting, port planning, and industrial contracting are already shaping the contours of future hydrogen trade. Market influence will be determined before trade volumes mature, not after.

Overall, the analysis shows that global hydrogen development is progressing, but as a series of **deliberate, negotiated, and system-dependent transitions** rather than a single acceleration curve. Countries that align policy durability, infrastructure planning, and demand formation mechanisms will be the ones to move hydrogen from strategic aspiration to industrial reality.

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## Background

Over the past five years, the global hydrogen market has evolved in a manner consistent with many emerging energy technologies: initially marked by strong enthusiasm<sup>[1],[2]</sup>, ambitious national strategies<sup>[3]</sup>, and early project announcements, followed by a more measured development pace as financial, technical, and policy realities have become clearer<sup>[4]</sup>. Beyond the typical challenges associated with scaling new technologies, including establishing supply chains, balancing supply and demand, and optimizing system performance, hydrogen deployment is uniquely shaped by policy and regulatory environments that vary across regions and, at times, within national jurisdictions. These dynamics create **heterogeneous market signals that influence investment decisions, commercial readiness, and the timing of large-scale deployment.**

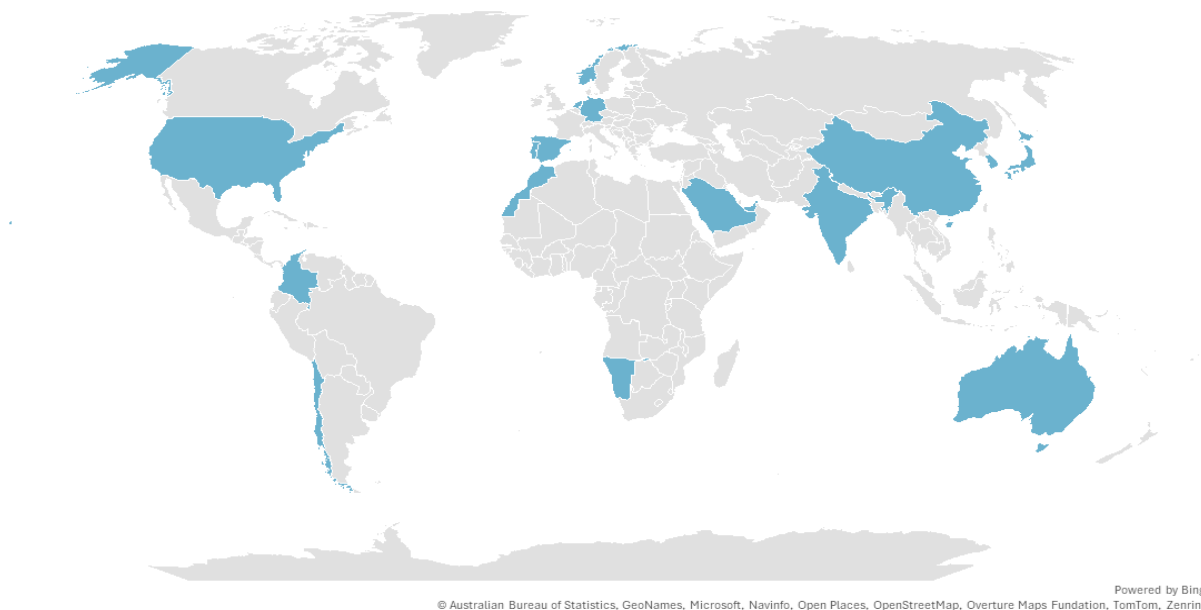
As of November 2025, seventy countries have released hydrogen strategies or roadmaps of varying maturity<sup>[3]</sup>, each outlining the role hydrogen may play in long-term decarbonization and industrial competitiveness. Across these strategies, governments and industry stakeholders consistently identify **barriers spanning political, economic, social, technical, and legal dimensions** - both within domestic markets and with respect to global trade positioning<sup>[5]</sup>. Recent macroeconomic conditions, including elevated interest rates and inflationary pressures, have further increased capital costs and financing uncertainty. At the same time, the continuity of public support remains sensitive to political change. For example, in the United States, the Biden administration's \$8 billion allocation for regional clean hydrogen hubs and associated demand-support mechanisms has faced reevaluation under the Trump administration<sup>[6]-[8]</sup>. Similarly, in Germany, the Constitutional Court's 2023 decision preventing the reallocation of unspent pandemic funds placed constraints on previously anticipated climate and energy investments, including hydrogen-related programs<sup>[9]</sup>.

Technology readiness and cost competitiveness also shape the pace and character of hydrogen market expansion. Recent analyses from the International Energy Agency's (IEA) *Global Hydrogen Review* highlight substantial variation in the technology readiness levels (TRLs) of hydrogen production, transport, and end-use pathways<sup>[10]</sup>. While some applications, such as hydrogen use in refineries and ammonia production, are commercially mature<sup>[11]</sup>, others, including hydrogen-based direct reduced iron<sup>[12]</sup>, synthetic fuels<sup>[13]</sup>, and large-scale storage<sup>[14]</sup>, remain in demonstration or early deployment phases. The competitiveness of hydrogen and hydrogen derivatives depends on regional renewable energy pricing, infrastructure availability, carbon policy frameworks, and long-term demand certainty. As the IEA notes, cost-competitive deployment is achievable in targeted industrial and heavy-transport applications under supportive policy environments, but

broader scaling will require coordinated investment in shared infrastructure and stable market signals<sup>[15]</sup>.

Despite these challenges, project development continues. In 2024, 434 hydrogen projects reached final investment decision (FID), representing approximately \$10 billion USD in committed capital<sup>[16]</sup>. Countries and companies have also continued to enter memoranda of understanding (MoUs) and binding offtake agreements to test supply chain feasibility and build early-stage market confidence. According to data provided by S&P Global Energy, as of November 2025, there are 444 documented hydrogen offtake agreements globally, not including MoUs. Ninety-six of these qualify as binding, defined as either a signed contract or an offtaker's participation in the project development consortium. This volume of commitments signals sustained momentum toward building long-term trade corridors and sector-specific deployment.

This report examines seventeen countries, shown in Figure 1, that have demonstrated meaningful engagement in hydrogen development, whether through domestic industrial use cases, export-oriented production strategies, or bilateral supply agreements. These countries, listed below, were selected and analyzed to provide an integrated view of policy positioning, market activity, and strategic direction.



*Figure 1. Countries analyzed in this report. The countries were selected to represent various regions shaping hydrogen development globally, capturing variation across resource endowments, market maturity, policy ambition, industrial structure, and existing or planned participation in international hydrogen trade.*

- Australia
- Chile
- China
- Colombia
- Germany
- India
- Japan
- Morocco

- Namibia
- Norway
- Portugal
- Saudi Arabia
- South Korea
- Spain
- The Netherlands
- United Arab Emirates
- United States

The seventeen countries included in this analysis were selected to reflect a diverse set of hydrogen market trajectories, strategic motivations, and regional contexts. Together, they represent a mix of established industrial economies, emerging exporters, technology leaders, and resource-rich production centers. Countries such as **Germany, Japan, South Korea, and the Netherlands** have positioned hydrogen as a key element of **industrial decarbonization and energy security strategies**<sup>[17]-[20]</sup>, driven by high energy import dependence and commitments to deep emissions reductions. Others, including **Australia, Chile, Morocco, Namibia, Saudi Arabia, and the United Arab Emirates**, are pursuing export-oriented hydrogen pathways, **leveraging abundant renewable resources** or existing energy trade relationships to develop competitive production for international markets<sup>[21]-[25]</sup>. The **United States, India, China, Portugal, Spain, Norway, and Colombia** illustrate a range of **hybrid strategies**, combining domestic deployment goals with varying degrees of export ambition, infrastructure development, and industrial transformation<sup>[26]-[33]</sup>.

By selecting countries that differ in geography, economic structure, market maturity, and policy design, this analysis enables comparison across multiple dimensions of hydrogen sector development, including production cost drivers, regulatory environments, supply chain readiness, industrial demand centers, and international trade postures. The resulting cross-country assessment supports a broader understanding of how hydrogen markets are forming globally, where common enabling conditions appear, and how different national strategies are shaping early trade and investment patterns.

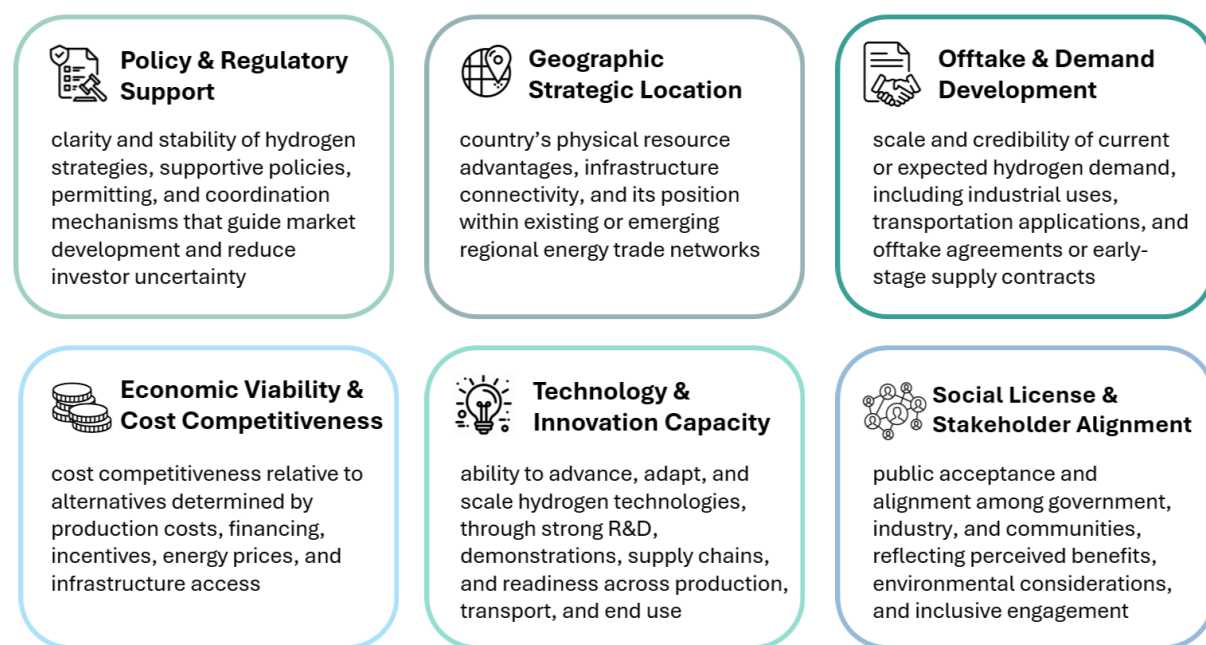
The report is organized into three primary components. First, the **Methodology** section outlines the comparative framework used to evaluate each country across six analytic factors, including the challenges and constraints each country has self-identified in standing up a hydrogen market. Second, the **Country Profiles** present one-page summaries that describe representative projects, current and expected energy mixes, hydrogen policy focus areas, and emerging trade postures. Third, the **Regional and Cross-Cutting Analysis** provides narrative comparisons across four regions - Europe, Asia/Asia Pacific, the Americas, and the Middle East and North Africa (MENA) - highlighting shared policy trends, technological priorities, enabling conditions, investment risks, and emerging financing patterns. The report concludes with key insights and implications for

stakeholders engaged in strategic planning, international energy trade, and long-term market development.

## Methodology

This analysis draws on desktop research conducted across countries representing a diverse range of hydrogen development pathways and strategic positions in the emerging global hydrogen economy (see Figure 2). Countries were selected to capture variation across resource endowments, market maturity, policy ambition, industrial structure, and existing or planned participation in international hydrogen trade. This approach allows for comparison not only between established industrial economies and emerging exporters, but also across regions that are shaping hydrogen development for different strategic purposes – such as energy security, industrial decarbonization, and export market creation.

To evaluate each country’s positioning, **we examined developments across six criteria** that consistently appear in national hydrogen strategies and in international assessments, including the IEA’s *Global Hydrogen Review*<sup>[5], [10], [15]</sup>:



These six criteria were selected because they broadly reflect the enabling conditions and constraints that countries themselves identify in their hydrogen roadmaps, consultation documents, and industrial planning strategies. Together, they capture not only structural characteristics (such as resource potential and existing industrial bases) but also dynamic factors (such as stakeholder confidence, policy stability, and the maturity of market signals).

Each country was assessed qualitatively using a 0–5 Likert scale, with scoring descriptors defined in the tables that follow. The scoring framework was informed by two primary sources of evidence: (1) barriers and priorities self-identified in national hydrogen strategies and sectoral policy plans, and (2) insights from recent IEA analyses examining readiness, cost competitiveness, and market formation challenges.

A brief definition for each criterion, as well as their Likert scale, are shown below.

## Policy and Regulatory Environment

This criterion reflects the clarity, stability, and maturity of national hydrogen strategies, supportive policy instruments, permitting frameworks, and coordination mechanisms that guide market development and reduce investor uncertainty.

<b>Score</b>	<b>Descriptor</b>	<b>Description</b>
0	Absent or unfavorable	No hydrogen policy or strategy; no incentives, mandates, or regulations supporting hydrogen deployment; unclear permitting or licensing environment
1	Nascent	Hydrogen mentioned in broader energy plans, but no enabling mechanisms (tax credits, grants, or standards); limited institutional capacity or clarity
2	Emerging support	National hydrogen strategy or roadmap published; some pilot-level funding or R&D incentives, but limited implementation or budget; regulatory frameworks under discussion
3	Structured but limited	Clear incentive mechanism (tax credits, grants, clean fuel standards) with initial uptake; emerging certification efforts and permitting guidance, but incomplete or inconsistent application
4	Robust, active framework	Multiple operational policy levers: fiscal incentives, demand mandates, carbon-intensity standards, and/or export-import frameworks; transparent permitting and certification schemes; policy continuity across political cycles
5	Comprehensive, best practice	Fully operational, long-term hydrogen framework integrated with national-level climate and industrial policies; includes carbon-intensity tracking, cross-border alignment (multi-country agreements and/or ongoing negotiations), and functioning support markets

## Geographic Strategic Location

Captures the country’s physical resource advantages (renewables, land availability, storage potential), infrastructure connectivity (ports, pipelines, industrial hubs), and its position within existing or emerging regional energy trade networks.

Score	Descriptor	Description
0	Remote or unfavorable	Remote, poor access to infrastructure or demand
1	Limited infrastructure or demand access	Peripheral access; some energy or port infrastructure exists nearby, but connectivity remains limited due to significant distance or logistical constraints
2	Developing access	Infrastructure development or corridor planning underway; moderate potential for integration with domestic industry or ports in the medium term
3	Moderately strategic	Moderately connected or reasonable proximity; located within reach of industrial zones or ports or co-located; basic infrastructure exists or is under construction
4	Advantageous location	Feedstock, infrastructure, and wide national market access; close to industrial demand or export terminals with established logistics networks
5	Prime strategic hub	Strategic hub with export potential, positioned within or near key trade routes or demand centers; operational or committed infrastructure

## Offtake and Demand Development

Indicates the strength, scale, and credibility of current or expected hydrogen demand, including industrial use cases, transportation applications, and offtake agreements or early-stage supply contracts that signal market pull.

Score	Descriptor	Description
0	No market or demand signal	No identified end use
1	Preliminary, conceptual market interest	Early-stage discussions or conceptual studies identifying potential sectors but no formal expressions or interest or MoUs
2	Emerging interest	Non-binding MoUs or letters of intent with potential buyers (domestic or export); no contracted volumes
3	Developing offtake pipeline	Mix of early-stage MoUs and a few pre-contract agreements; off-takers assessing certification or delivery terms; growing demand in target sectors
4	Committed demand	Majority of project capacities covered by signed offtake agreement, binding term sheets

5	Operational offtake market	Active transport and consumption or, at minimum, signed long-term offtake contracts with diversified buyers (domestic and export)
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## Economic Viability and Cost Competitiveness

Represents expected production costs and delivered cost competitiveness relative to alternatives, shaped by energy prices, financing conditions, incentives, and access to required inputs and supporting infrastructure.

Score	Descriptor	Description
0	No economic pathway	High cost, no clear path to profitability; no market mechanism to bridge cost gap
1	Policy-dependent	Requires substantial grants or subsidies to be viable; no set cost-reduction trajectory in place
2	Early-stage economics	Pilot or demo-scale projects exploring cost reductions; dependent on learning curves or expected renewable cost declines to approach competitiveness by 2035
3	Marginal viability	Projects could achieve parity with strong policy support and/or carbon pricing; near breakeven under favorable assumptions
4	Competitive within region	Levelized cost of hydrogen (LCOH) near parity with conventional fuels
5	Proven profitability	Proven profitability or clear path to sustained competitiveness; access to ultra-low-cost renewables, efficient supply chains, and mature financing

## Technology and Innovation Capacity

Reflects the country's ability to advance, adapt, and scale hydrogen technologies, based on R&D ecosystems, demonstration project activity, supply chain capability, and readiness levels across production, transport, and end use.

Score	Descriptor	Description
0	Absent	No domestic capability; no local R&D ecosystem or technical expertise in hydrogen-related technologies
1	Minimal capacity	Isolated research activity; limited academic or research participation in hydrogen topics; few technology pilots; no coordination between research institutions and/or industry
2	Emerging ecosystem	Early-stage R&D and partnerships; growing national interest with initial research funding or pilot projects; some collaboration between universities, public research agencies and/or industry

3	Developing innovation base	Active R&D and early commercialization; presence of demonstration-scale projects; developing access to international technology partnerships
4	Advanced capacity	Strong national R&D programs linked to commercialization pathways; domestic manufacturing of key technologies (electrolyzers, storage)
5	Global technology leader	Mature domestic ecosystems and R&D institutions driving global innovation; exporter of hydrogen technologies

## Social License and Stakeholder Alignment

Captures public acceptance, community support, and alignment among government, industry, civil society, and local stakeholders, including perceived benefits, environmental considerations, and the inclusiveness of engagement processes.

Score	Descriptor	Description
0	Absent or adverse environment	Strong opposition or lack of engagement; public or community resistance to hydrogen projects; no established mechanisms for consultation or transparency
1	Weak alignment	Limited stakeholder outreach; early government or industry communication efforts, but low community trust
2	Emerging awareness	Initial public engagement; stakeholders beginning to be informed through workshops or consultations (two-way communication); early discussions on workforce development
3	Structured engagement	Active, but inconsistent engagement; regular consultation processes for major projects; some workforce training initiatives or similar community-focused processes, but uneven implementation across regions and projects
4	Collaborative, transparent governance	Established, trusted engagement processes; workforce development and economic impact analyses integrated into hydrogen programs; few active opposition movements
5	Deep, institutionalized support	Deep, institutionalized support across communities, labor groups, and industries; transparent governance and strong public trust and buy-in

**Scores reflect the synthesis of multiple sources of information** rather than quantitative measurement or index construction. This approach was chosen to align with the current state of the hydrogen market, where many deployment pathways remain at varied TRLs,

and where timelines, costs, and market conditions are evolving. Within this context, qualitative comparative evaluation provides a structured way to interpret readiness and momentum across countries without overstating precision.

This methodological framework provides the foundation for the Country Snapshots and the Regional and Cross-Cutting Analysis that follow, supporting an integrated understanding of how hydrogen markets are forming across different national and regional contexts.

## Country Snapshots

Table 1 summarizes the countries' scores on the six criteria. Additional details for each country are found in the subsequent pages, including current energy mixes.<sup>[34]</sup> These scores are intended to provide a high-level comparative view of relative readiness and should be interpreted directionally rather than as precise quantitative rankings. They are most useful when considered alongside the context presented in each country's profile.

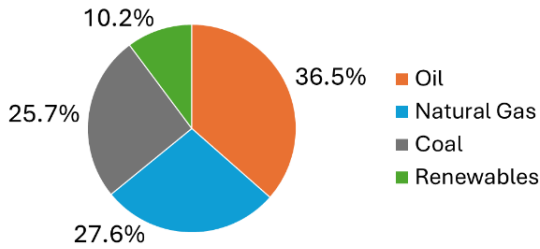
	Policy & Regulatory Support	Geographic Strategic Location	Market Demand	Economic Viability	Technology & Innovation Capacity	Social License & Stakeholder Engagement
Australia	■ ■ ■ ■ ■ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □
Chile	■ ■ ■ ■ ■ □	■ ■ ■ □ □ □	■ ■ ■ ■ □ □	■ ■ ■ □ □ □	■ ■ ■ □ □ □	■ ■ ■ ■ □ □
China	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □
Colombia	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □	■ ■ ■ □ □ □	■ ■ ■ □ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □
Germany	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ □	■ ■ ■ □ □ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □
India	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □
Japan	■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □
Morocco	■ ■ ■ ■ □ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □
Namibia	■ ■ ■ □ □ □	■ ■ ■ ■ □ □	■ ■ ■ □ □ □	■ ■ ■ □ □ □	■ ■ ■ □ □ □	■ ■ ■ □ □ □
Netherlands	■ ■ ■ ■ □ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □
Norway	■ ■ ■ ■ □ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □
Portugal	■ ■ ■ ■ ■ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □	■ ■ ■ □ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □
Saudi Arabia	■ ■ ■ □ □ □	■ ■ ■ ■ ■ ■	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □
South Korea	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □
Spain	■ ■ ■ ■ ■ □	■ ■ ■ ■ ■ □	■ ■ ■ ■ □ □	■ ■ ■ □ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □
UAE	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □
USA	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □	■ ■ ■ ■ □ □

Table 1. Summary results of countries' scores on six selected criteria reflecting overall hydrogen market stability and robustness.

# Australia



## Energy Mix



In September 2025, the government announced a 62% to 70% range in emissions reduction target by 2035 with increased renewable generation and gradual decommissioning of coal power plants.<sup>[a]</sup> Achieving this target will require continued expansion of utility-scale solar and wind, transmission upgrades, and storage investments, as coal retires and the power system shifts toward higher renewable penetration supported by firming resources.

## Energy/Hydrogen Policy

Australia's National Hydrogen Strategy and state grants support early hydrogen projects and infrastructure; domestic transport infrastructure is currently in feasibility stages.<sup>[b]</sup>

Low-emission hydrogen standards are being developed to meet international standards.<sup>[c], [d]</sup>

Export readiness is a key policy goal, with coordinated efforts on ports, shipping trials, and offtake agreements.<sup>[b]</sup> Australia is a major energy exporter (coal, LNG) and is pivoting toward green hydrogen carriers like ammonia and liquid hydrogen to diversify and capture emerging value chains.<sup>[e], [f]</sup>

## Readiness Score



## Trade Posture

Australia benefits from proximity to high-demand markets. It is currently pursuing trade agreements and dialogues with countries (Japan, South Korea, Singapore); H<sub>2</sub> derivatives pilot shipments planned or underway to Asian markets.<sup>[f], [g]</sup> These efforts reflect a deliberate strategy to position Australia as a long-term supplier of green H<sub>2</sub> and ammonia into emerging Indo-Pacific supply chains.

## Notable Projects

Name	Key Players	Tech./Product	Location
AREH	InterContinental Energy	Wind and solar for H <sub>2</sub> /NH <sub>3</sub> export	Pilbara
HESC	Kawasaki, AGL, J-Power	LH <sub>2</sub> production and shipping to Japan	Latrobe
FFI	Fortescue	Electrolysis for industrial decarb.	Multiple
ARENA	Gladstone Ports, Shell, Origin	NH <sub>3</sub> export	Queensland

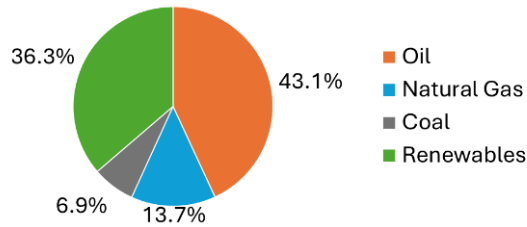


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# Chile



## Energy Mix



In 2023, the Chilean government reaffirmed its intention to complete coal phase-out by 2040 while expanding renewable generation, targeting roughly 80% renewable electricity penetration.<sup>[a]</sup> This transition is expected to be supported by large-scale deployment of energy storage, including lithium-based systems projected to reach approximately 6 GW by 2050, leveraging Chile’s domestic mineral resources to enhance grid stability and firm variable renewable output.<sup>[b]</sup>

## Energy/Hydrogen Policy

Chile’s National Green Hydrogen Strategy provides a policy framework backed by a \$50 million support facility, tax incentives, and public-private R&D initiatives to accelerate project deployment.<sup>[c],[d]</sup> Regulatory efforts are advancing through international collaboration, including work with Germany to develop certification schemes aligned with global standards.<sup>[e]</sup>

Focus is entirely on green hydrogen, using electrolysis powered by abundant solar and wind energy. Chile aims to have 5 GW of electrolyzer capacity under development by 2025 and 25 GW by 2030.<sup>[c]</sup>

## Readiness Score



## Trade Posture

Chile is advancing plans to develop export corridors through strategic coastal hubs, including Punta Arenas in the Magallanes region and Antofagasta in the north, as gateways for ammonia and other derivatives.<sup>[c]</sup> Backed by exceptional solar and wind resources, Chile is developing partnerships with Germany and the EU to position itself as a future export supplier.<sup>[f],[g]</sup>

## Notable Projects

Name	Key Players	Tech./Product	Location
Haru Oni	HIF Global Siemens Energy	Electrolysis for e-fuel for export to EU	Magallanes
HIF	Porsche, Enel, Siemens Energy	LH2 production and shipping to Japan	Magallanes
FFI	Fortescue	Electrolysis for industrial decarb.	Antofaga

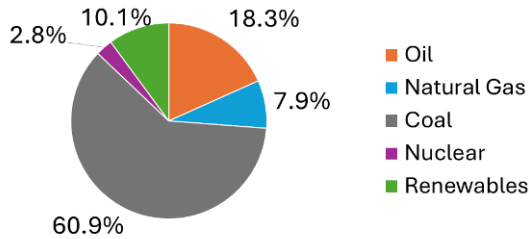


**References** [a] Government of Chile, *National Energy Policy 2050 (Política Energética 2050)*, Ministry of Energy Chile, 2023 update. [b] Government of Chile, *Energy Storage Roadmap (Hoja de Ruta de Almacenamiento Energético)*, Ministry of Energy Chile, 2023. [c] Ministerio de Energía (Chile), *Estrategia Nacional de Hidrógeno Verde*, 2020. [d] CORFO, “Corfo adjudica propuestas de Hidrógeno Verde que atraerán inversiones por 1.000 millones de dólares,” 2021. [e] BMWK & Ministerio de Energía de Chile, *German–Chilean Energy Partnership on Green Hydrogen*, 2021. [f] European Commission, *EU–Chile Advanced Framework Agreement*, 2022. [g] Aritzia, T. et al. “Interrogating green hydrogen roadmaps: narratives of imminence and the anticipation of asymmetric energy futures.” *The Extractive Industries and Society*, Vol. 26. January 2026.

# China



## Energy Mix



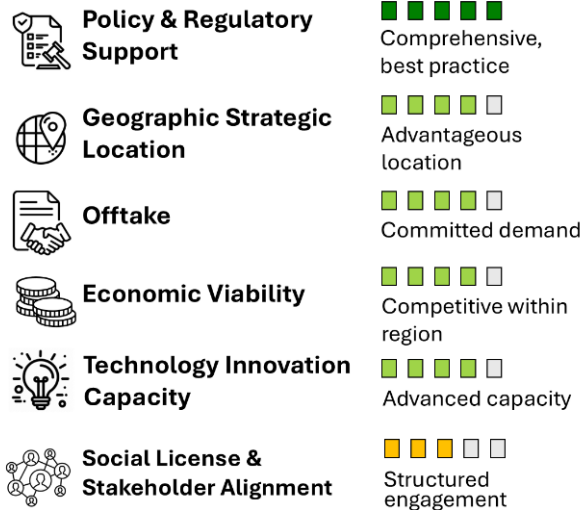
While coal remains the backbone of China's baseload electricity system, the government is rapidly expanding renewable capacity through large-scale clean energy investment programs expected to exceed USD 625 billion in the coming decade.<sup>[a],[b],[c]</sup>

## Energy/Hydrogen Policy

China released its first long-term hydrogen plan (2021–2035) through the National Development and Reform Commission (NDRC), establishing a national framework for scaling H<sub>2</sub> production and end-use. Policy support includes subsidies and purchase incentives for fuel-cell vehicles, investment in refueling infrastructure, and pilot projects across the value chain.<sup>[d],[e]</sup>

In 2025, China introduced a draft Clean and Low-Carbon Hydrogen Evaluation Standard, proposing a renewable hydrogen emissions threshold of ≤2.0 kg CO<sub>2</sub>e/kg H<sub>2</sub> - stricter than comparable benchmarks in the U.S. and EU. Additional policy measures include expanded central-budget support from the NDRC, which can provide up to 20% co-funding for hydrogen-related industrial and energy projects.<sup>[f],[g]</sup>

## Readiness Score



## Trade Posture

China is the world's largest producer and consumer of hydrogen and is increasingly positioning itself as a potential exporter of hydrogen technologies and related equipment. Its network of major deepwater ports and proximity to key Asian markets provide geographic advantages that could support future regional trade in hydrogen and its derivatives.<sup>[e]</sup>

## Notable Projects

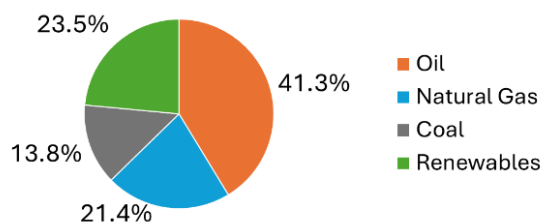
Name	Key Players	Tech./Product	Location
Chifeng Green Hydrogen & Ammonia	Envision Energy, Marubeni Corporation	Hydrogen and ammonia production	Chifeng
Hydrogen Valley	CIMC Enric, CEEC	H <sub>2</sub> ammonia and methanol integrated production	Songyuan
Yulin Demonstration	Trina Green Hydrogen, Shaanxi	Green hydrogen for industrial use	Yulin



**References** [a] International Energy Agency, China Energy Mix, IEA, 2026. [b] International Energy Agency, "World Energy Investment 2025," France, 2025. [c] National Development and Reform Commission (NDRC), "China's 14th Five-Year Renewable Energy Development Plan," 2022. [d] National Development and Reform Commission (NDRC) & National Energy Administration (NEA), *Medium and Long-Term Plan for Hydrogen Energy Industry Development (2021–2035)*, 2022. [e] International Energy Agency, *Global Hydrogen Review 2023*. [f] China Electricity Council, Draft Clean and Low-Carbon Hydrogen Evaluation Standard, 2025. [g] National Development and Reform Commission (NDRC), Management Measures for Special Investments in Central Budget for Energy Conservation and Carbon Reduction, 2025.

# Colombia

## Energy Mix



Colombia's long-term energy strategy emphasizes a gradual transition away from fossil fuels, accelerated deployment of renewable resources including solar and wind, and the development of low-carbon hydrogen, framed within a broader commitment to carbon neutrality by 2050. The strategy also highlights energy diversification, regional economic development, and long-term investment attraction as central pillars of the transition.<sup>[a],[b]</sup>

## Energy/Hydrogen Policy

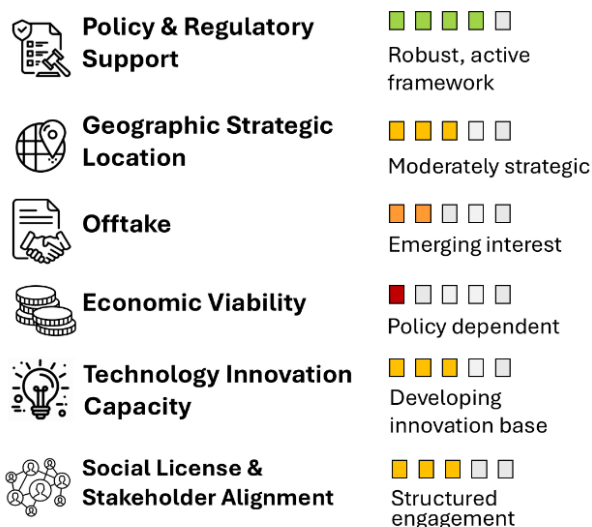
Colombia's hydrogen policies provide tax credits, VAT exemptions, and preferential customs treatment for hydrogen equipment.<sup>[b],[c],[d]</sup>

Government incentives designed to accelerate early project development and infrastructure buildout. A hydrogen certification framework is being developed in partnership with Germany's PtX Hub to align with international carbon-intensity and sustainability standards.

Policy efforts prioritize establishing hydrogen export corridors to the EU and Asia, reinforced by MoUs with Germany, Chile, and Japan to enable future trade and technology cooperation.<sup>[e]</sup>



## Readiness Score



## Trade Posture

Colombia is exploring future hydrogen export routes through its Caribbean port infrastructure.<sup>[f]</sup> The country benefits from exceptional renewable potential – particularly wind and solar resources in La Guajira – and has established international cooperation frameworks on hydrogen with partners including Germany and the European Union.<sup>[b],[e]</sup>

## Notable Projects

Name	Key Players	Tech./Product	Location
Ecopetrol	Ecopetrol, Repsol	Green and blue hydrogen pilots for industrial fuels and export	National
Guajira I	Enel, Ecopetrol	Green hydrogen for ammonia/fertilizer	La Guajira
Barranquilla Cluster	ANDI, IDB, Ecopetrol	Port-integrated hydrogen export hub	Barranquilla
Cartagena H <sub>2</sub> Terminal	Promigas, Port Authorities	Terminal for EU/Asia LH <sub>2</sub> exports	Cartagena

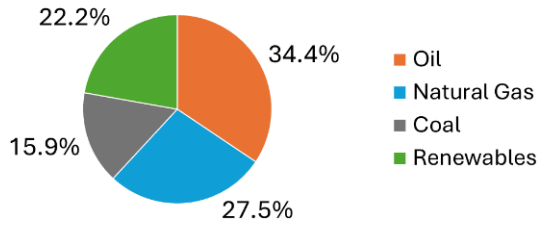


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# Germany



## Energy Mix



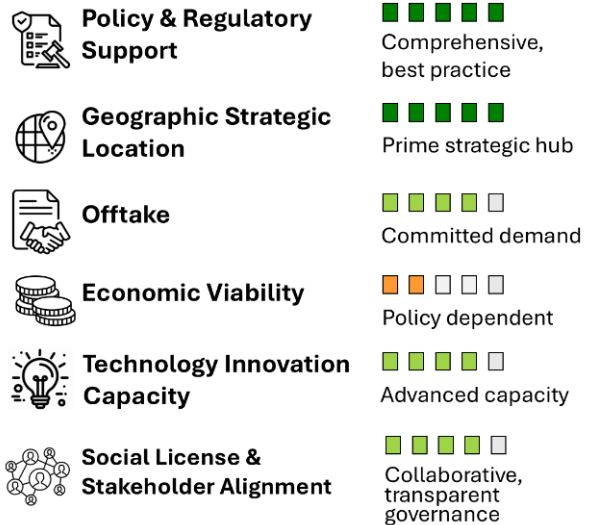
Germany plans to expand renewable electricity generation to supply approximately 80% of its power demand by 2030 as part of its broader strategy to achieve climate neutrality by mid-century. The country has also established one of the world's most ambitious hydrogen strategies, targeting large-scale domestic deployment alongside substantial hydrogen imports to support industrial decarbonization.<sup>[a],[b]</sup>

## Energy/Hydrogen Policy

Germany expects its hydrogen demand to reach 360–500 TWh by 2045. Its National Hydrogen Strategy, updated in 2023, commits €9 billion (€7 billion domestic, €2 billion for international partnerships) to accelerate the production and infrastructure of green hydrogen.<sup>[c]</sup>

Public funding and incentives prioritize low emission hydrogen, aligning with EU frameworks such as CBAM and RFNBO to ensure low-carbon integrity.<sup>[d],[e]</sup> The 2024 Hydrogen Import Strategy outlines certification systems, supply chain development, and port and pipeline infrastructure to secure reliable global imports.<sup>[f]</sup>

## Readiness Score



## Trade Posture

Hydrogen import routes are being advanced through pipeline corridors across the North Sea, Baltic, and Southern Europe/North Africa, as well as coastal import terminals and port-based conversion facilities.

Germany's central location in Europe and its extensive strengths its role as the main hydrogen gateway to the EU's industrial heartland.<sup>[f],[g]</sup>

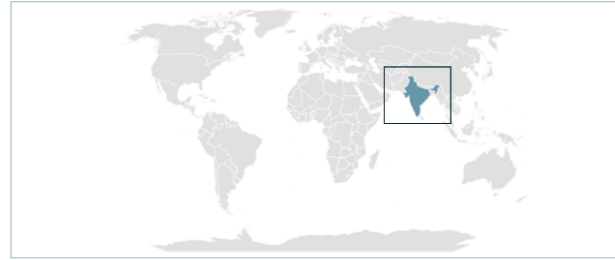
## Notable Projects

Name	Key Players	Tech./Product	Location
REFHYNE	Shell, ITM Power, EU FCH JU	PEM electrolysis	National
Salzgitter steel	Salzgitter AG, Uniper	Hydrogen-based DRI steel plant	Salzgitter
H2 Power Plants	RWE, Uniper, EnBW	New and converted gas plants	Nationwide
Thyssenkrupp Steel	Thyssenkrupp, Air Liquide, BMW	Green hydrogen-powered DRI steelworks	Duisburg

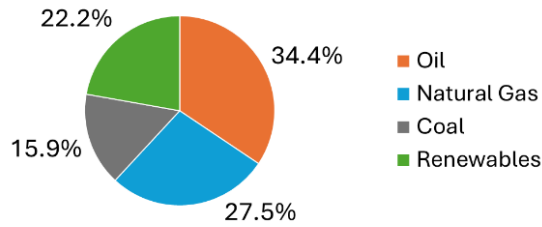


**References** [a] Federal Ministry for Economic Affairs and Climate Action (BMWK), Germany's Renewable Energy Sources Act (EEG 2023), Berlin, 2022. [b] International Energy Agency, Germany 2023 Energy Policy Review, Paris: IEA, 2023. [c] Federal Ministry for Economic Affairs and Climate Action (BMWK), National Hydrogen Strategy – Update 2023, Berlin, 2023. [d] European Commission, Carbon Border Adjustment Mechanism (CBAM), Brussels, 2023. [e] European Commission, Renewable Fuels of Non-Biological Origin (RFNBO) Delegated Regulation, Brussels, 2023. [f] Federal Ministry for Economic Affairs and Climate Action (BMWK), Hydrogen Import Strategy, Berlin, 2024. [g] European Hydrogen Backbone Initiative, European Hydrogen Backbone: A European Hydrogen Infrastructure Vision Covering 28 Countries, 2022.

# India



## Energy Mix



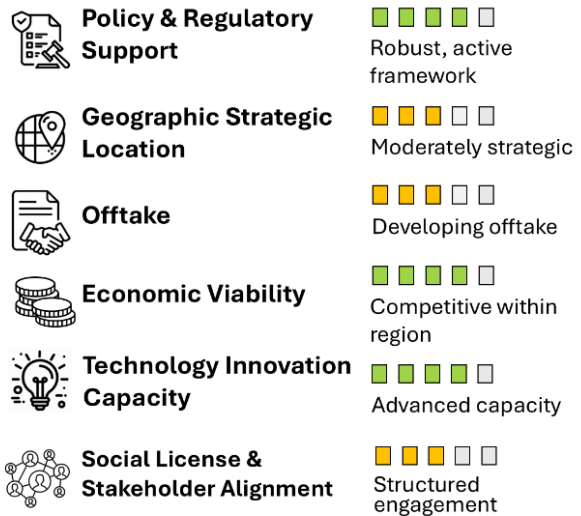
India has committed to achieving net-zero emissions by 2070, supported by interim targets to install 500 GW of non-fossil electricity capacity by 2030 and reduce emissions intensity by 45% relative to 2005 levels. These targets reflect a broader strategy to expand renewable generation while sustaining economic growth and improving energy security.<sup>[a],[b],[c]</sup>

## Energy/Hydrogen Policy

India's National Green Hydrogen Mission allocates roughly \$2.4 billion in incentives and subsidies to accelerate domestic electrolyzer manufacturing and large-scale green hydrogen production.<sup>[d],[e]</sup>

The Ministry of New and Renewable Energy (MNRE), working with the Bureau of Indian Standards, is developing national certification and standards frameworks for green hydrogen aligned with emerging international benchmarks. Export development is also a strategic priority, with cooperation agreements signed with partners including the EU and Japan and major ports such as Kandla and Visakhapatnam being positioned as future hydrogen export hubs.<sup>[f],[g]</sup>

## Readiness Score



## Trade Posture

Future hydrogen export routes are being developed through major east and west coast ports, supported by emerging pipeline and industrial corridor infrastructure linking production regions to export terminals. India's long coastline, strong solar resource potential, and strategic location along major maritime trade routes underpin its ambition to become a key hydrogen exporter.<sup>[d],[f]</sup>

## Notable Projects

Name	Key Players	Tech./Product	Location
Greenko Ammonia	Greenko, Keppel	Ammonia for export to Singapore and Japan	Kakinada, Andhra Pradesh
ACME H2 Hub	ACME, Tata Steel	Hydrogen for steel applications	Odisha & Tamil
NTPC H2 Mobility	NTPC, Indian Railways	Hydrogen buses and trains	Ladakh, Gujarat
Reliance Plan	Reliance Industries	Multi-GW green hydrogen ecosystem	Gujarat

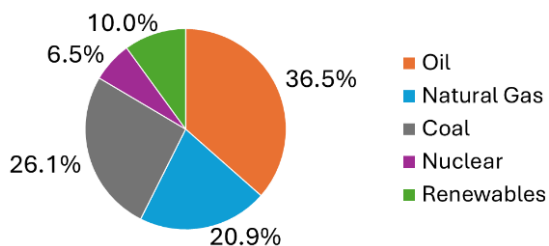


**References** [a] Government of India, "India's Long-Term Low-Emission Development Strategy," UNFCCC, 2022. [b] International Energy Agency, India Energy Outlook 2023, Paris: IEA, 2023. [c] Government of India, Ministry of Power, "India's Updated Nationally Determined Contribution (NDC)," UNFCCC Submission, 2022. [d] Government of India, Ministry of New and Renewable Energy, "National Green Hydrogen Mission," New Delhi, 2024. [e] Government of India, Ministry of New and Renewable Energy, Schemes & Guidelines for Implementation of the National Green Hydrogen Mission, 2023. [f] International Energy Agency, Global Hydrogen Review 2024, Paris: IEA, 2024. [g] International Renewable Energy Agency, Global Hydrogen Trade Outlook, Abu Dhabi: IRENA, 2022.

# Japan



## Energy Mix



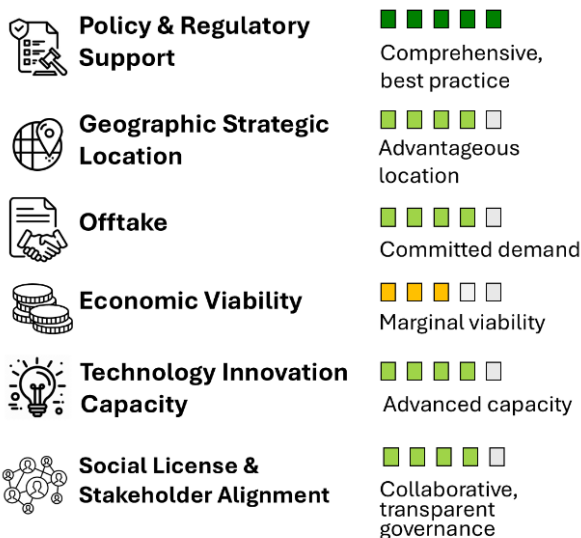
Japan has committed to achieving net-zero greenhouse gas emissions by 2050 and reducing emissions by 46% by 2030 relative to 2013 levels. These targets are supported by expanded renewable energy deployment, continued use of nuclear generation, and the integration of hydrogen and other low-carbon fuels into the national energy system.<sup>[a],[b],[c]</sup>

## Energy/Hydrogen Policy

Japan has committed more than \$25 billion through its Green Innovation Fund (2021) to support the development of hydrogen production, transport, and end-use infrastructure as part of its National Hydrogen Strategy and broader industrial decarbonization and energy security agenda.<sup>[d],[e]</sup>

While Japan does not yet impose binding carbon-intensity thresholds for hydrogen, the government is developing certification and accounting frameworks aligned with emerging international standards to facilitate compatibility with key trading partners such as the European Union, Australia, and future global hydrogen markets.<sup>[f],[g]</sup>

## Readiness Score



## Trade Posture

Japan's geography, advanced port infrastructure, and long-standing energy trade relationships position it as a central H<sub>2</sub> import and distribution hub in the Asia-Pacific region. Active supply corridors are being developed with Australia for liquefied H<sub>2</sub> and with the UAE for ammonia, as well as broader cooperation agreements with partners including Saudi Arabia, Norway, and the EU.<sup>[e],[f],[g],[h]</sup>

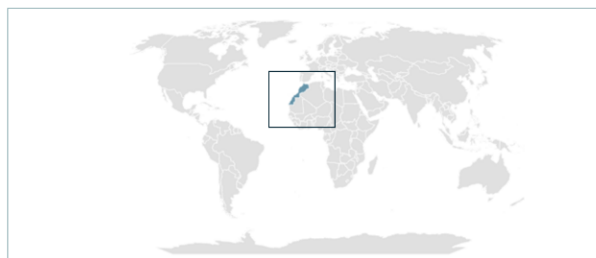
## Notable Projects

Name	Key Players	Tech./Product	Location
Kawasaki Hydrogen Road	Kawasaki Heavy Industries, J-Power	Liquid Hydrogen supply chain; first hydrogen tanker + import terminal	Kobe-Osaka
FH2R	NEDO, Toshiba, Tohoku	10 MW solar PV electrolysis	Fukushima
Yokohama Smart City	Tokyo Gas, ENEROS, H2 Mobility Japan	Mobility and urban hydrogen ecosystem	Yokohama

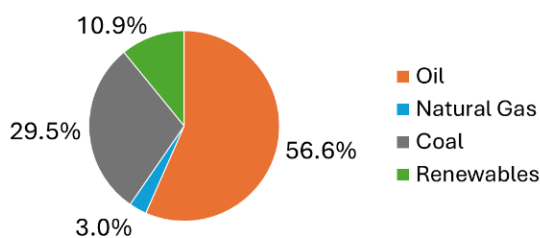


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# Morocco

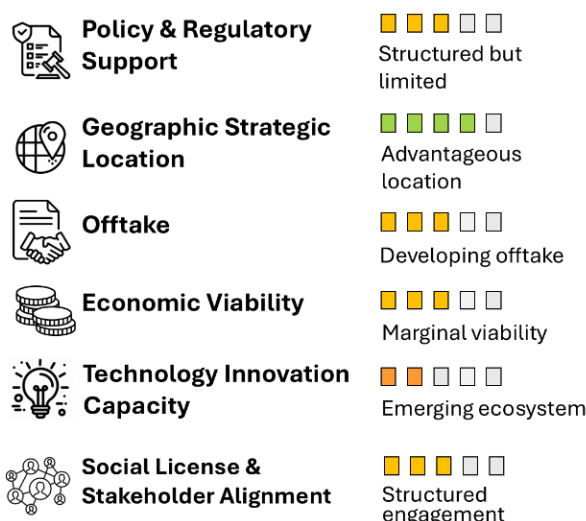


## Energy Mix



Morocco aims to achieve 52% renewable electricity capacity by 2030, building on large-scale solar and wind development across the country. At the same time, the government views natural gas as a transitional fuel to support grid reliability and industrial growth, with plans to develop LNG import infrastructure and expand gas pipeline connectivity. These efforts aim to balance renewable expansion with energy security while enabling the integration of emerging low-carbon fuels such as green hydrogen.<sup>[a],[b],[c],[d]</sup>

## Readiness Score



## Energy/Hydrogen Policy

Morocco's "Offre Maroc" framework provides land access guarantees, tax exemptions, customs relief, and streamlined permitting to accelerate green H<sub>2</sub> projects. Renewable energy legislation supports investment in generation and infrastructure needed to scale H<sub>2</sub> production. While Morocco does not impose carbon-intensity mandates, projects are aligning with EU RFNBO and CBAM requirements to maintain access to European markets. Hydrogen exports are a priority, supported by plans for port terminals and potential European pipeline connections.<sup>[e],[f],[g],[h]</sup>

## Trade Posture

Hydrogen export routes are explored through the Maghreb–Europe corridor, alongside new electricity and HVDC interconnections that could support future H<sub>2</sub> and power trade with Europe. Morocco's proximity to European markets, exceptional solar and wind resources, and partnerships with Germany and the EU position it as a promising participant in emerging H<sub>2</sub> corridors.<sup>[b],[c],[h]</sup>

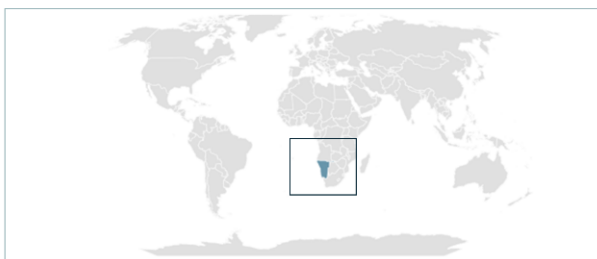
## Notable Projects

Name	Key Players	Tech./Product	Location
Six-project green hydrogen program	ORNX, Taqa–Cepsa, Nareva, ACWA, UEG/CTG	6 integrated H <sub>2</sub> /ammonia/fuels/steel projects for export	Southern Morocco
Guelmim-Oued Noun	TotalEnergies, Eren, CIP, A.P. Møller	Green hydrogen for export to Europe	Guelmim-Oued Noun
OCP – Engie renewable & H <sub>2</sub> cluster	OCP, Engie	Port-integrated hydrogen export hub	National

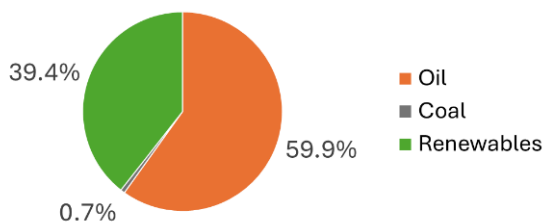


**References** [a] Kingdom of Morocco, Ministry of Energy Transition and Sustainable Development, Morocco Energy Strategy, Rabat, Morocco, 2022. [b] International Energy Agency, Morocco 2023 Energy Policy Review, Paris: IEA, 2023. [c] International Renewable Energy Agency, Renewable Energy Market Analysis: North Africa, Abu Dhabi: IRENA, 2020. [d] Oxford Institute for Energy Studies, The Global Outlook for Gas Demand in a \$6 World, 2025. [e] Kingdom of Morocco, Ministry of Energy Transition and Sustainable Development, "Morocco's Green Hydrogen Offer - 'Offre Maroc'," Rabat, 2023. [f] International Energy Agency, Morocco 2023 Energy Policy Review, Paris: IEA, 2023. [g] International Renewable Energy Agency, Global Hydrogen Trade Outlook, Abu Dhabi: IRENA, 2022. [h] World Bank, Morocco Green Hydrogen Development Outlook, Washington, DC, 2023.

# Namibia

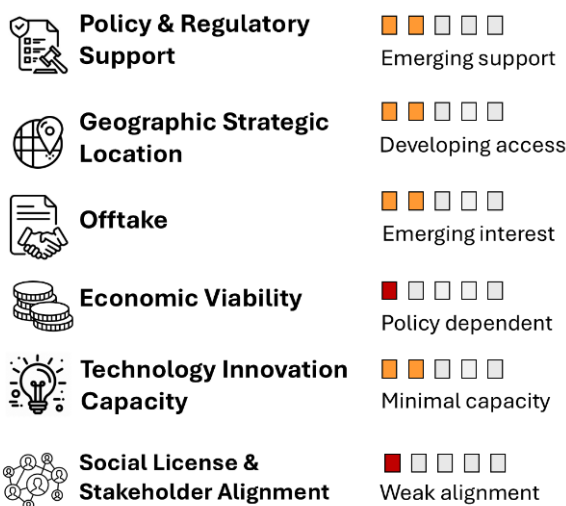


## Energy Mix



Namibia aims to increase the renewable share of its energy mix to 70% by 2030, expanding solar and wind capacity while reducing reliance on electricity imports from neighboring countries. The country is also positioning itself as a major future producer of green hydrogen and hydrogen derivatives, leveraging abundant renewable resources and large-scale project developments to support both domestic use and export markets in Europe and Asia.<sup>[a],[b],[c],[d]</sup>

## Readiness Score



## Energy/Hydrogen Policy

Namibia's National Green Hydrogen Strategy establishes fiscal incentives and investment mechanisms to attract international capital for large-scale green hydrogen projects. While formal carbon-intensity regulations have not yet been adopted, the government has signaled interest in future carbon pricing or certification frameworks aligned with emerging international standards. Hydrogen exports remain the central objective of Namibia's strategy, supported by government engagement in international partnerships aimed at developing infrastructure and securing long-term offtake agreements.<sup>[a],[b],[c],[d]</sup>

## Trade Posture

Future hydrogen export routes are expected to utilize Atlantic ports such as Lüderitz and Walvis Bay, positioning Namibia to supply emerging hydrogen markets in Europe and Asia. The country's hydrogen sector is therefore strongly dependent on foreign investment and international partnerships to finance large-scale infrastructure and project development.<sup>[a],[b],[e],[f]</sup>

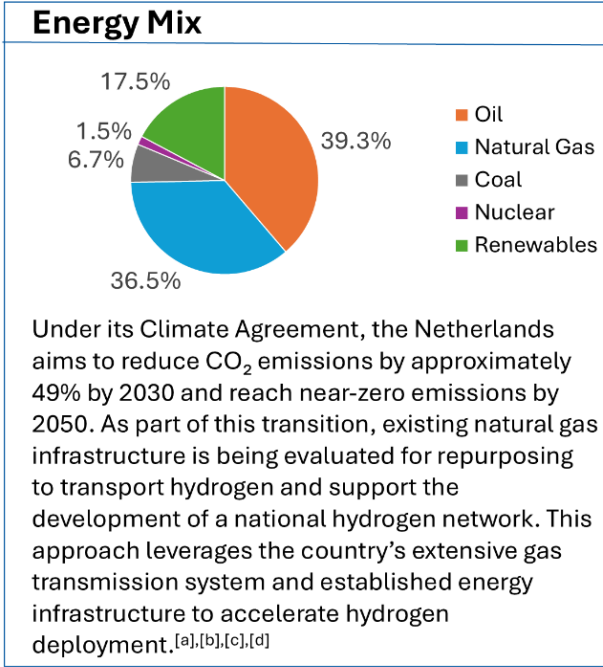
## Notable Projects

Name	Key Players	Tech./Product	Location
Kudu Green H2	Kudu Hydrogen, EU investors	Export-focused ammonia production from green hydrogen	Lüderitz
Walvis Bay H2 Hub	Namibian Ports Authority, private investors	Green hydrogen export infrastructure	Walvis Bay
Mobility H2 Pilots	Namibian Government, local partners	Small-scale hydrogen refueling stations	Windhoek
Project Oshivela	Hylron, German-Namibian consortium	Direct reduced iron from green hydrogen	Arandis, Erongo Region



**References** <sup>[a]</sup> Government of Namibia, Ministry of Mines and Energy, Namibia Green Hydrogen Strategy, Windhoek, 2022. <sup>[b]</sup> International Energy Agency, Global Hydrogen Review 2024, Paris: IEA, 2024. <sup>[c]</sup> International Renewable Energy Agency, Global Hydrogen Trade Outlook, Abu Dhabi: IRENA, 2022. <sup>[d]</sup> World Bank, Namibia Green Hydrogen Program: Project Overview, Washington, DC, 2023. <sup>[e]</sup> Hyphen Hydrogen Energy, Tsau //Khaeb Green Hydrogen Project Overview, 2023. <sup>[f]</sup> "European Union and Port of Rotterdam support Namport in expansion of Lüderitz Port." European Union – Delegation of the European Union to Namibia, 2025

# Netherlands



### Readiness Score

- Policy & Regulatory Support**: 3/5 (Structured but limited)
- Geographic Strategic Location**: 4/5 (Advantageous location)
- Offtake**: 3/5 (Developing offtake)
- Economic Viability**: 3/5 (Marginal viability)
- Technology Innovation Capacity**: 4/5 (Advanced capacity)
- Social License & Stakeholder Alignment**: 3/5 (Structured engagement)

### Energy/Hydrogen Policy

The Netherlands supports hydrogen deployment through funding programs including the SDE++ scheme, DEI+ innovation program, and the National Growth Fund, which finance low-carbon energy projects. Subsidies for hydrogen production and infrastructure are estimated at roughly €1.43 billion per GW of deployed capacity. Policy efforts focus on aligning certification with EU Guarantees of Origin and low-carbon standards while integrating hydrogen infrastructure with the Port of Rotterdam and emerging European hydrogen corridors.<sup>[e],[f],[g],[h]</sup>

### Trade Posture

Future hydrogen import and export routes are expected to center on the Port of Rotterdam, Europe's largest energy and industrial hub. The port's extensive infrastructure, integrated pipeline networks, and active participation in EU hydrogen initiatives and bilateral partnerships provide strong logistical and geographic advantages for large-scale hydrogen trade.<sup>[d],[g],[h]</sup>

### Notable Projects

Name	Key Players	Tech./Product	Location
NorthH2	Equinor, Gasunie, Groningen	Green hydrogen for industry/export	Northern Netherlands
Holland H2 1	Shell	CO <sub>2</sub> -neutral industrial feedstock	Maasvlakte, Rotterdam
HyWay27 & Hydrogen Backbone	Gasunie, Dutch Government	National hydrogen transport network	National

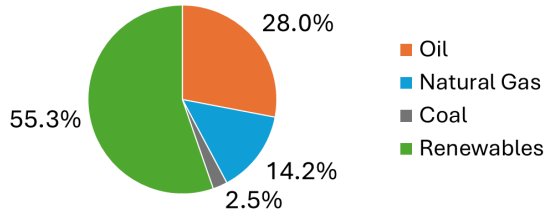
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[a] Government of the Netherlands, "Climate Agreement (Klimaatakkoord)," The Hague, 2019. [b] Gasunie, "Hydrogen Network Netherlands" (HyNetwork Services and National Hydrogen Infrastructure Plan), Groningen, 2023. [c] International Energy Agency, Netherlands 2020 Energy Policy Review, Paris: IEA, 2020. [d] European Hydrogen Backbone Initiative, European Hydrogen Backbone: A European Hydrogen Infrastructure Vision Covering 28 Countries, 2023. [e] Government of the Netherlands, "Stimulation of Sustainable Energy Production and Climate Transition (SDE++)," The Hague, 2023. [f] European Commission, "Renewable Fuels of Non-Biological Origin (RFNBO) Delegated Regulation," Brussels, 2023. [g] International Energy Agency, Global Hydrogen Review 2024, Paris: IEA, 2024. [h] Port of Rotterdam Authority, "Hydrogen Vision and Import Strategy for Rotterdam," Rotterdam, 2022.

# Norway



## Energy Mix



Norway already operates one of the world’s most decarbonized electricity systems, with the majority of power generation supplied by hydropower. The country plans to further expand renewable generation through additional hydropower optimization, growing wind capacity, and increased electrification of industry and transport. These efforts are intended to strengthen Norway’s low-carbon energy system while supporting emerging clean energy sectors, including hydrogen production and export.<sup>[a],[b],[c]</sup>

## Energy/Hydrogen Policy

Norway’s National Hydrogen Strategy outlines public support, demonstration funding, and cross-sector coordination, focusing on industrial applications and maritime decarbonization. Policy efforts emphasize commercial pilot projects and leveraging the existing industrial and maritime sectors rather than subsidizing large export-scale projects without clear demand signals. Norway is also aligning with EU and international frameworks on certification, carbon accounting, and guarantees of origin to ensure compatibility with emerging European hydrogen markets.<sup>[d],[e],[f]</sup>

## Readiness Score



## Trade Posture

Future hydrogen export pathways are expected to focus on ammonia shipping to European markets. Norway’s proximity to continental Europe and established energy expertise provide strategic advantages for hydrogen trade. Partnerships and memoranda of understanding with German and other European utilities are advancing early offtake discussions.<sup>[d],[e],[g],[h]</sup>

## Notable Projects

Name	Key Players	Tech./Product	Location
Skipavika / SkiGa	Fuella / developers, utility partners	Ammonia offtake for German/European buyers	Western Norway
Dockside H <sub>2</sub> hubs	HydePoint, Norwegian Hydrogen, Fuella	Modular electrolysis for maritime refueling, local industry	Multiple coastal sites
Equinor H <sub>2</sub> & CCUS	Equinor, partners	Industrial offtake + storage-linked blue hydrogen production	Barranquilla

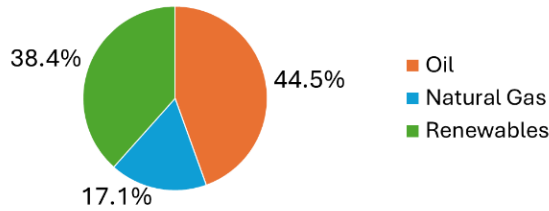


**References** <sup>[a]</sup> International Energy Agency, Norway 2022 Energy Policy Review, Paris: IEA, 2022. <sup>[b]</sup> International Renewable Energy Agency, Renewable Capacity Statistics 2024, Abu Dhabi: IRENA, 2024. <sup>[c]</sup> Norwegian Ministry of Energy, “Energy21,” Oslo, 2023. <sup>[d]</sup> Norwegian Ministry of Petroleum and Energy, Hydrogen Roadmap for Norway, Oslo, 2021. <sup>[e]</sup> International Energy Agency, Global Hydrogen Review 2024, Paris: IEA, 2024. <sup>[f]</sup> European Commission, Renewable Fuels of Non-Biological Origin (RFNBO) Delegated Regulation, Brussels, 2023. <sup>[g]</sup> International Renewable Energy Agency, Global Hydrogen Trade Outlook, Abu Dhabi: IRENA, 2022. <sup>[h]</sup> RWE and Equinor, “Germany and Norway to Build Hydrogen Pipeline,” 2023.

# Portugal

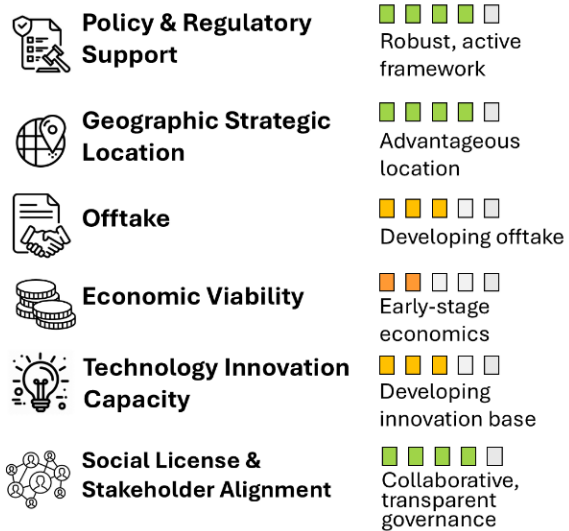


## Energy Mix



Portugal aims to achieve carbon neutrality by 2050 while rapidly expanding renewable energy generation across its power sector. National energy plans target roughly 80% renewable electricity generation by 2030, driven primarily by growth in wind and solar capacity. These efforts build on Portugal’s already high renewable share and are intended to reduce emissions, strengthen energy independence, and support the development of emerging low-carbon industries such as green hydrogen.<sup>[a],[b],[c]</sup>

## Readiness Score



## Energy/Hydrogen Policy

Portugal’s National Hydrogen Strategy positions green H<sub>2</sub> as a key instrument for decarbonization and export-oriented industrial development. Significant public support is being mobilized through EU Recovery and Resilience funds and national allocations, including a €70 million package for H<sub>2</sub> and renewable-gas projects, with R&D and permitting measures to accelerate deployment. Government incentives focus on green H<sub>2</sub> pathways, coordinated with EU certification and RFNBO frameworks to ensure compatibility with European market standards.<sup>[d],[e],[f]</sup>

## Trade Posture

Portugal’s trade strategy emphasizes strengthening EU energy partnerships and maritime export corridors, with the Port of Sines positioned as a hub for H<sub>2</sub> carriers destined for European and global markets. The country’s Atlantic port infrastructure, combined with strong offshore and onshore wind and solar resources, provides strategic advantages for future hydrogen production and export.<sup>[d],[g],[h]</sup>

## Notable Projects

Name	Key Players	Tech./Product	Location
H2 Sines Project	EDP, Galp, Toyota	Large-scale green hydrogen via offshore wind for export	Sines
GreenH2Atlantic	EDP, Engie, Galp, Bondati, Martifer and others	~100 MW electrolyser to produce hydrogen from newly-built renewables	Sines
CelZa	REN Gasodutos, Engas, GRT gas	Pipeline to transport 100 % hydrogen across the Iberian Peninsula	National

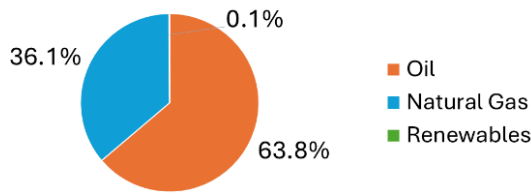


**References** [a] Government of Portugal, Ministry of Environment and Climate Action, National Energy and Climate Plan (PNEC) 2030, Lisbon, 2020. [b] European Commission, “Assessment of the Final Updated National Energy and Climate Plan of Portugal,” Brussels, 2025. [c] International Energy Agency, Portugal 2021 Energy Policy Review, Paris: IEA, 2021. [d] Government of Portugal, National Hydrogen Strategy (EN-H2), Lisbon, 2020. [e] European Commission, “Renewable Fuels of Non-Biological Origin (RFNBO) Delegated Regulation,” Brussels, 2023. [f] International Energy Agency, Global Hydrogen Review 2024, Paris: IEA, 2024 [g] European Commission, “REPowerEU Plan: Joint European Action for More Affordable, Secure and Sustainable Energy,” Brussels, 2022. [h] GreenH2Atlantic, “About the Project,” European Project N. 101036908. 2022.

# Saudi Arabia



## Energy Mix

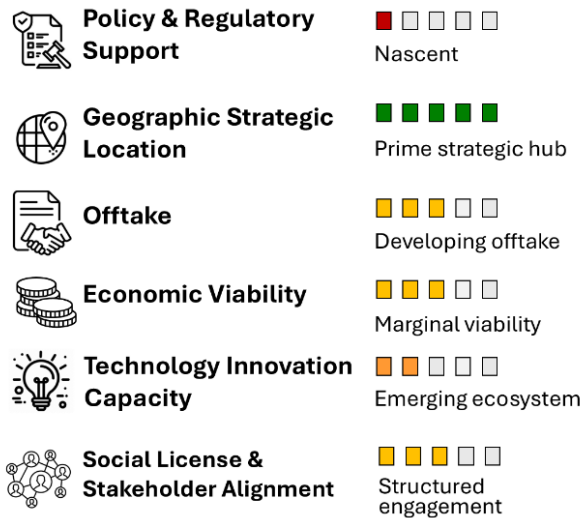


Under the Saudi Green Initiative (SGI), Saudi Arabia aims to generate 50% of its electricity from renewable sources by 2030 while reducing emissions by approximately 278 million tonnes of CO<sub>2</sub> annually. The initiative forms a central component of the country's broader strategy to diversify its energy mix and support long-term decarbonization.<sup>[a],[b]</sup>

## Energy/Hydrogen Policy

Saudi Arabia does not rely on formal tax credits or subsidy programs; instead, large-scale public financing is provided through the Public Investment Fund (PIF) and direct state-backed project investments. The country also does not currently implement domestic carbon pricing, though hydrogen projects are being structured to comply with international market requirements such as EU RFNBO and CBAM-aligned thresholds. Hydrogen development is a central pillar of Vision 2030, with explicit government support aimed at positioning Saudi Arabia as a leading global hydrogen exporter. Major projects, including large-scale ammonia production facilities, are being developed to supply international markets.<sup>[a],[b],[c],[d]</sup>

## Readiness Score



## Trade Posture

Saudi Arabia is developing hydrogen export routes linking Jubail and other Gulf ports with markets in Japan and South Korea, with additional capacity planned through Red Sea terminals. Proximity to key Asian and European markets, combined with deepwater port infrastructure, established energy corridors, and international MOUs, supports the country's ambitions for large-scale trade.<sup>[b],[d],[g],[h]</sup>

## Notable Projects

Name	Key Players	Tech./Product	Location
NEOM Green H2	Air Products, ACWA, Power NEOM	Green hydrogen for hydrogen/ammonia export	NEOM
Aramco/SABIC pilot	Aramco, SABIC, IEEJ, JERA	Blue hydrogen for export	Jubail
Ma'aden Ammonia 3	Ma'aden	Blue hydrogen with CCS for industrial and ammonia export	Ras Al-Khair

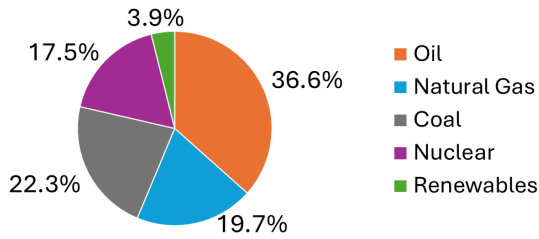


**References** [a] "Saudi & Middle East Green Initiatives" (Saudi Arabia's Climate Commitments and Energy Transition Goals) Riyadh, 2021. [b] International Energy Agency, Global Hydrogen Review 2024, Paris: IEA, 2024. [c] Kingdom of Saudi Arabia, "Vision 2030," Riyadh, 2016. [d] ACWA Power, "NEOM Green Hydrogen Project," Riyadh, 2023. [e] European Commission, Renewable Fuels of Non-Biological Origin (RFNBO) Delegated Regulation, Brussels, 2023. [f] European Commission, "Renewable Fuels of Non-Biological Origin (RFNBO) Delegated Regulation," Brussels, 2023. [g] International Energy Agency, Global Hydrogen Review 2024, Paris: IEA, 2024. [h] International Renewable Energy Agency, Global Hydrogen Trade Outlook, Abu Dhabi: IRENA, 2022.

# South Korea



## Energy Mix

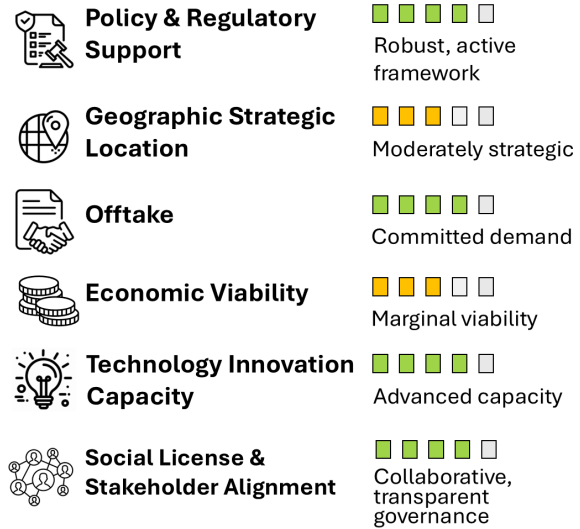


South Korea is expanding renewable energy as part of its long-term decarbonization strategy, targeting roughly 20% renewable electricity generation by 2030. This expansion is expected to be complemented by nuclear power, projected to account for around 30% of generation, alongside growing use of hydrogen and other low-carbon fuels across industry and power sectors. These efforts are intended to strengthen energy security while supporting the country’s broader transition toward a low-carbon energy system.<sup>[a],[b],[c]</sup>

## Energy/Hydrogen Policy

South Korea’s Hydrogen Economy Promotion and Hydrogen Safety Management Act establishes a national legal framework to support H<sub>2</sub> industry development while ensuring robust safety standards. Government incentives include subsidies for H<sub>2</sub> production facilities, fuel cell vehicle deployment, and related infrastructure development. Carbon emissions are regulated through the Korea Emissions Trading Scheme (K-ETS), while the government is also pursuing international partnerships and bilateral agreements to develop global hydrogen supply chains..<sup>[b],[c],[d],[e]</sup>

## Readiness Score



## Trade Posture

Hydrogen and ammonia shipping routes are being developed to support South Korea’s emerging import supply chains. The country’s advanced port infrastructure and strategic geographic location position it as a regional hub for H<sub>2</sub> trade. Bilateral agreements and MOUs with Australia and several Middle Eastern countries are advancing supply partnerships and future import corridors..<sup>[b],[c],[f],[g]</sup>

## Notable Projects

Name	Key Players	Tech./Product	Location
HyNet	SK E&S, Hyundai	Blue H2 with CCS for industrial use and pilot export routes	Ulsan
Pohang H2 Cluster	POSCO, Korea Electric Power Corp	Green hydrogen for teal decarbonization & local energy supply	Pohang
LNG-H2 Hybrid Power Plant	Korea East-West Powe Co	Power generation with LNG and H2 blend	Dangjin

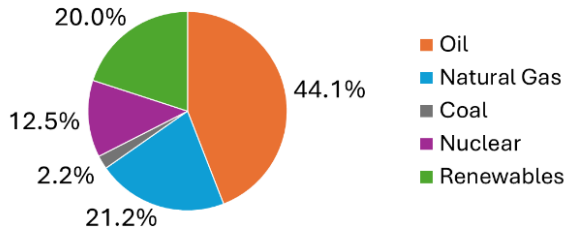


**References** [a] Government of the Republic of Korea, Ministry of Trade, Industry and Energy (MOTIE), “The 10th Basic Plan for Long-Term Electricity Supply and Demand,” Seoul, 2023. [b] International Energy Agency, Korea 2023 Energy Policy Review, Paris: IEA, 2023. [c] Government of the Republic of Korea, “Hydrogen Economy Roadmap of Korea,” Seoul, 2019. [d] Government of the Republic of Korea, “Hydrogen Economy Promotion and Hydrogen Safety Management Act,” Seoul, 2020. [e] International Carbon Action Partnership, “Korea Emissions Trading Scheme (K-ETS),” Berlin, 2023. [f] International Renewable Energy Agency, Global Hydrogen Trade Outlook, Abu Dhabi: IRENA, 2022. [g] Korea Energy Economics Institute, Korea Hydrogen Economy Development Strategy, Ulsan, 2023.

# Spain



## Energy Mix

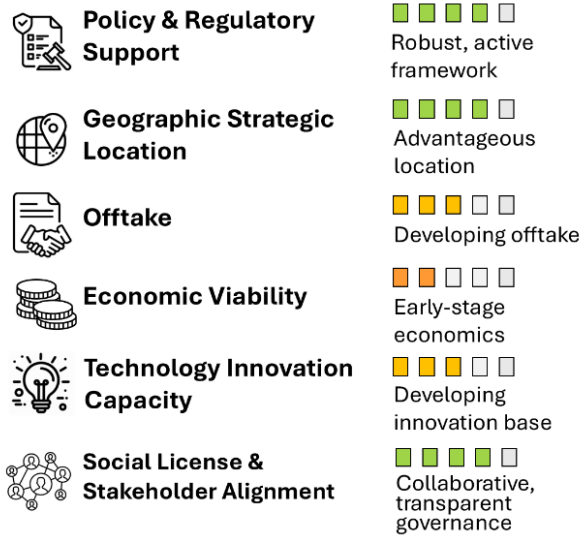


Spain aims to achieve carbon neutrality by 2050 while significantly expanding renewable energy across its power and industrial sectors. Under its national energy and climate plans, the country targets a 23% renewable share in final energy consumption by 2030, supported by rapid growth in solar and wind generation. These efforts form part of Spain’s broader strategy to reduce emissions, strengthen energy security, and support emerging low-carbon technologies such as hydrogen.<sup>[a],[b],[c]</sup>

## Energy/Hydrogen Policy

Spain supports hydrogen deployment through grants, industrial cluster funding, and subsidy mechanisms under national recovery programs and EU IPCEI frameworks, aimed at accelerating electrolyzer deployment and hydrogen value-chain development. Carbon pricing signals are provided through participation in the EU Emissions Trading System (EU ETS), alongside complementary national measures to support clean H<sub>2</sub> adoption. Spain’s H<sub>2</sub> strategy is also closely integrated with EU-wide market and infrastructure frameworks, which shape export and import pathways.<sup>[d],[e],[f],[h]</sup>

## Readiness Score



## Trade Posture

Spain is advancing bilateral and multilateral cooperation with partners including France and Morocco to support the development of regional hydrogen corridors. The country’s port infrastructure and geographic position between the Atlantic and Mediterranean basins provide strategic access to emerging hydrogen trade routes across Europe and North Africa.<sup>[d],[e],[g]</sup>

## Notable Projects

Name	Key Players	Tech./Product	Location
Puertollano Hydrogen Valley	Iberdrola, Enagás, Repsol	Electrolysis with offshore wind for export and mobility	Puertollano
Huelva Hydrogen Hub	Fertiberia, Cepsa	Green H <sub>2</sub> for ammonia/fertilizer export	Huelva
Valencia Hydrogen Valley	Iberdrola, Acciona, local govt	Electrolysis H <sub>2</sub> production for public transport, power generation pilots	Valencia

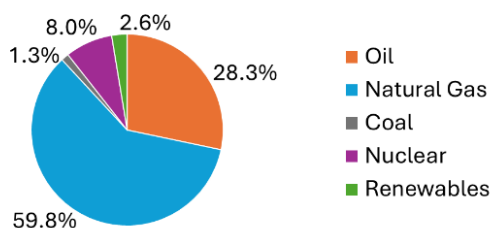


**References** [a] Government of Spain, Ministry for the Ecological Transition and the Demographic Challenge, Spain’s Integrated National Energy and Climate Plan (PNIEC) 2021–2030, Madrid, 2020. [b] European Commission, “NextGenerationEU: European Commission endorses Spain’s €69.5 billion recovery and resilience plan,” 2021. [c] International Energy Agency, Spain 2021 Energy Policy Review, Paris: IEA, 2021. [d] European Hydrogen Backbone Initiative, European Hydrogen Backbone: A European Hydrogen Infrastructure Vision Covering 28 Countries, 2023. [e] Government of Spain, Ministry for the Ecological Transition and the Demographic Challenge, “Hydrogen Roadmap: A Commitment to Renewable Hydrogen,” Madrid, 2020. [f] Insight EU Monitoring, “EU Commission sets out rules for renewable hydrogen,” Brussels, 2023. [g] International Energy Agency, Global Hydrogen Review 2024, Paris: IEA, 2024. [h] European Commission, “EU Emissions Trading System (EU ETS),” Brussels, 2023.

# UAE



## Energy Mix

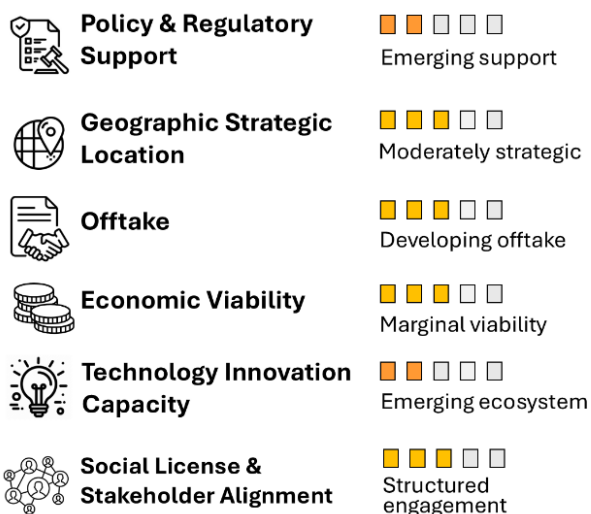


The United Arab Emirates is expanding solar and nuclear generation as part of its strategy to reduce the carbon intensity of its energy system. Under the UAE Energy Strategy 2050, the country is scaling large solar projects and integrating nuclear power from the Barakah Nuclear Energy Plant to increase the share of clean electricity in the power mix. These efforts support the UAE’s broader Net Zero by 2050 initiative, which aims to diversify the energy system while reducing long-term emissions.<sup>[a],[b],[c]</sup>

## Energy/Hydrogen Policy

The UAE’s National Hydrogen Strategy and emirate-level initiatives outline production ambitions and financing mechanisms, such as industrial investment platforms like TA’ZIZ, to support large-scale hydrogen development. However, detailed regulatory frameworks and market rules for hydrogen remain under development. Export plays a central role in the UAE’s strategy, and the government is actively engaging with international partners on certification systems and carbon accounting frameworks to align with emerging global low-carbon standards.<sup>[b],[d],[e],[f]</sup>

## Readiness Score



## Trade Posture

Future H<sub>2</sub> exports are expected to leverage the UAE’s established energy infrastructure, operating through major ports such as Ruwais, Fujairah, and Khalifa. The UAE has signed bilateral MOUs with partners including Japan, Germany, and other potential import markets, while its strategy prioritizes maritime shipping routes rather than hydrogen pipeline corridors.<sup>[b],[d],[f]</sup>

## Notable Projects

Name	Key Players	Tech./Product	Location
ADNOC Ruwais	ADNOC, TA’ZIZ, Tecnimont MAIRE	Large-scale low-carbon/blue ammonia target ~1 Mtpa	Ruwais, Abu Dhabi
Masdar green H <sub>2</sub> & green-steel pilots	Masdar, Emirates Steel, international partners	Electrolysis pilots; H <sub>2</sub> for steel & industrial uses	Abu Dhabi
Hydrogen oasis	UAE Government, Masdar, Mubadala, DOE	National R&D centers, cluster & hub planning	Abu Dhabi

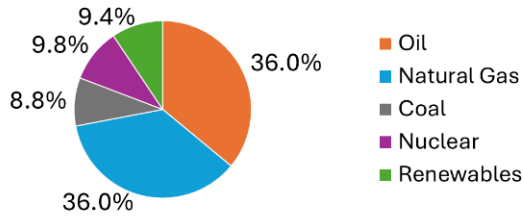


**References** [a] Government of the United Arab Emirates, “UAE Energy Strategy 2050,” Abu Dhabi, 2017. [b] International Energy Agency, Global Hydrogen Review 2024, Paris: IEA, 2024. [c] International Atomic Energy Agency, “UAE Combats Climate Change with Nuclear Power,” Vienna, 2023. [d] Government of the United Arab Emirates, “UAE Hydrogen Leadership Roadmap,” Abu Dhabi, 2021. [e] ADNOC, “ADNOC and TAQA Announce 27-Year Utilities Agreement with TA’ZIZ, Enabling World-Scale Chemicals Production at Ruwais,” Abu Dhabi, 2026. [f] International Renewable Energy Agency, Global Hydrogen Trade Outlook, Abu Dhabi: IRENA, 2022.

# USA



## Energy Mix



Recent policy signals from the current U.S. administration indicate a shift away from earlier federal net-zero climate targets, with increased emphasis on expanding domestic fossil fuel production and nuclear energy development as part of broader energy security and economic priorities.<sup>[a],[b],[c]</sup>

## Energy/Hydrogen Policy

The U.S. hydrogen policy framework was established under the Inflation Reduction Act (IRA), which created the Section 45V Clean Hydrogen Production Tax Credit, offering up to \$3/kg for low-carbon hydrogen, alongside related incentives under Sections 45X, 45Q, and 48C. Carbon-intensity thresholds under 45V effectively set lifecycle emissions benchmarks based on the Department of Energy’s Clean Hydrogen Production Standard and GREET-based lifecycle accounting methodologies. Recent policy signals under the Trump administration have introduced uncertainty regarding the implementation and long-term structure of federal hydrogen incentives, with ongoing reviews and updates to tax credit guidance and federal funding programs.<sup>[b],[d],[e],[f],[g]</sup>

## Readiness Score

<b>Policy &amp; Regulatory Support</b>	 Structured but limited
<b>Geographic Strategic Location</b>	 Moderately strategic
<b>Offtake</b>	 Developing pipeline
<b>Economic Viability</b>	 Marginal viability
<b>Technology Innovation Capacity</b>	 Developing innovation base
<b>Social License &amp; Stakeholder Alignment</b>	 Structured engagement

## Trade Posture

Hydrogen export routes are expected to develop through Gulf Coast and West Coast ports, where pilot projects for ammonia and liquid hydrogen shipping are currently being explored. Bilateral cooperation is advancing with partners including Japan, South Korea, and the European Union through technology partnerships and hydrogen supply-chain coordination.<sup>[c],[h]</sup>

## Notable Projects

Name	Key Players	Tech./Product	Location
Regional H2 Hubs	DOE, Industrial, Research, and State partners	Production, delivery infrastructure, end-uses in transportation/ industry	National
ACES Delta	Chevron, Mitsubishi, Magnum Development	Green hydrogen production and storage	Utah
Baytown Hydrogen & Ammonia Project	Exxon, ADNOC	Hydrogen + ammonia export	Texas

**References** [a] U.S. Energy Information Administration, Annual Energy Outlook 2024, Washington, DC: EIA, 2024. [b] The White House, Executive Orders: “Unleashing American Energy” Washington, DC, 2025. [c] International Energy Agency, Global Hydrogen Review 2024, Paris: IEA, 2024. [d] U.S. Department of Energy, U.S. National Clean Hydrogen Strategy and Roadmap, Washington, DC, 2023. [e] Credit for Production of Clean Hydrogen and Energy Credit, 26 CFR Part 1, Federal Register, vol. 90, no. 7, pp. 1935, Jan. 10, 2025. [f] U.S. Congress, “H.R. 1 - One Big Beautiful Bill Act,” 119th Cong., 1st sess., 2025. [g] Argonne National Laboratory, “Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies (GREET) Model,” Argonne, IL, 2025. [h] Dept. of Energy, “Energy Department Announces Termination of 223 Projects, Saving over \$7.5 Billion.” 2025. [i] International Renewable Energy Agency, Global Hydrogen Trade Outlook, Abu Dhabi: IRENA, 2022.

## Regional Comparison

Although hydrogen strategies share common high-level objectives – industrial decarbonization, energy diversification, and long-run competitiveness – the underlying logic of hydrogen development varies significantly across regions. These differences reflect structural characteristics including energy import dependence, renewable resource availability, industrial base composition, legacy infrastructure, and institutional capacity. The result is not a linear “race” toward hydrogen adoption, but a differentiated landscape in which countries pursue distinct roles in the shaping of future hydrogen trade: demand anchors, supply centers, technology developers, or transit and certification hubs.

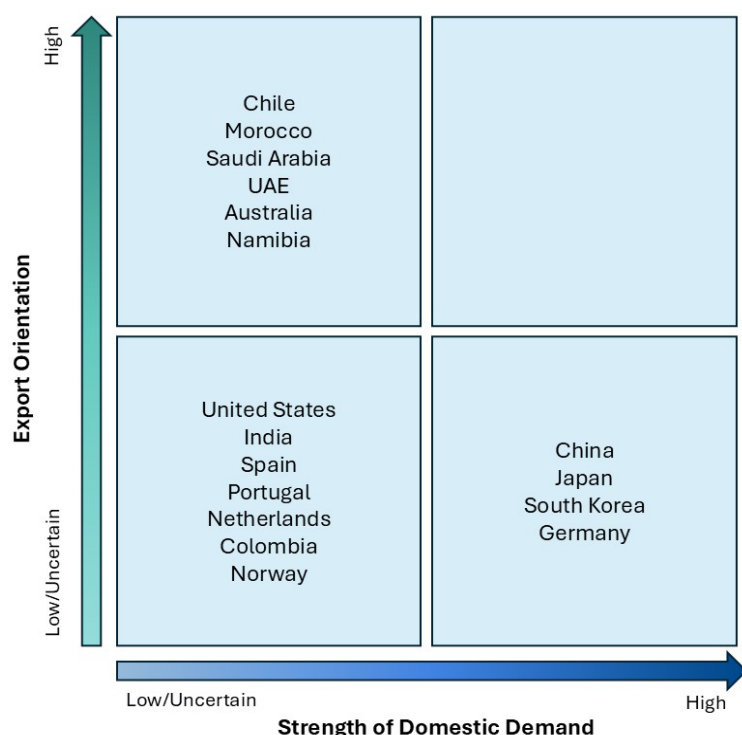


Figure 2. Matrix showing how national strategies of the seventeen countries in this analysis compare along both their domestic market formation and the degree to which they are planning to participate in a global hydrogen market.

While countries are often compared on the basis of technology costs or announced project pipelines, the more meaningful distinction lies in how each country is positioning itself within the emerging hydrogen economy. Rather than converging toward a single market model, national strategies are differentiating along two fundamental dimensions: the extent to which hydrogen is tied to domestic industrial decarbonization and internal market formation, and the degree to which each country is pursuing export-oriented production or participation in cross-border supply chains. The matrix in

Figure 2 maps the seventeen countries in this study according to these two drivers, illustrating the emergence of four distinct market orientations. These positions are not fixed; however, they reflect strategic directionality: the industrial identities countries are currently building, the infrastructure they are prioritizing, and the types of policy signals shaping project development today.

The countries positioned in the upper left quadrant - Chile, Morocco, Saudi Arabia, the United Arab Emirates, Namibia, and Australia - are primarily pursuing hydrogen as a resource-based export industry. These markets are characterized by high-quality

renewable or fossil-based feedstock resources, existing energy export infrastructure, and explicit government strategies to secure long-term offtake agreements with international buyers. Their success is shaped less by domestic industrial demand and more by their ability to convert project announcements into bankable supply chains. For most of these exporters, commercial viability depends on contracting certainty, port readiness, and compatibility with emerging certification systems in import markets. As a result, these countries are actively engaging in bilateral agreements, pilot shipments, and co-development of standards as a means to reduce pricing and policy uncertainty for early export volumes.

Conversely, the countries located in the bottom right quadrant – Japan, South Korea, and Germany – are shaping the emerging hydrogen market through procurement policy, industrial decarbonization programs, and strategic import planning. Their strategies derive from high fossil fuel import dependence, ambitious emissions targets, and limited domestic renewable resource availability. Rather than competing to produce low-cost hydrogen, these countries are leveraging state coordination, sectoral planning, and long-duration industrial contracting mechanisms to create predictable demand signals. In doing so, they serve as market stabilizers for global supply chains: their willingness to commit to structured demand formation is one of the strongest determinants of which export projects move toward final investment decision. This role gives them outsized influence in shaping certification norms, pricing structures, and international logistics models.

The group in the lower left quadrant – including the United States, India, Spain, Portugal, and to some extent the Netherlands – exhibit a more mixed hydrogen strategy. Their trajectories reflect simultaneous industrial decarbonization objectives and selective export ambitions, often tied to specific sectors such as refining, chemicals, shipping fuels, or steel. In these countries, hydrogen deployment is advancing most effectively where demand aggregation mechanisms exist or where regional industrial clusters provide a natural concentration of offtakers. However, these markets face ongoing uncertainties related to regulatory stability, hydrogen pricing frameworks, and the degree of public support required to enable cross-sector coordination. Their strategic flexibility could position them to benefit from multiple pathways, but it also means that timing and sequencing of infrastructure investment will be particularly important.

Finally, markets such as Colombia and potentially Namibia within certain sectors, are characterized by early-stage strategy development with limited internal demand visibility. These countries demonstrate growing political interest and early planning activity, but have yet to either secure reliable domestic offtake or stable external buyers. Their next steps depend heavily on access to concessional financing, investment de-risking instruments, and the development of clear value propositions within regional industrial systems.

Without these conditions, hydrogen development risks remaining aspirational rather than transformative.

Taken together, these market orientations reflect not only resource and infrastructure conditions, but also the institutional and coordination capacities that shape how countries signal commitment, share risk, and move from pilot activity to large-scale deployment. The distribution of roles across the global hydrogen landscape underscores a central insight of this report: **hydrogen market formation is not only determined by technology cost curves, but by policy certainty, contracting frameworks, certification alignment, workforce readiness, and the credibility of long-term demand.**

It is in this context that country-reported barriers become particularly important. The figure that follows draws on Iacob et al. (2025), analyzing how countries themselves characterize the challenges they face in hydrogen implementation, and where the core frictions in market formation are emerging globally [5]. Figure 2 reveals a consistent pattern across global hydrogen development. Countries do not struggle primarily with the conceptual role of hydrogen in decarbonization; rather, they face practical constraints in operationalizing deployment. The most frequently cited barriers – **infrastructure development, market formation, certification and standards alignment, and workforce development** – suggest that hydrogen readiness is constrained less by technology maturity than by **institutional capacity to coordinate systems-level change.**

Notably, the seventeen countries analyzed in this report mirror these global patterns, indicating that even advanced industrial economies face challenges in aligning long-duration capital planning, permitting frameworks, and market stabilization mechanisms. The distribution of barriers supports the conclusion that hydrogen deployment is fundamentally a coordination challenge, requiring sustained alignment across government agencies, regulators, industrial actors, financiers, and local communities.

## Europe

In Europe, hydrogen has emerged as a central pillar of both climate strategy and energy security planning. Germany, Spain, Portugal, Norway, and the Netherlands have articulated hydrogen's role in decarbonizing heavy industry, replacing natural gas in district heating networks<sup>[35]</sup>, and providing flexibility in a power system increasingly shaped by variable renewables<sup>[36], [37]</sup>. Policy frameworks are comparatively mature: the EU's Hydrogen Bank, the Carbon Border Adjustment Mechanism (CBAM), and updates to the Renewable Energy Directive provide clear regulatory architecture, including rules for certifying renewable hydrogen and mechanisms linking subsidies to emissions accounting<sup>[38]-[41]</sup>.

However, Europe's progress is shaped by cost-competitiveness constraints and infrastructure bottlenecks. Many European countries have limited land availability for new

renewable energy capacity, and transmission constraints have slowed growth in some regions<sup>[42], [43]</sup>. As a result, many European hydrogen strategies explicitly integrate import dependence<sup>[19], [20], [44]–[50]</sup>.

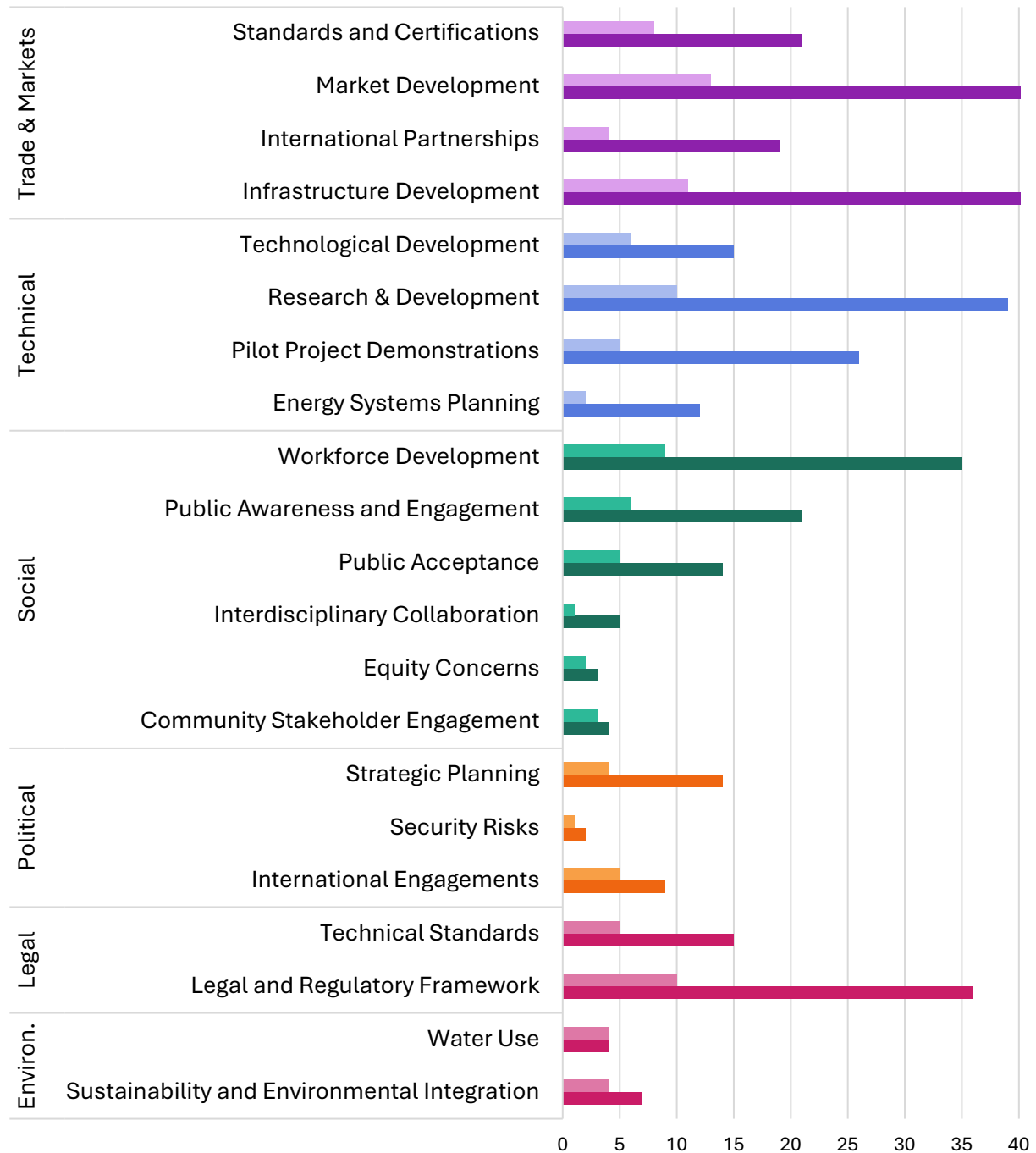


Figure 3. Count of distinct countries whose national roadmaps and/or reports on hydrogen market development identified challenges and barriers within each category. Figure and analysis generated by authors. The OHI sub-selection for this report is shown in the lighter bars across each category, as compared to the original analysis of the existing 56 national hydrogen roadmaps.

Iberia, with comparatively strong wind and solar resources, has positioned itself as a southern European hydrogen production hub, while Germany and the Netherlands have prioritized port-based import hubs, maritime ammonia receiving terminals, and the conversion of existing natural gas pipelines.

The European approach is therefore one of **planned market coordination**: policy clarity is high, demand signals are increasingly credible, and cross-border infrastructure planning is well underway. Yet delivery timetables remain sensitive to permitting timelines<sup>[43]</sup>, labor constraints<sup>[51]</sup>, and domestic political pressures around land use and industrial restructuring<sup>[43], [52]</sup>.

## Asia and Asia-Pacific

In the Asia and Asia-Pacific regions, the distinction between hydrogen-consuming economies and hydrogen-producing economies is especially clear. Japan and South Korea are the world's most advanced hydrogen demand strategists: both have articulated national procurement frameworks, supported early demonstration consortia, and invested in port infrastructure capable of receiving liquefied or ammonia-based hydrogen derivatives. Their import orientation is shaped by structural energy dependence: limited domestic renewable resource potential, high LNG exposure, and vulnerability to external supply shocks.

In contrast, Australia and India have positioned hydrogen as a lever for industrial development and export competitiveness. Australia's hydrogen hubs emphasize large-scale wind and solar capacity, while India's National Green Hydrogen Mission links hydrogen production to fertilizer reform, public procurement, and long-horizon export strategy. China, meanwhile, has prioritized domestic demonstration, manufacturing scale, and rapid deployment of electrolytic hydrogen rather than international market creation. China now has over 600 operating, planned, or under-construction electrolytic hydrogen projects and leads globally in electrolyzer production volumes and cost reduction, shaping regional and global price trajectories.<sup>[53], [54]</sup>

Recent policy developments further reinforce China's evolving position in the regional hydrogen landscape. The draft "Clean and Low-Carbon Hydrogen Evaluation Standard" proposes a renewable hydrogen threshold of  $\leq 2.0$  kg CO<sub>2</sub>e/kg H<sub>2</sub> - stricter than both U.S. and EU benchmarks - and signals movement toward a nationally recognized carbon-intensity framework.<sup>[55]</sup> The NDRC has also expanded central-budget support to cover up to 20% of eligible hydrogen-related project costs, indicating a growing willingness to centrally steer low-carbon hydrogen development.<sup>[56], [57]</sup> While China's strategy has historically been domestically focused, recent policy signals suggest a stronger central-government interest

in defining low-carbon hydrogen in ways that could eventually support limited export participation.

Across the region, a defining feature is the centrality of **state-led market formation**: early adoption depends on government-backed offtake guarantees, cost-shared demonstration funding, and strategic industrial policy rather than merchant market signals.

## The Americas

The Americas present a **resource-rich but structurally fragmented** hydrogen landscape. In the United States, high innovation capacity and strong tax-incentive signals from the Inflation Reduction Act[58] are tempered by mounting uncertainty around projects' long-term eligibility for the 45V production tax credit, ongoing rulemaking ambiguity, and the recent cancellation or restructuring of several federally funded hydrogen hubs[59], [60]. As a result, **both supply and demand formation remain unsettled**, with project developers facing unclear long-term revenue expectations and buyers struggling to assess price stability. California remains the most advanced domestic demand center, though transportation-focused markets are still early-stage and unevenly concentrated[61], [62]. At the same time, the U.S. Gulf Coast is emerging as the country's most strategically important hydrogen corridor - a region with abundant renewable and thermal resources, dense industrial clusters, and extensive export-ready port infrastructure[63]–[65]. Given the United States' dual strategic aim of serving domestic industrial decarbonization needs while pursuing overseas market opportunities, the Gulf Coast is uniquely positioned to anchor future large-scale hydrogen and derivative exports.

In contrast, Chile has emerged as a global cost-leading green hydrogen prospect, particularly in the Magallanes region, where exceptional wind profiles reduce levelized hydrogen production costs[66]. However, Chile's export orientation requires deep-water port expansion, transmission investments, and long-term bilateral purchase agreements – all of which remain under development. Colombia occupies an intermediate position: strong national interest and resource endowment, but commercial momentum remains limited by financing costs and domestic demand constraints[67].

## Middle East and North Africa (MENA)

Hydrogen strategies in Saudi Arabia, the UAE, Morocco, and Namibia are characterized by state-coordinated planning and an **export-first industrial policy**. Large-scale projects, including NEOM in Saudi Arabia, reflect vertically integrated development models that combine renewable generation, electrolyzer installation, ammonia conversion, and export terminal infrastructure[68]. These countries benefit from sovereign capital and experience with global energy trade, which reduce financing risk in early project phases.

However, challenges arise around water resource integration, domestic value creation, and the balance between foreign investment and national economic diversification goals. Namibia and Morocco exemplify emerging supply markets with strong resource potential but face constraints in national workforce readiness, currency stability, and regulatory standardization<sup>[23], [25]</sup>.

## Cross-Cutting Insights

While hydrogen strategies differ in emphasis, sequencing, and policy design, a consistent set of structural factors shapes market readiness across the seventeen countries assessed. These factors are not primarily technological; rather, they reflect the institutional and economic foundations required to enable new energy markets to form. The following insights synthesize lessons across regions and illustrate how countries are converging – sometimes intentionally, sometimes by necessity – on a shared set of enabling conditions.

### Hydrogen Progress Depends on Institutional Stability and Policy

#### Durability

Across nearly all countries assessed, **policy durability – rather than policy ambition – is the most significant determinant** of investor confidence. Even in markets with strong national strategies, such as Germany, Japan, Australia, and the United States, investors continue to reference concerns related to program longevity, eligibility clarity, and the reliability of multi-year funding commitments. This reflects the inherently long-duration investment profile of hydrogen infrastructure, where production, conversion, transport, and end-use assets must be financed on timelines of 15-25 years.

Countries with the most consistent momentum, such as Japan, South Korea, Germany, Spain, and the Netherlands, have paired strategy development with institutionalized mechanisms that insulate hydrogen planning from short-term electoral or budget cycles. These mechanisms include:

- Public procurement mandates and demand guarantees (Japan, Korea)
- Dedicated agencies to administer hydrogen regulation (Germany, EU bodies, Australia’s Renewable Energy Agency and Clean Energy Finance Corporation)
- Codified production standards and import certification frameworks (EU Renewable Fuels of Non-Biological Origin and Carbon Border Adjustment Mechanism)

In contrast, countries where hydrogen investment is subject to political turnover, federal–subnational misalignment, or financing volatility (United States, India, Colombia, Namibia) face extended project development cycles not because of weaker resource endowments or technical capacity, but because policy continuity remains uncertain.

This suggests that institutional maturity, rather than resource advantage, is emerging as the defining competitive differentiator in the first phase of global hydrogen market formation. Early policy-setters are not only shaping domestic markets; they are setting the global rules that future producers will have to follow.

## Offtake Design and Market Coordination Are the Gatekeepers to Bankability

Across all regions, the primary barrier to reaching FID is offtake certainty, reflecting the interdependence between demand formation and cost competitiveness: without price parity or credible support mechanisms, long-term procurement commitments remain limited. Hydrogen's commercial viability depends on the ability to secure long-term purchase agreements with end-use industries - steel, ammonia, refining, power generation, shipping fuels, and heavy transport - at predictable and stable pricing.

Countries differ sharply in how they attempt to bridge this bankability gap:

- Japan and South Korea are government-coordinating demand by pooling industrial buyers and co-financing early procurement.
- Germany and the Netherlands are advancing contracts-for-difference (CfD) mechanisms to close cost gaps between low-carbon hydrogen and fossil incumbents.
- Chile and Morocco are pursuing export-oriented offtake memoranda with Europe and Asia, but must still convert these MoUs into binding, volume-specific supply contracts.
- The United States offers production-side tax incentives, but lacks direct demand-pull instruments, resulting in supply projects advancing faster than offtake commitments.

This divergence highlights a critical insight: **supply-side incentives alone cannot create a hydrogen economy.** Market formation requires aligned buyer groups, standardized contract structures, transparent emissions accounting, and pricing mechanisms that allow industrial end-users to hedge long-run exposure. **Put simply, hydrogen projects are not constrained by technology - they are constrained by the difficulty of engineering long-term commercial relationships**

Hydrogen markets are therefore not emerging as commodity markets first. They are emerging as coordinated industrial procurement ecosystems, where policy plays the role of first buyer or risk-absorber until market liquidity develops. Countries that successfully de-risk demand today will determine which projects move first, which technologies scale, and which trade corridors ultimately solidify.

## Infrastructure, Land/Water Integration, and Workforce Planning

### Determine Deployment Speed

Hydrogen deployment cannot be meaningfully advanced by production subsidies alone. It **requires synchronized system planning** across:

- Power generation (renewables, grid interconnection, and balancing assets)
- Water sourcing (desalination, wastewater reuse, or inland transport)
- Transport and distribution infrastructure (pipelines, port terminals, rail, and storage)
- Workforce training and industrial reskilling

Countries that treat these components as **parallel planning requirements, rather than sequential steps**, are advancing more quickly. Early movers are increasingly adopting corridor-level planning by linking renewable generation zones, industrial clusters, and export terminals, for example, instead of treating these elements as isolated infrastructure assets. For example:

- Norway and the Netherlands are retrofitting existing gas networks and port clusters through coordinated regulatory authorities.
- Saudi Arabia and the UAE are bundling renewable development, desalination systems, ammonia conversion, and maritime logistics in vertically integrated projects from the outset.
- Japan and South Korea are upgrading import terminals and ship refueling corridors ahead of large-scale hydrogen arrival.

Countries that proactively coordinate land availability, zoning, environmental permitting, and transmission expansion could also see materially shorter development timelines, demonstrating that permitting reform is as critical as capital availability.

Conversely, countries that plan production first and seek to address infrastructure and workforce needs later, such as Chile, India, Namibia, Colombia, and portions of the United States, experience longer lead times, higher front-end engineering costs, and greater exposure to political and commercial risk during mid-project execution.

Crucially, workforce development is emerging as a universal bottleneck. Hydrogen deployment draws from skilled labor pools in industrial welding, electrical systems, pipeline integrity, construction management, process engineering, and specialized safety training. Regions without active retraining pipelines risk deployment delays even when capital is available. The need for parallel infrastructure and workforce planning also underscores the advantage held by countries with legacy oil, gas, petrochemical, or maritime sectors, where existing skills and pipelines can be repurposed to accelerate

hydrogen deployment. This reinforces a central insight: **Hydrogen is not just a technology transition; it is a systems-integration and workforce transition.**

## Strategic Roles in the Emerging Global Hydrogen Trade

Across the seventeen countries, five functional roles are becoming visible:

<b>Role</b>	<b>Characteristics</b>	<b>Example Countries</b>
<b>Demand Anchors</b>	Industrial economies driving procurement and standard-setting	Japan, South Korea, Germany
<b>Export Supply Hubs</b>	Renewable-rich or gas-rich producers seeking long-term export contracts	Chile, Saudi Arabia, Morocco, UAE, Australia, Namibia
<b>Technology &amp; Components Leaders</b>	Electrolyzer, storage, shipping, and integration system manufacturers	China, United States, Norway
<b>Certification &amp; Logistics Gateways</b>	Port and regulatory hubs that make trade possible; connective tissue between exporters and importers	Netherlands, Spain, Portugal
<b>Hybrid Strategies</b>	Active hydrogen policy interest and early deployment activity; uncertain balance between domestic demand and export competitiveness	India, Colombia

The map in Figure 4 illustrates the emerging strategic roles countries are assuming in the global hydrogen economy. Rather than progressing along a single linear path toward market maturity, countries are differentiating according to their structural advantages, policy priorities, and industrial orientations. Some are positioned to act as long-term demand anchors, using hydrogen to decarbonize steel, chemicals, and heavy transport sectors. Others are shaping themselves as export-oriented production hubs, leveraging low-cost renewable resources or existing energy infrastructure. A smaller group is exerting influence through technology leadership and systems engineering capacity, while another set is becoming critical certification and logistics gateways responsible for enabling cross-border trade. A final group remains in hybrid or transitional positions, actively developing strategies while the balance between domestic use and export potential continues to evolve.

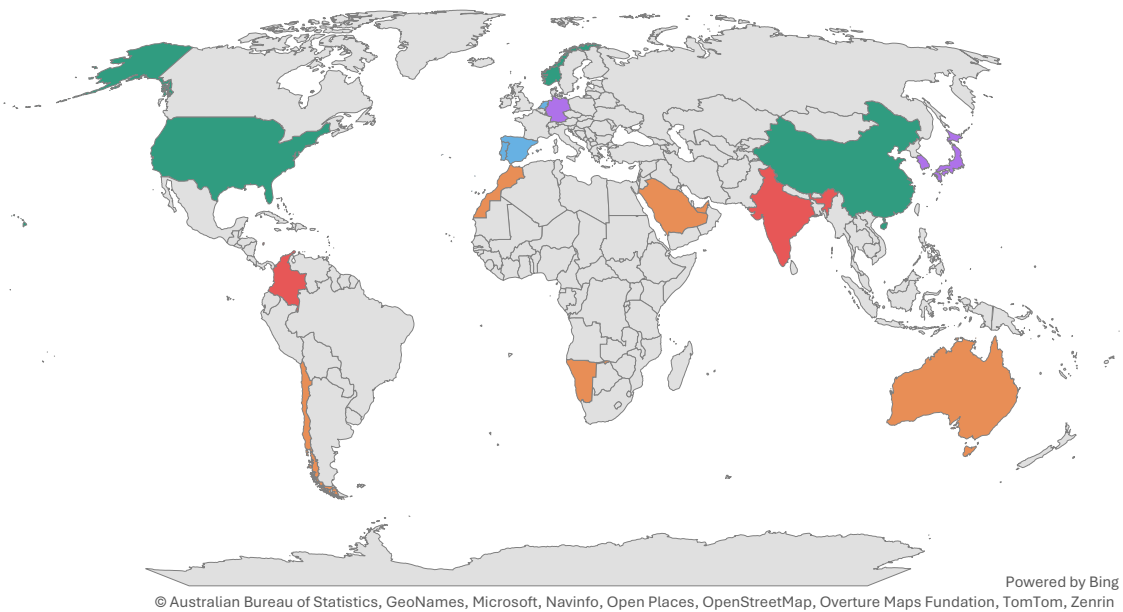
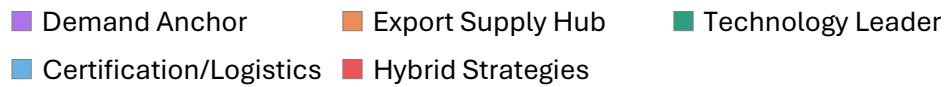


Figure 4. Global map highlighting strategic roles that are emerging in the global hydrogen trade based on analyses in this report.

Countries may shift roles over time, but market influence is being determined now, not once trade volumes mature. The early movers in standards, contracting frameworks, certification, port conversion, and workforce development are the ones shaping what the global hydrogen market will look like.

## Conclusions

The comparative assessment of seventeen national hydrogen markets demonstrates that hydrogen development is proceeding **not as a synchronized global transformation**, but as a set of regionally **differentiated strategies** shaped by resource endowments, industrial structure, policy orientation, and geopolitical positioning. In some economies, such as Japan, South Korea, Germany, and the Netherlands, hydrogen has become embedded in long-term industrial decarbonization planning and energy security strategy, supported by state-backed procurement signals and sustained investment in enabling infrastructure. In others, including Chile, Saudi Arabia, the United Arab Emirates, and Morocco, hydrogen is advancing primarily as an export-oriented development pathway, in which resource competitiveness and the ability to structure reliable cross-border trade relationships are central. Still others, including the United States, India, China, and Colombia, are experimenting with hybrid market formations in which domestic decarbonization,

industrial competitiveness, and export positioning are simultaneously, and sometimes unevenly, pursued.

Across these contexts, one conclusion is clear: hydrogen's trajectory over the next decade will be shaped less by technological constraints than by institutional, regulatory, and market coordination capacity. While electrolyzer cost reductions, CCS integration, and transport technologies continue to mature, the decisive variable affecting project timelines and investor commitment is the degree to which governments and market actors can create durable, credible conditions for long-term commercial participation. Those conditions include predictable regulation, multi-year funding and procurement signals, standardized emissions accounting, and coordinated infrastructure planning. Markets that can supply these features will be positioned to advance hydrogen from planning into deployment; those that cannot, will continue to experience delayed timelines, higher risk premiums, and constrained momentum.

## Expected Market Developments

In the near to medium term, hydrogen deployment is likely to advance most rapidly in demand-led industrial clusters where the logic of substitution is clearest: refining, ammonia and methanol production, steelmaking, maritime bunkering, and certain heavy transport corridors. Countries such as Japan and Germany, where hydrogen is tied explicitly to industrial competitiveness and energy security, are positioned to continue shaping procurement norms, certification standards, and emissions accounting frameworks that will influence the global market. Their strategic orientation is not toward low-cost hydrogen, but toward secure and reliable supply chains supported by long-duration contracts and diplomatic energy relationships. These countries will effectively act as the price signal-setters for early international hydrogen trade.

At the same time, export-oriented production hubs are likely to consolidate. Not every country with strong renewable resources will become a global hydrogen exporter; scale advantages will accrue to those regions capable of co-locating renewable power development, conversion assets, storage capacity, port infrastructure, and skilled labor. Chile, Saudi Arabia, and the UAE are already advancing in this direction, not because of resource abundance alone, but because they have paired resource advantage with state-backed project coordination and financing structures capable of absorbing early-stage market uncertainty. Through these models, global hydrogen trade over the next five years will most likely take the form of bilateral corridor development, rather than open, commodity-like market exchange.

Finally, the role of certification and standards alignment will become increasingly central. Divergent frameworks governing emissions intensity, grid temporal matching, carrier form,

and lifecycle accounting may determine the trade compatibility between regions more strongly than production cost differences. The next phase of hydrogen market development will therefore require regulatory diplomacy in parallel with infrastructure deployment.

## Strategic Implications for Market Participants

For developers, the analysis emphasizes the importance of commercial coordination early in the project cycle. Technical feasibility and cost modeling are necessary but not sufficient to secure investment. Increasingly, successful developers are structuring projects around buyer needs from the outset: co-designing volumes, contract duration, emissions accounting attributes, and carrier forms in close consultation with industrial end-users. Flexibility across derivative product pathways (hydrogen, ammonia, methanol, power-to-process integration) has emerged as a practical risk-mitigation strategy, particularly as trade and certification rules continue to evolve.

For policymakers, the central implication is that demand formation and institutional continuity are now the principal levers for market acceleration. Production incentives alone, whether through tax credits or capital grants, cannot bring projects to final investment decision without corresponding demand-side confidence mechanisms. Governments that have begun to play an explicit coordination role, such as aggregating buyers, standardizing offtake contracting, and providing price-stabilization guarantees, are accelerating deployment more rapidly than those relying on market self-organization. Long-term planning of infrastructure, including power networks, water systems, ports, storage, distribution corridors, is also emerging as a determinant of both deployment pace and regional competitiveness.

For financiers, the findings suggest that the nature of project risk in hydrogen differs from other energy infrastructure classes. The technology risk is relatively low, given that core system components are adaptations of established industrial processes. The primary risks are instead policy durability, contract standardization, and certification alignment. Financing structures that distribute risk across public and private actors, such as joint ventures, sovereign-backed guarantees, and blended finance, are proving more effective at advancing early projects than merchant or single-sponsor models.

## Closing Perspectives

Hydrogen markets will not emerge everywhere, nor will they emerge uniformly. The coming decade will be defined by deliberate, negotiated market formation, in which a smaller number of countries assume leadership roles in setting standards, developing infrastructure, and anchoring long-duration trade relationships. The countries that succeed will be those that treat hydrogen not simply as a fuel, but as a system-scale industrial transformation, requiring governance stability, coordinated investment, and sustained

cross-sector alignment. In this context, the strategic question is no longer whether hydrogen will play a role in global decarbonization, but where, how, and under what institutional conditions that role will materialize first.

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The Open Hydrogen Initiative includes a broad range of stakeholders who are collaborating to develop open-source protocols that will unlock hydrogen's potential to decarbonize energy-intensive sectors. It was developed by GTI Energy and S&P Global Commodity Insights.

GTI Energy is focused on developing, scaling, and deploying energy transition solutions that improve lives, economies, and the environment.

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