Task Force 4
Refuelling Growth: Clean Energy and Green Transitions

GOVERNING A FUTURE HYDROGEN-BASED SOCIETY

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Abstract

Hydrogen has the potential to play a significant role in long-term decarbonisation. It has the unique ability to store and transport large amounts of energy, making it a versatile and promising option. One of the critical benefits of hydrogen is its ability to be used in hard-to-abate sectors. However, clean hydrogen production and infrastructure require huge investments until 2050. Only US$22 billion final investment decision (FID) commitments towards 2030 exist, with most of the FID projects directed towards clean ammonia production. Amid a prolonged energy crisis, the G20 must take concrete steps to overcome this challenge by establishing market certainty and strengthening international collaboration. This policy brief focuses on how contribution and collaboration by the G20 countries can develop and deploy clean hydrogen technologies to achieve the net-zero emissions goal. Further, this policy brief provides the framework to encourage low-carbon hydrogen and ammonia dissemination.

The Challenge

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There has been increasing interest in hydrogen utilisation as the key to a carbon-neutral world. Countries and firms have pledged to achieve carbon neutrality between 2050 and 2060, encouraging the quest for fossil-free energy sources, especially after the Paris Agreement and later Conference of Parties (COP). Thirty-six countries joined the Breakthrough Agenda of COP26, which aims for affordable, renewable, and low-carbon hydrogen by 2030. The G7 nations launched the G7 Hydrogen Action Pact in 2022 to accelerate clean hydrogen infrastructure and deployment. At least 60 countries are working on national strategies and roadmaps in hydrogen, with advanced economies—such as those in the European Union (EU), Australia, and Japan—having progressive headway. The G20 countries of the Global South, such as China, Saudi Arabia, India, Chile, and South Africa, have also demonstrated a strong interest in developing clean hydrogen. Meanwhile, the business world has proposed 680 clean hydrogen projects until the first half of 2022. These projects predominantly focus on ammonia production and aim for the international energy market. About 35 percent (by hydrogen volume) of hydrogen carrier projects through 2030 are for clean ammonia (UNFCCC, 2022; Crolius, 2023; G7 Germany, 2022; Hydrogen Council and McKinsey & Company, 2022; International Renewable Energy Agency, 2022; Royal Society, 2020).

In energy transition discussions, policymakers are increasingly assessing the role of hydrogen in decarbonising hard-to-abate sectors such as industry and transport. Ammonia is now more attractive as a hydrogen carrier. Further, in Japan, the exploration of direct utilisation of clean ammonia for electricity generation, ships and industrial furnaces has developed significantly (Watanabe, 2023). In 2021, about 23 percent of global energy-related CO2 emissions came from energy use in industry and another 5.2 percent from industrial processes, making industry the world's second-largest CO2-emitting sector. Further, the transport sector contributed about 23 percent to global energy-related CO2 emissions (International Energy Agency, 2020).

Thus, for hydrogen to be accepted as a low-carbon fuel source, its production methods must also be decarbonised

(Hasan and Shabaneh, 2021; Nature, 2022). Even though renewable "green" hydrogen can be made by using electricity from renewable sources to split water molecules, this process is costly in comparison to the more conventional production methods. With the increase in electricity generation from renewable energy sources, the future of hydrogen looks bright as it is now supported by a broad range of energy market players (Franza, 2020).

The progress of clean hydrogen development still needs to accelerate and requires more ambitious investments. Uncertainty regarding the absence of a policy framework and unharmonised global standards hinders the market creation of clean hydrogen. Heavy investment in clean ammonia projects requires a long-term contract with buyers in the value chain to make them feasible and sustainable.

Global turmoil has disturbed energy supply and caused price volatility in the past three years. The EU, which has an ambitious net-zero target, has seen a surge in its coal consumption by approximately 22 percent in 2020–2022 due to the skyrocketing price of Russian gas supply (International Energy Agency, 2022). A more vulnerable condition is prevalent in developing countries, characterized by political instability, weak institutions, limited investment capacity, high legal and political uncertainty, and inadequate infrastructure. Consequently, the development of a robust clean hydrogen strategy in these regions is often hindered or poorly developed (Skowron and Fünfgelt, 2021). Further, there is no energy security architecture to protect the countries that will drive the energy demand for hydrogen, especially green hydrogen. If the supply and demand of green hydrogen are not secured through global cooperation, countries will pursue their energy security strategies without regard to others (Ghosh et al., 2022). These situations raise scepticism about accelerating the low or zero-carbon energy transition.

The G20's Role

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The G20, as the most significant global economy and consumer of over 80 percent of global energy, will significantly impact world sustainability. In the context of hydrogen, ammonia has emerged as the predominant tradable derivative of hydrogen in today's market. Seven top ammonia-producing countries are G20 members, accounting for 70 percent to 85 percent of international ammonia trade (Argus, 2021). Strategic actions in developing the clean energy transition through clean hydrogen will reshape the global energy consumption and production landscape. Since clean hydrogen—especially in the form of ammonia—will be a tradable commodity, the role of G20 as a worldwide economic cooperation platform is becoming relevant compared to other forms of multinational cooperation. The G20 can also facilitate the perspectives of both advanced and emerging economies. Having Indonesia (2022), India (2023) and Brazil (2024), and South Africa (2025) lead the grouping may increase the representation of emerging countries in G20 commitments and programmes. This will help the G20 create a level playing field for all countries.

The 2023 G20 summit presents a significant opportunity to translate energy transition commitments into tangible actions, with a particular emphasis on advancing the development and utilisation of clean hydrogen. In 2022, the G20 focused on energy security and renewable energy deployment. Those are part of commitments produced during the Indonesia summit—significant among them are the G20 Bali Leader's Declaration; Decade of Actions: Bali Energy Transition Roadmap; and the B20 Policy Paper: Energy, Sustainability and Climate Task Force—Bali Energy Transition Roadmap. However, the G20 is yet to explicitly convey programmes to carry out low-carbon energy technology and infrastructure implementation. The India-led G20 ought to generate inclusive joint programmes, which will become an essential milestone in the energy transition.

Recommendations to the G20

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Form a formal joint strategic working institution to manage collaboration and coordination for global clean hydrogen development

Rationale: The G20 could form international committees to make the cooperation and collaborative process between the countries smooth and relevant. The G7 launched a similar working group (G7 Hydrogen Action Pact) in 2022. The collaborative body should represent the interests of all G20 stakeholders—from conventional fuel-exporting to future hydrogen-importing countries. It is vital to cater to the interest of all stakeholders, especially prospective hydrogen exporters and importers. This initiative must be formulated as a bridge between the countries, developers, and consumers as a policy coordination tool.

The G20 institution on hydrogen could focus on the following:

- Assess the capabilities of member countries and their role in a clean hydrogen economy
- Accelerate the interaction between hydrocarbon exporters, potential future clean hydrogen exporters, and importers such as China, India, Australia, and Saudi Arabia, who will likely become key hydrogen importers and exporters in the next decade based on their current energy policy targets
- Support the development of long-term green hydrogen delivery contracts and international policies linked to joint infrastructure investment for hydrogen deliveries
- Define the standards for different hydrogen technologies and production processes by considering specific emission profiles and long-term stability
- Establish standards for effective monitoring, reporting, safety, and verification of hydrogen production and transportation
- Create a database for country-level instruments that incentivise the production of green hydrogen. This database could serve as a knowledge base for other countries and enable them to implement similar policy instruments
- Coordinate with global research and development institute on green hydrogen

Establish a harmonised certification framework to encourage a vigorous clean hydrogen and ammonia value chain

Rationale: The market is a vehicle for a smooth, greener energy transition; hence, certification is a prerequisite. Standardising clean hydrogen and ammonia products is crucial to ensure flexibility and enlargement of the international market. Certification is necessary to distinguish low-carbon products from the rest. Clean hydrogen certification has already been under the spotlight for years. Conversely, existing global certification in clean ammonia is limited and fragmented. This condition evolves as the market for clean ammonia is in its infancy while also being the most favourable hydrogen derivative for intercontinental trade.

Clean hydrogen and ammonia certification schemes must be harmonised globally. Countries have developed polarisation on free trade, political, economic, and environmental perspectives. For instance, Germany ambitiously sets formal and voluntary hydrogen economy schemes. On the contrary, Japan prioritises the supply of low-cost hydrogen and ammonia over carbon footprint credentials. Japan had discussed certification in 2017 but then stagnated (Wenger and Wagner, 2021).

As a solution, the G20 could agree on definitions and methodologies among existing and future certification schemes. The requirements should be identified and harmonised to measure the emissions of hydrogen production, transport and end-use. These include specifying where the boundaries lie for emissions' quantification, thresholds, validation and measurement methods, product specifications, and other related factors. To resolve this issue, the regulation from various certificatory must be harmonised to be valid worldwide among G20 members as potential buyers and sellers. G20 can work with international certification bodies working on ammonia to establish a harmonised framework. Additionally, mutual recognition of national standards among G20 members may be feasible in the short term (de Brito, Kauffmann, and Pelkmans, 2016).

Launch a hydrogen roadmap for clean hydrogen technology implementation while balancing low-carbon ammonia supply in the food-energy mix

Rationale: The demand for clean hydrogen is projected to grow up to seven times in 2050, yet it still needs to be implemented on a massive scale today (International Renewable Energy Agency, 2022). The G20 should address and identify the gap in understanding ammonia as a crucial backbone in the hydrogen and clean energy transition by adapting to local contexts, markets, and opportunities. Several G20 countries, mainly G7 members, have addressed the importance of blue and green ammonia as a hydrogen carrier for various applications such as marine fuel and electricity generation, which is a potential new market. It will depend on the local demand growth and end users to ensure the gradual growth of the clean ammonia market as the largest off-taker of hydrogen. Policymakers may also set up policy priorities based on the country's strategic directions and available resources, focusing on identifying the highest-value market that will enable rapid implementation and economic scalability of green hydrogen, particularly in heavy and hard-to-abate industries.

Key strategies to accelerate the upscale and large implementation of clean ammonia might be related to economic and technical drivers. Economic drivers aim to enhance competitiveness by leveraging the technology and production cost of blue and green ammonia. Progressive carbon pricing and low-carbon energy source consumption incentives should be imposed to encourage clean ammonia production, especially for countries with limited renewable energy availability. Emerging countries in the G20 should carefully analyse and break down the investment and annual costs across the value chain to identify the specific areas where policy and financial support will be needed to reduce costs.

The G20 could focus on ensuring the most viable technological pathway of blue and green ammonia, i.e., carbon capture utilisation/storage (CCU/CCS) technology. During the transition period, blue ammonia will be vital for the emerging economies among the G20, allowing them to stay on track with their emission reduction targets

without requiring significant changes to their existing infrastructure or major investments. The largest contributor to the total capital costs of green ammonia would be renewable power and electrolysis, making up 80 percent of total costs (OECD, 2022). Future policies should be oriented not only towards the upstream industries but also towards downstream industries. It is essential to verify the energy balance, i.e., electricity supply, to ensure the availability and affordability of green hydrogen in local entities.

Since hydrogen can produce ammonia, a key component of fertilisers, G20 countries could carefully assess the role of clean ammonia in maintaining the supply-demand balance in global energy and food security. The existing ammonia production is also emission-intensive, more than twice of crude steel production and four times that of cement (International Energy Agency, 2021). There must be a clear and sustainable trajectory for enabling clean ammonia to contribute to both directions and thus be included in the national strategy of G20 members, from the starting point of the value chain until the end user. Incentives and tax deductions should be given to specific end users to maintain their attractiveness, that is, the lower minimum price for food-security–related utilisation.

Coordinate and create an emission trading system through international market mechanisms

Rationale: Creating an enabling market for an emission trading system for the use of green hydrogen could be developed through the guidelines of the Paris Agreement's Article 6.2 and 6.4 Mechanisms (UNFCCC, 2021).

G20 countries should develop a methodology in the context of Article 6.2 and submit it to the United Nations Framework Convention on Climate Change for their further recommendations. These methodologies are a necessary tool for enabling carbon credits and associated revenues. Methodologies should consider both direct emissions and indirect emissions from the power sector. In addition, a similar approach to clean development mechanism must be taken to identify uncertainties around the stability of stored carbon. These methodologies not only prevent imbalances and address energy

security concerns but also have the potential to be implemented and used by the global market.

Promote R&D collaboration and public-private partnership within the G20 to build a low-carbon hydrogen value chain for an equitable future hydrogen-based society

Rationale: The G20 countries should ensure more significant support for R&D in green hydrogen and ammonia demonstration projects. The G20 may develop specific green funding as well as grants and loans to develop clean hydrogen. G20 India should push the G20 Sustainable Financing Working Group to create a funding scheme for clean hydrogen development. As a reference, the World Bank developed an H4D partnership during COP27 to increase the knowledge base in low-carbon hydrogen technologies for developing countries (World Bank, 2022). We have learnt from B20 Indonesia that businesses recognise and endorse the utilisation of clean hydrogen and ammonia as a route to achieving net zero emissions, mainly focusing on the CCU/S technology and ammonia co-firing. Developing certification, policy, and R&D strategy within the G20 will increase industries' confidence to invest in clean hydrogen. A cross-border "hydrogen valley" might be the essential model as a go-to-platform for scaling the clean hydrogen ecosystem (Biebuyck, 2021).

Targeted R&D support instruments are required to reduce the cost of electrolysers and make large-scale green hydrogen production more competitive. Large-scale demonstration projects are also needed to reduce costs through economies of scale, economies of scope and learning by doing. G20 countries should provide financial incentives such as public loans or guarantees to promote innovation. They should also ensure that knowledge flows globally and R&D institutes can benefit from publicly funded R&D and demonstration projects. G20 countries need to create an ecosystem to ensure healthy competition and low barriers to entry for R&D institutions. Cooperation and coordination between countries are also needed to favour knowledge diffusion. In other words, collaboration on the clean technology development in the ecosystem is required to leverage human resources.

Several countries have published national strategies for hydrogen with ambitious hydrogen production targets by 2030. Between 2008 and 2019, several countries increased public R&D spending on hydrogen, while others cut public spending on R&D by more than half. However, the global stability in the number of hydrogen patents casts doubt on the capacity to develop hydrogen-related technologies and achieve the cost reductions needed to make green hydrogen competitive in the near future. In addition, the share of young firms in hydrogen patents is declining (OECD, 2022).

The utilisation of ammonia as a hydrogen carrier and its direct use in the combustion system of the marine and power sectors is being investigated due to potential technical and economic feasibility. The environmental issue should also be addressed, especially when developing CCS technologies, taking into consideration specific geological conditions in countries with a higher risk of disasters. Reliable production of blue ammonia through CCS technology is crucial not only to facilitate a smooth energy transition but also to mitigate potential environmental risks. Specifically, it is important for blue ammonia producers to collaborate with upstream oil industries, as the emitted CO2 from ammonia plants can be used for the recovery of oil- and gas-depleted wells. As marine fuel, there is a concern about the nitrogen cycle stability (Wolfram et al., 2022).

Intensive R&D activities should be performed to make the technology competitive and address the technology risk of clean hydrogen implementation. The R&D should also explore the role of G20 members in the clean hydrogen value chain. The renewable capability of emerging countries should be assessed, contributing to, and benefiting from a hydrogen economy.

Attribution: Yagyavalk Bhatt et al., “Governing a Future Hydrogen-based Society,” *T20 Policy Brief*, July 2023.

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