

# **ACCELERATING THE TRULY LOW-CARBON HYDROGEN TRANSITION IN JAPAN**

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## Summary

Japan, with its vision to become a 'hydrogen society', is at a critical juncture in its energy transition. The country has the potential to become a global leader in the low-carbon hydrogen economy. To realise this, Japan must prioritise green and truly low-carbon hydrogen: where robust emissions accounting and lifecycle assessments are applied to ensure its environmental sustainability. Japan is at a crossroads where it is ripe to be a leader in not just hydrogen adoption but securing the primacy of green and truly low-carbon hydrogen as an integral component of its energy policy. If the Japanese government is intent on becoming a 'hydrogen society', we challenge it to become a 'green and truly low-carbon hydrogen society', and our recommendations will push that vision forward.

This paper outlines the key policy actions Japan must take to accelerate the adoption of truly low-carbon hydrogen. It calls for the introduction of standards enabling low-carbon hydrogen, dedicated sub-quotas for green and truly low-carbon hydrogen, and the establishment of a hydrogen bidding market that rewards low-emission technologies: all of which will align Japan's strategy with international best practices seen in regions like the European Union and the United Kingdom.

Japan's leadership in green and truly low-carbon hydrogen will not only support its decarbonisation goals but also ensure its economic competitiveness as global markets shift toward stricter carbon regulations. We are already seeing Japan take the necessary steps to adopt green and truly low-carbon hydrogen, but there's still more work to be done. Through fostering international collaboration such as friendshoring in, the face of rising global tensions, supporting technological innovation, and scaling both green and truly low-carbon hydrogen production, Japan can secure its energy future while positioning itself as a key player in the global hydrogen economy.

### Key Recommendations:

- Set Standards Enabling Truly Low-Carbon Hydrogen
- Establish Green Hydrogen Sub Quotas
- Create a Dedicated Green Hydrogen Bidding Market
- Support Technology and Innovation
- Develop Hydrogen Infrastructure
- Implement Financial Incentives and Carbon Pricing

# 1.Introduction

The Asia-Pacific region is well-positioned to capitalise on the transition to green and truly low-carbon hydrogen by decarbonising hard-to-electrify industries and enhancing energy security. Japan and South Korea are set to become large-scale importers of hydrogen, driven by ambitious policies. China is ramping up green hydrogen production capacity and electrolyser manufacturing at an unprecedented pace. Australia and India are advancing production of both green hydrogen and ammonia, while countries like Indonesia, Malaysia, Thailand, and Vietnam have significant potential to scale renewable energy and hydrogen industries.

For Japan, hydrogen and its derivatives (such as ammonia and , methanol) as well as products made using green hydrogen (like green steel) represent a critical opportunity to reduce CO<sub>2</sub> emissions and transition away from fossil fuels. The Japanese government has started in earnest to transform the nation into a 'hydrogen society' as seen through the passing in May 2024 of the '**Hydrogen Society Promotion Act**' in the Japanese Diet.<sup>1</sup> This Act, buttressed by the 3 trillion yen (\$20.85 billion USD) in subsidies for the adoption of low carbon hydrogen and the government's 2023 Basic Hydrogen Strategy, illustrates that Japan is placing big bets on hydrogen.<sup>2</sup> Japan has also set a target where hydrogen and ammonia will make up about 1 per cent of all power within Japan by 2030.<sup>3</sup> While this is an important aspect to focus on, GH2 believes that the differentiator of green hydrogen is its ability to decarbonise hard-to-abate sectors: namely steel, maritime operations, and aviation fuels, along with other downstream products like fertilisers. Japan has the opportunity to diversify its energy supply base, reduce dependence on a narrow group of exporters, and establish a more secure and sustainable energy future through the adoption of green and truly low carbon hydrogen.

Japan must now decide how to ramp up its hydrogen supply chain as it targets 3 million tonnes of hydrogen by 2030 and 20 million tonnes of hydrogen by 2050.<sup>4</sup> These targets are the combined sum of domestically produced and imported low carbon hydrogen and ammonia. We are already seeing the needle move in this direction, with Japan's annual hydrogen and fuel cell market forecasted to be 1 trillion yen (\$9 billion USD) in 2030 and 8 trillion yen in 2050.<sup>5</sup> While the government has favoured blue hydrogen due to its purported lower initial costs and faster scalability (which need to be tested in the real world), the adoption of green hydrogen, powered by renewables, must be championed. According to BloombergNEF, green hydrogen is projected to become cheaper than blue hydrogen in many global markets, including Japan, by 2030, due to it being driven by economies of scale and advancements in electrolysis technology.<sup>6</sup> It does not make sense to invest only in blue hydrogen initially and then switch over to green hydrogen for several reasons. Blue hydrogen facilities risk becoming stranded assets as the world transitions away from fossil fuels and will always track with the price of natural gas. The **Balance of Plant (BoP)** systems necessary to keep a power plant running stably and efficiently, along with large electrolysers crucial to the creation of green hydrogen, take

time to build and cannot immediately be slotted into place even if production greatly increases in the next few years. The infrastructure for green hydrogen needs to be built from the onset of hydrogen adoption. The other factor is the rapidly decreasing cost of renewable energy which will ensure green hydrogen becomes cheaper due to market forces; thereby creating a virtuous cycle of renewable energy development. Prioritising green and low-carbon hydrogen will provide more significant reductions in greenhouse gases; a crucial consideration as the **EU's Carbon Border Adjustment Mechanism (CBAM)** and similar policies gain global influence.

## 2. Policy Instruments for a Green and Truly Low-Carbon Hydrogen Supply

To diversify Japan's hydrogen supply and ensure it aligns with decarbonisation goals, a series of targeted policy instruments are needed to promote green hydrogen and truly low-carbon hydrogen over higher-emission alternatives. These instruments will ensure Japan remains competitive in the global hydrogen market and achieves its decarbonisation targets.

### 2.1. Set Standards Enabling Low-Carbon Hydrogen

- **Lower the emissions threshold:** Tighten the current 3.4 kg-CO<sub>2</sub>e/kg-H<sub>2</sub> limit to incentivise only truly low-carbon hydrogen. This includes both green hydrogen and blue hydrogen that adheres to robust emissions accounting through lifecycle assessments.
  - The European Union has set a limit of 3.38 kg-CO<sub>2</sub>e/kg-H<sub>2</sub> (Well to Wheel), which includes emissions from production, transport, and consumption.<sup>7</sup>
  - The United Kingdom has a threshold of 2.4 kg-CO<sub>2</sub>e/kg-H<sub>2</sub> (Well to Gate).<sup>8</sup>
  - Private-sector standards, like the Green Hydrogen Standard, propose an emissions threshold as low as 1 kg-CO<sub>2</sub>e/kg-H<sub>2</sub> (up to production). This is the Green Hydrogen Organisation's target, and we believe it is both rigorous and practical to meet decarbonisation targets.

There are significant concerns regarding Japan's emissions standards, as highlighted in a **recent report** by the Green Hydrogen Catapult and the Green Hydrogen Organisation using analysis from RMI. The report underscores that unless hydrogen-importing countries like Japan and South Korea adopt rigorous, site-specific measurements of upstream methane emissions and implement full lifecycle assessments — covering production, transportation, and consumption — they risk underestimating emissions from

blue hydrogen by as much as 43-67 per cent.<sup>9</sup> More scrutiny needs to be undertaken regarding hydrogen produced by fossil fuels in all steps of the hydrogen lifecycle. This is particularly concerning given Japan's reliance on blue hydrogen and ammonia imports which may qualify as low carbon under the current Japanese definition and threshold based on the well-to-gate model. Japan is at risk of spending trillions of yen on hydrogen that will not actually decarbonise its energy sector and may even cause further carbon emissions.

Japan must align its emissions standards with the aforementioned international benchmarks and incorporate full lifecycle assessments that include upstream methane emissions, transportation, and consumption. This will ensure Japan does not underestimate emissions and remains competitive in the global hydrogen market. It will also allow that products made using hydrogen such as cars made with green steel to avoid being subject to CBAM taxes due to the high carbon intensity of the blue hydrogen. Regulatory harmonisation across different jurisdictions is integral to building a green and truly low-carbon hydrogen economy. Setting robust emission standards that align with other likeminded countries will foster a level playing field for both international and domestic markets that promotes not just business certainty but adoption of green hydrogen standards writ large; with Japan leading the pack as the world's first 'hydrogen society'.

## 2.2. Establish Green and Truly Low-Carbon Hydrogen Sub-Quotas

- **Mandate a sub-quota:** Require a growing share of hydrogen supply (e.g., 50 per cent) to come from green hydrogen by setting clear short-term and long-term goals (2024-2030, as well as 2040 & 2050).
- **Regulatory support:** Amend laws to support compliance, certification, and enforcement of hydrogen standards that distinguish between low-carbon hydrogen types.
- **Incentives:** Offer subsidies, tax credits, and financial incentives to offset the higher initial costs of both green and truly low-carbon hydrogen production.

The Hydrogen Society Promotion Act is an important first step in the development of green and truly low-carbon hydrogen quotas. While at the time of the development of this whitepaper the Japanese government has not unveiled any specific quotas for green and truly low-carbon hydrogen, they have outlined their general targets for 2030, 2040, and 2050:

Year	Hydrogen (million tonnes/year)	Ammonia (million tonnes/year)
2030	3.0	3.0 (=0.5 H <sub>2</sub> )
2040	Combined H <sub>2</sub> /NH <sub>3</sub> target: 12.0	Combined H <sub>2</sub> /NH <sub>3</sub> target: 12.0
2050	20.0	30.0 (=5.0 H <sub>2</sub> )

Japan's idealised cost targets include hydrogen being priced at ¥30/Nm<sup>3</sup> (approximately ¥334/kg) and ammonia within the range of the late teens ¥/Nm<sup>3</sup>. What is missing here is Japan's specific quotas around how much of this hydrogen/ammonia is green or truly 'low carbon', especially with a higher-than-average definition for 'low carbon'. It is critical to promote the adoption of green and truly low carbon sources of hydrogen from the onset and requiring a growing share of the hydrogen supply to be truly green with achievable targets from 2030 onward.

## 2.3. Create a Dedicated Green Hydrogen Bidding Market

- **Dedicated market for green hydrogen:** Establish a bidding market for both green and low-carbon hydrogen that allows for transparent allocation of funds and resources. Separate rounds for different technologies, like the UK model, will ensure that innovative hydrogen technologies (e.g. electrolysis and carbon capture) are prioritised.
- **Incentives:** In conjunction with the current **Contracts for Difference (CfD)** scheme, offer premium pricing, guaranteed purchase agreements, and performance-based bonuses to reward low-emission green hydrogen projects that encourage technological innovation, and which focus on hard to abate sectors which cannot be directly electrified. These include steelmaking, fertiliser production, marine, and aviation fuels as well as long duration energy storage for grid balancing.
- **Transparency and fairness:** Ensure a transparent bidding process with clear participation criteria, standardised evaluation metrics, and regular audits.
- **International collaboration:** Coordinate with markets like the UK and EU to harmonise standards and strategies, promoting cross-border trade and knowledge sharing.

The cost to produce green hydrogen, while projected to decrease with the reduction in electrolysis costs, are currently still higher than blue or even grey hydrogen. To address this dissonance, Japan needs to create an environment where it is commercially feasible and sustainable for private sector companies to operate in the green hydrogen sector. Private-public partnerships are key, and government support such as generous subsidies for green and truly low carbon hydrogen must be available. The 3 trillion-yen in subsidies allocated for the Contracts for Difference (CfD) scheme through the Hydrogen Society Promotion Act is a step forward in stabilising and promoting domestically produced and imported green and low-carbon hydrogen.<sup>10</sup> This, in addition to the additional 1.3 trillion yen in subsidies allocated for the decarbonisation of heavy industries, such as steel, chemicals, transportation, etc. to use green and truly low-carbon hydrogen, are laudable measures at supporting this nascent sector.<sup>11</sup> The aforementioned Act also includes support measures through the **Japan Organisation for Metals and Energy Security (JOGMEC)** like price differential supports, infrastructure development support, and special measures for regulations such as the High Pressure Gas Safety Act, Road Act, and the Port and Harbour Act to provide regulatory certainty for businesses as well as the necessary financial incentives to make the switch to low-carbon power sources.<sup>12</sup> Japan still has a long way to go to foster a bidding market for green and low-carbon hydrogen but understands the necessity of doing so.

The Japanese government's welcome awareness is aware of the need for low-carbon hydrogen is appreciated, and Japan has specifically called out the need to increase the share of low-carbon hydrogen at the onset of its efforts to promote the widespread use of hydrogen and ammonia. This is done by developing a market design that provides incentives for purchasing truly low-carbon hydrogen and establishing regulatory incentives for more truly low-carbon hydrogen adoption. Japanese companies will not invest on a long-term time horizon for hydrogen or ammonia production if pricing mechanisms and future market developments are unclear. Successful implementation of these pricing mechanisms is crucial for adoption. While Japanese subsidies in this space are still inadequate in the grand scheme of things, it is devoting more funds than other nations such as Germany, the UK, and Australia.<sup>13</sup> The Asia-Pacific nation needs to ensure that the bidding market it creates through its policies align with international standards as seen in likeminded nations. Japan needs to provide certainty to the private sector and create policies that harmonise with other jurisdictions to show firms that there is a clear return on investment in green and truly low-carbon hydrogen.

## 2.4. Support Technology and Innovation

- **Boost R&D:** Increase funding for electrolysis technologies and other hydrogen innovations through research grants and public-private partnerships.



- **Foster innovation hubs:** Create centres to support startups and small businesses to ensure technological growth and commercialisation; particularly in green hydrogen technologies.

Japan has been on the cutting edge of hydrogen technology. To demonstrate their innovation in this field, Japan will leverage the Osaka Expo 2025 to deliver a vision where a hydrogen society can come alive, as hydrogen and ammonia-related energy sources will power its exhibits.<sup>14</sup> It would behoove the Japanese government and the Expo leaders to focus on using green and truly low-carbon hydrogen to build not just an example of what a hydrogen society could look like, but one that is green and truly carbon free from well to gate.

Innovation hubs should leverage unique regional specialisations to act as mini-laboratories for the deployment of green and low-carbon hydrogen technologies. Matching local demand and industrial characteristics with innovation is necessary to ensure that R&D has the potential to scale not just on a regional level, but nationally. For example, the prefecture of Fukushima is working with hydrogen businesses and other prefectural governments to advance their own vision of a hydrogen society.<sup>15</sup> This is supported by the federal government, as well as the Japan Hydrogen Association (JH2A), who encourage local governments to work with like-minded partners on hydrogen initiatives through public-private partnerships. This vision for Fukushima is elaborated in the Japanese government's Seventh Basic Energy Plan: its triennial energy strategy document.<sup>16</sup> These hubs are not without their own hurdles, however. Heavy administrative burden for municipal governments, as well as lack of financial incentives for companies to operate in such areas, has led to the slow adoption of these innovation hubs. Having adequate staff necessary to tackle local decarbonisation efforts is also a barrier to adoption. Creating regional regulatory sandboxes to provide the framework necessary for innovation to occur, with incentives for companies, along with enticing clean energy knowledge experts to work in these spaces, will be crucial in the success of these innovation hubs.

The key in all of this in the transition to a hydrogen society is moving from the development phase of technology to commercialisation; where hydrogen technology is adopted not just by the private sector, but by domestic consumers (i.e. Japanese citizens) in their daily life. The hydrogen industry needs to achieve self-sustainability, and it is incumbent on the Japanese government to provide the necessary supports, such as boosting R&D and innovation hubs, to foster the commercialisation of hydrogen technology.



## 2.5. Develop Hydrogen Infrastructure

- **Public-private investment:** Mobilise both public and private funds to build hydrogen transport, storage, and refuelling infrastructure to accommodate both green and truly low-carbon hydrogen.
- **Standardisation:** Implement robust certification, safety, and environmental standards to promote international trade and supply chain efficiency.

Building the infrastructure needed to become a true green hydrogen society is a challenge for the Japanese government. The most salient example of this is Japan's hydrogen highway and the inability to meet government targets. The hydrogen highway is a grid of hydrogen fuelling stations that provide fuel for hydrogen fuel cell vehicles (HFCV).<sup>17</sup> The Japanese government had lofty goals of building 160 stations by 2020.<sup>18</sup> This goal was eventually met, but as of May 2023, there are only 181 hydrogen stations across the country.<sup>19</sup> The lack of uptake in HFCVs, due to the current high cost of hydrogen and fuel cells, has inhibited the construction of these hydrogen fuelling stations. Japan is pivoting and will focus on ensuring these fuelling stations are multi-purpose to meet a wide variety of hydrogen demands now also include ports, and local industrial facilities.<sup>20</sup> Japan has lofty goals in building out its hydrogen infrastructure and is willing to put down the capital and develop support programs for first movers who make large scale investment decisions into hydrogen infrastructure. It is incumbent that Japan develops this framework with green and truly low-carbon hydrogen at the forefront of all major construction projects.

Japan has the potential not just to be a world leader in the adoption of green and truly low-carbon hydrogen, but also to shape international standards. The Japanese government's hydrogen strategy describes that they will identify areas where standardisation efforts will be fruitful for hydrogen supply chain construction and hydrogen-related industries. Continuing this leadership, Japan hosted Pacific Island leaders and notes that they will be exploring the possibility of green hydrogen projects in the Pacific Island region.<sup>21</sup> This, coupled with the regulatory harmonisation of standards with current leaders in this space such as the EU, positions Japan to be one of the major voices of hydrogen and ammonia adoption. Building on this momentum, Japan needs to make green and truly low-carbon hydrogen not just one pillar of their hydrogen strategy but be champions of green and truly low-carbon hydrogen that will meet decarbonisation targets in an efficient and practical way.

## 2.6. Implement Financial Incentives and Carbon Pricing

- **Subsidies and carbon pricing:** Use carbon taxes or cap-and-trade mechanisms to penalise higher-emission hydrogen forms, while offering subsidies and tax credits for green and truly low-carbon hydrogen projects.

- **Green bonds and funds:** Provide long-term financial mechanisms like green bonds and investment funds to ensure stable financing for the hydrogen sector.

Japan, one of the most carbon intensive nations in the world, has been taking steps (albeit slow, incremental steps) to implement carbon pricing mechanisms.<sup>22</sup> In 2012, the “**Special Provisions for Taxation for Climate Change Mitigation**” came into effect.<sup>23</sup> This tax, paid by businesses that import petroleum and petroleum byproducts (including coal), aims to reduce the environmental impact of fossil fuel use with an equivalent tax of 289 yen per tonne of CO<sub>2</sub>.<sup>24</sup>

To support the desired goal of carbon neutrality by 2050, the Japanese Diet passed the Green Transformation (GX) Promotion Act in May 2023.<sup>25</sup> GX Economic Transition Bonds, with funding allocated to over 20 trillion yen over 10 years, will act as the government’s fiscal policy tool to support projects that will help meet Japan’s decarbonisation targets without further burdening the taxpayer.<sup>26</sup> So far, 3 trillion yen has been issued from 2023 to 2024.<sup>27</sup> To pay for this tranche of funding, the Japanese government is implementing carbon pricing measures in addition to the climate change mitigation tax: namely, an emissions trading system (i.e. a cap-and-trade model) and a fossil fuel levy.

The emissions trading system has started off as a voluntary measure for industry and other stakeholders through what has been dubbed the Green Transformation League (GX League).<sup>28</sup> This GX League currently has 747 participating entities as of March 2024, but will be in full effect for all industry stakeholders who emit more than 100,000 tons of carbon dioxide annually by 2026-27.<sup>29</sup> Guidelines will be set out by this date, although more advocacy is required to ensure a robust and meaningful cap-and-trade system that has some regulatory teeth to incent adoption. There are already two voluntary cap-and-trade systems in place in Japan (i.e. the Tokyo Emissions Trading System and the Saitama Emissions Trading System), and the synthesis of these cap-and-trade systems will help foster a viable carbon credit market system.<sup>30</sup>

The Fossil Fuel Levy, set to be introduced in 2028, will be used to build up the capital necessary for the GX Economic Transition Bonds.<sup>31</sup> It will focus on companies that import fossil fuels with a low burden then gradually increasing in cost to change behaviour. Not technically a tax, the Fossil Fuel Levy is stipulated within the GX Promotion Act, and its price will be determined by Cabinet Order every year.<sup>32</sup>

Financial incentives such as these for green and truly low-carbon hydrogen projects are not just necessary to promote industry buy in but are critical in completely changing the paradigm of carbon emissions through hydrogen and ammonia use. It is only through Japanese leadership that hard-to-abate sectors like steelmaking, chemical products, shipping, and others can truly decarbonise with green and truly low-carbon hydrogen. A consistent supply is necessary at a price point that makes sense for industry to invest. The Japanese government has set up a 2 trillion yen Green Innovation Fund, coupled with the Carbon Neutrality Declaration, to support 800 billion yen in hydrogen-related technologies for technology development and commercialisation.<sup>33</sup> On a longer time

horizon, the GX Economic Transition Bonds of up to 20 trillion yen to attract private and public sector investors into compiling a pool of 150 trillion yen or more worth of investments over the next decade.<sup>34</sup> GH2 lauds this approach but encourages the Japanese government to continue to push the envelope on financial incentives for green and truly low-carbon hydrogen initiatives.

As previously mentioned, the Japanese government has implemented, as part of the Hydrogen Society Promotion Act passed in May 2024, a Contract for Difference (CfD) type subsidy to incent the adoption of what the Japanese government has determined as 'low carbon' hydrogen. The support measures are structured around two main pillars: price gap support and infrastructure development support which are both administered through JOGMEC. The price gap support covers the difference between the benchmark price (what suppliers need to charge) and the reference price (what end-users would pay based on alternative fuel costs). The subsidy rate is set at 100 per cent of eligible expenses, with specific caps to ensure budget control. To access the price gap supports, projects must supply a minimum of 1,000 tons hydrogen equivalent annually and focus on hard-to-decarbonise sectors. The infrastructure development support system has a higher threshold of 10,000 tons annually and requires clear regional economic benefits. These projects must demonstrate shared infrastructure potential for multiple users and have strong community support.

A key component is the Plan Certification System. This allows businesses to submit plans to METI either individually or jointly. These plans must demonstrate economic viability and contribute to strengthening Japan's industrial competitiveness. Importantly, for those seeking financial support, plans must be joint submissions between supply businesses and user businesses with clear commitments to begin supply within a specified timeframe and continue for a minimum duration.

The framework also establishes judgment standards for hydrogen supply businesses, emphasising three key initiatives: **utilising renewable energy sources, implementing appropriate carbon capture and storage measures**, and **using environmental certificates** when unable to meet the first two requirements. METI maintains oversight authority and can provide guidance or issue orders when necessary.

This comprehensive approach aims to create self-sustaining supply chains and establish hydrogen as a viable alternative to fossil fuels, with a clear focus on both immediate development and long-term sustainability. The framework balances the need for immediate action with long-term planning while providing support for both smaller pioneering projects and larger-scale hub development initiatives.

While this CfD scheme is designed to attract investment into this space, the 3 trillion yen in subsidies announced at the onset of 2024, according to industry experts, is not enough to sufficiently incentivise the production of low-carbon hydrogen. According to ENEOS, one of Japan's largest petroleum firms, the announced subsidies will barely cover 0.5

million tonnes of annual hydrogen supply.<sup>35</sup> Japan's current target is 3 million tonnes of hydrogen by 2030 and 12 million tonnes by 2040: thereby noting a huge discrepancy in figures.<sup>36</sup> The Japanese government needs to think of other novel approaches, such as green bonds and the use taxes to penalise higher-emission hydrogen forms, to set the groundwork necessary to jumpstart green and low-carbon projects.

### 3. Conclusion

Japan stands at a pivotal moment in the global hydrogen transition. In its Basic Hydrogen Strategy, the Japanese government clearly states that low-carbon hydrogen is critical to meeting carbon neutrality for the country. To secure its leadership in this evolving market, Japan must make a decisive shift toward green hydrogen and truly low-carbon hydrogen, including blue hydrogen that is beholden to strict emissions accounting from well to gate. This requires tightening emissions standards, adopting sub-quotas for both green and low-carbon hydrogen, and implementing a dedicated hydrogen bidding market. These actions will position Japan at the forefront of the global hydrogen economy, driving innovation and decarbonisation efforts forward.

Beyond meeting decarbonisation targets, prioritising green and low-carbon hydrogen will enhance Japan's economic competitiveness, foster technological innovation, and bolster energy security. Japan needs to create the right competitive environment for industry to see the value of green and truly low-carbon hydrogen; not just for the fact that it will help Japan meet its decarbonisation targets, but to radically redefine how Japan secures its energy future in a fiscally competitive manner. Through embracing these strategies, Japan can lead the global transition to a more sustainable, low-carbon future. The time to act is now, and Japan's commitment to this transition will shape its long-term economic and environmental landscape.

# Endnotes

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