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The Political Economy of Japan's Net-Zero Vision in the Context of Energy Security

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ABSTRACT

This article analyzes Japan's ambitious 2050 net-zero emissions target and its effects on energy security with a primary focus on the strategic role of hydrogen technology Japan's energy security dilemma lies in its dependence on fossil fuels and nuclear power, and the challenges of transitioning to renewable energy sources. Understanding how Japan's 2050 Net-Zero Vision shapes its foreign and security policies is essential, especially as hydrogen technology plays a central role in these changes. This work posits that while Japan's hydrogen ambitions offer promise, the challenge of balancing energy security with net-zero goals is complex. The high costs of hydrogen production and ongoing reliance on fossil fuels complicate Japan's energy transition and international energy partnerships. The article employs a political economy framework to evaluate the feasibility and practicality of Japan's hydrogen-centric energy strategy, taking into account both domestic policy implications and its impact on global alliances. Why environmental and climate security is often secondary to economic security in energy discussions requires further examination. The article presents theoretical perspectives on the reduction of fossil fuel dependence, the enhancement of energy self-sufficiency, and the advancement of technologies that can mitigate long-term vulnerabilities. Hydrogen plays a pivotal role in Japan's energy and climate agenda, serving as a cornerstone for both domestic objectives and international collaboration. Furthermore, the article analyses Japan's hydrogen collaborations with ASEAN and Middle Eastern countries, along with the geopolitical and economic implications. This study identifies the opportunities and challenges in Japan's transition to new energy sources and examines the broader implications of Japan's energy security for global energy dynamics. The article maps the scope of major challenges Japan faces in balancing its net-zero targets—a critical issue for both regional and global policy—while ensuring its energy security..

Keywords: Japan's Hydrogen Diplomacy", Climate Change, Energy Security, Energy Transition, Renewable Energy.

JEL Classification Codes: N00, N15, N25, N45, N75, N85, N95, O38, O53, P00

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INTRODUCTION

As the climate and energy landscape rapidly evolves, the emphasis on sustainable and reliable energy sources has become critical. Energy supply, network connectivity, energy security concerns and geopolitical dynamics play an important role in the development of climate-related policies and actions. Recognizing the impact of these factors is crucial in developing comprehensive strategies to address the climate challenges (Kumar et al., 2021; Tanaka, 2013). Given the complexity of these challenges within an often-tumultuous international system, countries may adopt diverse measures tailored to their unique contexts. In this complex environment, it is crucial to maintain a variety of technological options to accelerate the shift towards carbon neutrality (MUFG, 2022, p. 14; Peña et al., 2022).

In response to global trends and the urgent challenges posed by climate change, nations around the world are striving to redefine their energy strategies to achieve sustainability. In line with these efforts, the Japanese government, as first announced by former Prime Minister (PM) Yoshihide Suga (2020-2021), is targeting 41% for fossil fuels, 20%-22% for nuclear power, and 36%-38% for renewables in its energy mix. Under the leadership of PM Fumio Kishida (2021-2024), this vision has been maintained, with the aim of achieving a balanced energy mix by 2030. Japan's 2050 Vision also calls for the strengthening of hydrogen technologies to support the energy sector in the Middle East and the promotion of green hydrogen in the ASEAN region.

Japan's 2050 Net-Zero Vision is influenced by a number of critical political and economic factors, including the country's limited domestic energy resources, geographic constraints, reliance on undemocratic states, and vulnerability to geopolitical disruptions (Ohta & Barrett, 2023, p. 8; Watanabe, 2021, pp. 40–41). The long-standing relationship between Japan and Middle Eastern nations, which has been shaped by their shared interests in energy

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security and the global political landscape, is a key factor in understanding the region's role in Japan's foreign policy and energy security. The 1973 Oil Crisis, which was initiated by the Organization of the Petroleum Exporting Countries (OPEC), is a notable example of the influence of these nations on Japan's energy landscape. The enduring partnership between Japan and these states is expected to continue well into the 21st century, as they remain critical to meeting Japan's energy demands.

Despite the stabilization of energy flows from the Middle East, the ongoing aggression of Russia in Ukraine has brought to the fore the challenges of ensuring energy security and supply diversification (Imahashi, 2022). Japan's heavy reliance on fossil fuels poses a substantial obstacle to the achievement of the ambitious targets outlined in its 2050 Vision, and there are significant uncertainties, particularly regarding the role of nuclear power in the energy transition. Without a definitive and efficacious transition to renewable energy sources, Japan's endeavours to attain energy independence and its net-zero emissions target could be substantially hindered.

Japan, significantly dependent on energy imports, is focusing on advanced technologies to improve resource efficiency and transportation, highlighting their essential impact on economic growth and national security. As Asia progresses in its shift to renewable energy, Japan is taking steps to lower Carbon dioxide emissions by incorporating sustainable energy sources such as ammonia. The increasing emphasis on sustainable energy storage, backed by existing suppliers, represents a crucial shift in Japan's energy security approach, reconciling environmental issues with national interests. Nonetheless, as an advanced country, Japan's 2050 Vision necessitates a comprehensive assessment of the political and economic factors that affect its viability and robustness. Mentel et al. (2020) emphasize that "economic, energy, and environmental security indicators exhibit systemic interconnections" (p. 177), illustrating the complex challenges that Japan encounters. Even with these links, in Japan's energy strategy, environmental and climate security continue to take a backseat to economic security, prompting important inquiries about the reasons for not flipping these priorities (McDonald, 2013; Nyman, 2018). Tackling these problems requires additional examination and thought.

Japan's energy security is significantly influenced by its reliance on energy imports, notably fossil fuels. In pursuit of its ambitious 2050 Net-Zero Vision, the nation faces mounting pressure to achieve a sustainable energy mix while safeguarding national security. Goldthau and Sitter (2015) underscore the evolving nature of energy as a commodity and its substantial impact on global economic and national security policies. Utilising these insights, the present research adopts a political economy perspective to analyse Japan's energy security, emphasising how its 2050 net-zero goals shape its foreign and security policies, particularly through the lens of hydrogen technology. The hypothesis suggests that Japan's strategic focus on hydrogen is driving a transformation in its foreign policy and energy strategy, creating both opportunities and challenges for its regional and global influence.

The article will assess how these strategies affect Japan's energy security, relationships with key Middle Eastern energy suppliers, and leadership in the ASEAN region. Ultimately, the article aims to evaluate the feasibility of Japan's net-zero ambitions by examining the interplay between domestic energy policies, international partnerships, and the political economy of energy security. By examining strategies centered around hydrogen, this paper advances knowledge of the challenges of attaining both economic and geopolitical stability and sustainable energy security.

This paper is organized into six sections. First, it introduces "New Concepts of Understanding the Paradox of Energy Security", offering a theoretical framework that underpins novel discussions. The next section, Japan's 2050 Vision in Policies and Practices, delves into Japan's specific policies, with subsections on Hydrogen Technology for Japan's Energy Security, A Hydrogen-Based Diplomacy in the ASEAN and Middle East, which analyze Japan's strategies and international collaborations. The paper then broadens the scope to discuss the current dynamics of energy politics, placing Japan's energy policies in a global context. Finally, the findings highlight the implications of Japan's energy transition for its foreign and security posture, and discuss the challenges Japan faces in reconciling energy security with its ambitious net-zero goals.

NEW CONCEPTS OF UNDERSTANDING THE PARADOX OF ENERGY SECURITY

In the conservative classical approach, energy consumption data serve as crucial indicators of a country's level of development (Cader et al., 2021; Gao et al., 2017). Japan's overarching grand strategy is to promote and maintain prosperity and technological advancement, which are essential for the country's economic security (Samuels, 2011). Energy is one of the most significant input of the Japanese economy, which produces and

provides advanced technological transformation. Samuels (1994) coined the term "techno-nationalism" for Japan, which refers to the belief that "technology is an essential component of national security and must be indigenized, diffused, and nurtured to make a nation prosperous and powerful" (Samuels, 1994, p. x). In the 1970s, following the "1973 Oil Crisis", Japan began to address energy security as a national security issue within the Comprehensive Security Concept (Akaha, 1991). This was motivated by a techno-nationalist mindset. On the 50th anniversary of the oil shock, Japan is implementing new sustainable energy strategies in a security context due to the imminent effects of the Ukraine War, global warming, and climate change (Sekiyama, 2023). It is anticipated that the attainment of this significant goal will become a more central priority in Japan's foreign and domestic policy.

The aspects of energy security and the environment interact in systemic behaviors and functioning of living and non-living systems and create a new global environment. This complexity is indicative of a paradigm shift, as Milina (2007; 2013) stated as she called for new energy security solutions based on renewables, electrification, and digitalization to cope with modern-day surface problems. Drawing from this, scholars such as Luft and Corin (2009), Nuttall and Manz (2008), and Sovacool and Brown (2010) delve deeper into how energy security technologies have revolutionized the conduct of international relations and the environment, which expands the debate. In this debate, Nyman's "The Energy Security Paradox" offers a rather nuanced understanding of the various contradictions contained within energy security for large global energy consumers, including the US and China. Nyman's framework could be highly instrumental in explaining Japan's present dilemma of energy security as well. She posits that the complete elimination of risk is unfeasible in the context of continued reliance on fossil fuels, and underscores the imperative for a transition towards low-carbon alternatives. The work of Nyman indicates the direction in which the various resistances to traditional models of energy security are increasing, with a set of new paradigms centered on renewables starting to take hold. Furthermore, Nyman's work also considers the role of transition in the context of mobilizing energy transitions toward a low-carbon future, as explored in greater depth by Newell (2021).

Nyman's analysis assisted us in interpreting Japan's energy policy as a traditional two-dimensional approach to energy security. While the first dimension focuses on a secure supply of energy, the second dimension aims at limiting the harmful environmental impact caused by energy consumption. Japanese policy has traditionally focused on the first dimension since 1973, but this necessary focus now needs to shift to the second dimension related to climate change. This is in accordance with the global initiatives of the "UN Sustainable Development Goals" (SDGs), COP26, COP27, and the G7 Declaration (Sekiyama, 2023), which collectively emphasise the advent of a new energy era, one that is defined by a connection between power, security, and energy independence.

The Japanese 2050 Vision epitomizes the Nyman paradox of sustaining the double agenda: environmental sustainability while coupled with dependence on conventional sources. Similarly, Nyman underlines such contradiction in energy policy between the US and China, while Japan also struggles between the pursuit of sustainability and the indelible mark of conventional energy source use.

JAPAN'S 2050 VISION IN POLICIES AND PRACTICES

Japan, as a pacifist actor in the international system[1], has the lowest rate of energy independence among the G-7, at just 11%, and, remarkably, the country continues efforts to pursue the transition to greener energy sources. For the first time in history in 2023, ammonia was mentioned Leaders' Communique, as the G-7 nations, in Japan, emphasized the significance of developing and utilizing low-carbon and renewable hydrogen. Furthermore, the G-7 countries have recognised that a number of nations are investigating the potential of utilising renewable and low-carbon hydrogen and its derivatives in the energy sector with the objective of generating thermal power with zero emissions. This depends on whether this approach is consistent with the 1.5°C objective and the shared goal of a fully or largely decarbonised power sector by 2035 (*G7 Hiroshima Leaders' Communiqué*, 2023). Despite energy security and climate change being considered the primary concerns for G20 countries in recent years (Doğrul & Akpınar, 2022, pp. 9–12), disagreements that arose at the G20 Energy Ministers' Meeting once again highlighted the significance of the G7's decision made during Japan's presidency in 2023.

1 Article 9 of the Japanese Constitution: "Aspiring sincerely to an international peace based on justice and order, the Japanese people forever renounce war as a sovereign right of the nation and the threat or use of force as means of settling international disputes. In order to accomplish the aim of the preceding paragraph, land, sea, and air forces, as well as other war potential, will never be maintained. The right of belligerency of the state will not be recognized."

Russia and Saudi Arabia both opposed the G20's proposal to triple countries' renewable energy capacity, which was discussed at the India-hosted G20 summit (Iwase, 2023).

Yet, Japan's "Strategic Energy Plan" (2021) has encountered challenges in determining which energy sources to prioritize, leading to a lack of clarity on the concept of balancing energy security and environmental concerns (Odeyemi & Sekiyama, 2022, p. 18; Ohno et al., 2022, pp. 3, 20). Despite the focus on nuclear, renewable, and hydrogen energy technologies as potential alternatives, the country finds itself caught in a dilemma due to the intricate nature of the energy, the country's energy needs, and their impacts. Some point that Japan, once referred to as a "nuclear village" (Koppenborg, 2021, p. 117) must rely on nuclear energy for the foreseeable future to decarbonize, and that the government should accept this reality (Harding, 2021; Nikkei Asia, 2021). Some posit that Japan's international competitiveness may decline further due to its comparatively slower progress compared to other major industrialised countries in the global advancement of new renewable energy technologies (The Asahi Shimbun, 2022; Akimoto, 2022). Others advocate for fossil hydrogen and suggest that the government investigate zero-emission hydrogen initiatives as well as onshore wind project alternatives (Kan, 2020, p. 14). Government policy dilemmas and hesitancy also have a significant effect on public opinion regarding climate change action. Yet Japan has substantial technological potential to support behaviour modification and introduce advanced energy facilities, such as nuclear and hydrogen technologies (Ogawa et al., 2022, p. 17). By harnessing this potential, the country can enable its citizens to embrace sustainable practices and contribute to global efforts in combating climate change.

Japan has achieved notable progress in reducing greenhouse gas emissions, with a 5% decline in 2020 marking the seventh consecutive year of reductions and a total decrease of 18% since 2013 (Ministry of the Environment, 2021). However, this progress remains insufficient to meet the revised target of a 46% reduction by 2030, partly due to the impact of the global pandemic. While the temporary decrease in emissions during the pandemic was encouraging, Japan's continued reliance on polluting fuels highlights the need for substantial increases in carbon taxes and more ambitious measures to achieve its net-zero goals (Ito & Takeo, 2022). Environment Minister Tsuyoshi Yamaguchi has emphasised that achieving net-zero emissions will necessitate measures beyond the implementation of a carbon tax and the establishment of a $17.5 billion green fund (Oda & Nobuhiro, 2022). Moreover, during a visit to Gulf countries in July 2023, PM Kishida emphasised Japan's commitment to collaborating with oil-producing nations to develop sustainable and cleaner energy solutions (Kantei, 2023), thereby reinforcing the need for both domestic and international efforts to address climate challenges.

Japan's revised goal of reducing emissions by 2030 has not been met, and the pandemic has exacerbated this challenge. In January 2022, Japan requested Indonesia's assistance in lifting the one-month ban on coal exports. Furthermore, Australia provided over 40 percent of Japan's LNG imports, and the two countries recently concluded nearly $1 billion in agreements for LNG extraction in Australia (Stringer, 2023). Japan is actively pursuing diversification of its LNG import sources by investigating the possibility of additional supplies from Qatar and the UAE (Kumagai, 2023). Russia is a significant energy supplier for Japan, providing 4% of the country's crude oil imports and 9% of its LNG imports. (Nikkei Asia, 2022). In the wake of the 2011 nuclear meltdowns at the Fukushima nuclear power plant, which precipitated a significant decline in the utilisation of nuclear power reactors, there has been a discernible surge in the reliance on carbon-based energy sources (Koppenborg, 2021). Japan is still reliant on nuclear energy for decarbonisation due to the lack of viable alternatives, despite the unfortunate consequences of the Fukushima disaster. In this context, the current progress and achievement levels towards the 2030 goals provide essential data for the assessment of the feasibility of Japan's 2050 Vision. In this sense, hydrogen technology is recognized as one of the pivotal technologies for achieving Japan's challenging targets for 2050.

HYDROGEN TECHNOLOGY FOR JAPAN'S ENERGY SECURITY

In many industries, including cement, steel, chemicals, and long-distance transportation, hydrogen can take the place of fossil fuels (Mundy, 2023). Hydrogen is frequently regarded as a pivotal solution for curbing emissions in industries where regulation is challenging due to its pervasive availability, minimal emissions, and adaptability. However, the majority of hydrogen is derived from fossil fuels, representing 6% of global natural gas consumption and 2% of coal consumption (MUFG, 2022, p. 102; IEA, 2023). The production of hydrogen results in the emission of approximately 830 million tonnes of CO_2 on an annual global basis. In order to realise its full potential as a clean energy source, it is necessary to produce hydrogen using either fossil

fuels in conjunction with "Carbon Capture, Utilisation, and Storage (CCUS)", nuclear power (referred to as blue hydrogen), or renewable energy (referred to as green hydrogen) (IRENA, 2022). Based on the current state of hydrogen fuel development, initiatives are underway to improve hydrogen capabilities. Several regions and countries, including the European Union and its member states such as Germany and the Netherlands, as well as Australia, have developed national strategies for hydrogen development (METI, 2021b). In countries where decarbonisation presents significant challenges, the utilisation of hydrogen is becoming increasingly prevalent in both commercial vehicles and the industrial sector. This is facilitating the introduction of hydrogen power generation and the establishment of hydrogen supply chains (MUFG, 2022, p. 102).

Japan was among the first countries to implement a comprehensive national hydrogen strategy, having established the "Basic Hydrogen Strategy" by December 2017 (METI, 2017a). Germany and France created their national hydrogen strategies in 2020. Japan is now at the forefront of global initiatives to create a society based on hydrogen as a result. This milestone was preceded by the government's 2014 "Strategic Roadmap for Hydrogen and Fuel Cells", which was updated in 2016 and 2019 following the development of the "Basic Hydrogen Strategy" (Ohno et al., 2022, p. 3). In accordance with this strategy, the government has disclosed its intention to invest 15 trillion yen (approximately $107 billion) in the hydrogen supply over the subsequent 15-year period. This investment is intended to facilitate the increased utilisation of hydrogen and accelerate the decarbonisation process by 2023 (The Japan Times, 2023a).

Overcoming value chain obstacles is crucial to advancing a hydrogen economy, especially the high cost of green hydrogen in comparison to hydrogen derived from fossil fuels. Hydrogen's low energy density also makes it difficult to store and transport, necessitating the use of carriers like synthetic fuels, which have drawbacks of their own and infrastructure needs specific to their use (MUFG, 2022, p. 103; IEA, 2019). Furthermore, it takes a significant amount of time and money to set up the infrastructure required for the distribution of hydrogen as fuel. According to the national and international financial ramifications of hydrogenation and dehydrogenation processes, this technology might not be ready for the market just yet (METI, 2022a, p. 103).

In general, infrastructure and costs typically differ between carriers. The introduction of ammonia as a substitute fuel is consistent with three fundamental government goals in Japan. First, the nation must secure its electricity supply, especially considering that 27% of its energy is presently generated by coal-fired power plants (Venditti, 2023). At the same time, Japan is dedicated to cutting Carbon dioxide emissions from coal, a major source of greenhouse gases, as quickly as possible. Ammonia is a desirable alternative for Japan because of its developed supply chain, affordability, and technological maturity (MUFG, 2022, pp. 102–103). The Institute of Energy Economics, Japan (IEEJ, 2020) report places emphasis on the targets set out in Japan's 2020 "Green Growth Strategy." The objective is to increase the demand for hydrogen to 3 million tons by 2030 and 20 million tons by 2050. Green hydrogen, which has a minimal carbon footprint, is in alignment with Japan's commitment to reducing greenhouse gas emissions. It also mitigates risks associated with global market volatility and political pressures against the use of fossil fuels, thereby enhancing energy security. Green hydrogen offers a stable alternative to blue hydrogen and its derivatives. The latter are highly vulnerable to price fluctuations in volatile fossil fuel markets. The greater availability of renewable resources in various regions enables the exploitation of green hydrogen production potential, allowing any nation to become an exporter of green hydrogen. Diversifying green hydrogen supply chains reduces susceptibility to supply disruptions and ensures a reliable and consistent energy source (Shibata et al., 2021). These factors drive Japan's efforts to develop a robust hydrogen industry, positioning it as a pivotal element in the country's transition towards a sustainable energy infrastructure.

The biggest corporations in Japan have undertaken significant global climate change mitigation projects. Thus, it is clear that creating solutions that meet the nation's energy and climate goals by 2050 will require a strong innovation and technology environment (METI, 2017b). Nevertheless, the financial outlay required to produce renewable hydrogen in Japan is greater than in other major economies. While the European Union has set itself the objective of producing 10 million kg of ecological hydrogen on an annual basis by 2030, Japan is still lagging behind China and Europe in this regard (Ohno et al., 2022). In contrast to $2 to $4 in the US and $3 to $6 in Germany, the cost of producing one kilogram of hydrogen in Japan ranges from $6 to $9 (Mukano, 2021).

In their endeavours to address climate change on an international scale, countries are investigating the potential for new commercial opportunities in the

development of hydrogen-related technologies (Take, 2022). For example, Japan is seeking to establish a collaborative partnership with Germany in the field of hydrogen technology (Kurmayer, 2023). Mitsubishi entered into a memorandum of understanding (MoU) with a municipal utility in Hamburg to investigate the viability of converting the recently decommissioned Moorburg coal-fired power plant into a hydrogen production facility (Mitsubishi Heavy Industries, 2021). This collaboration exemplifies the joint endeavours of Germany and Japan to leverage their respective expertise in hydrogen technology and expedite the transition to cleaner energy sources.

In a recent work Goichi Iwama (2023, p. 24) presents an overview of cutting-edge hydrogen companies in Japan, with a particular focus on notable developments such as Chiyoda Corporation's establishment of a hydrogen supply base in Kawasaki, which commenced construction in 2015 and commenced power generation in 2020. In addition, Osaka Gas introduced more efficient hydrogen production equipment in 2013, while Tokyo Gas began selling hydrogen at 1,100 yen per kg and opened a hydrogen station for fuel cell buses in 2019. ENEOS improved the efficiency of hydrogen production by 20% and, together with JERA, will open Japan's largest hydrogen station in Shinagawa in 2020. Taiyo Nippon Sanso halved the price of key hydrogen station equipment, and Iwatani Corporation established a large-scale hydrogen production plant in Fukushima Prefecture, producing 900 tons per year and expanding to 53 hydrogen stations by 2020. Toshiba developed hydrogen storage for wind-powered microgrids, while Kawasaki Heavy Industries partnered with Royal Dutch Shell for hydrogen transportation (The Japan Times, 2022a). Toyota established a hydrogen refueling company, expanded production facilities, and had success with a hydrogen-powered vehicle in a 2021 race. Mitsui invested in a California hydrogen station company, and Nippon Yusen Kabushiki Kaisha collaborated with Kawasaki Heavy Industries to commercialize fuel cell ships. Toray Industries increased carbon fiber production for fuel cell vehicles, while Toyota Tsusho Corporation conducted a feasibility study for hydrogen supply at the Port of Los Angeles. Mitsubishi Power is developing a hydrogen-fired natural gas turbine by 2023, and Mitsubishi Heavy Industries produced 300,000 tons of Bakken Energy and Blue Hydrogen in North Dakota in 2022. Asahi Kasei plans to operate an alkaline water electrolysis system in 2024, Kubota aims to demonstrate a fuel cell tractor in 2023, and Nippon Steel Corp. plans a demonstration test of hydrogen-reduced iron production in Kisarazu in 2026.

The focus and investment areas for hydrogen technologies are already quite advanced in Japan. The main priority of companies is to reduce costs and to enrich carbon fuels with green and blue ammonia. However, the key factor in this process will be the central policy to be pursued in relation to the demands for technology transfer from the energy supplier countries.

HYDROGEN-BASED DIPLOMACY IN ASEAN AND THE MIDDLE EAST

In the 1980s, Japan enacted its first alternative energy law, requiring utilities to use renewable energy and natural gas (Yamamoto, 1986). Later, in order to achieve a "hydrogen society", Japan prepared a basic hydrogen strategy in 2017 (Dellatte, 2023; JEMA, 2024). Because of its proximity to Japan and wealth of renewable energy sources, the ASEAN region has a great deal of potential (Janardhanan et al., 2021, pp. 3–4) to become Japan's primary supplier of environmentally friendly hydrogen, as stated in the "Strategy and Approaches of Japan's Energy Diplomacy" (Ministry of Foreign Affairs, 2024). Japan's energy imports would be diversified and its dependence on fossil fuels would be reduced if hydrogen were produced and shipped to Japan from this region. Given the region's access to renewable electricity and hydrogen sources, this strategic decision would also improve Japan's energy security. In addition, green hydrogen production in Japan will benefit from enhanced access to renewable resources made feasible by the ASEAN electric power industry's increased decarbonization efforts (Obayashi & Golubkova, 2023). Producers and distributors of green hydrogen have the opportunity to capitalise on the ASEAN region's potential to establish an early presence in a promising market, thereby positioning themselves as leaders in the emerging hydrogen economy.

In 2023, Japan marked the "50th anniversary of ASEAN-Japan friendship and cooperation" (Ministry of Foreign Affairs, 2023b). Within the bounds of this partnership, Japan may lend assistance to ASEAN nations in formulating decarbonization policies that are both ambitious and doable, considering the unique conditions and requirements of the area. This aid can take many forms, including financial and technological aid, the exchange of useful information, and the promotion of mutually agreeable standards for infrastructure, transportation, storage, rule-making, and safety. Master plans might be based on in-depth research that was undertaken to identify local difficulties and generate specialized solutions. Stakeholder dialogues, meanwhile, may help important players in the energy transition process work together and coordinate their efforts.

The prospect of ASEAN-Japan collaboration (Ministry of Foreign Affairs, 2022) presents a tempting opportunity to advance sustainable energy practices. The geographical proximity and renewable energy resources of ASEAN nations provide an opportunity for the development of a mutually beneficial partnership is a strategic advantage for Japan. Through a series of concerted initiatives, this collaborative effort could expedite the adoption of sustainable energy technologies in the ASEAN region. There is a general aversion to security-focused alliances in this region. The enabling of major Japanese technology companies to play a crucial role in strengthening energy security, in conjunction with their investments in renewable energy sectors, could serve to enhance the effectiveness of Japanese foreign policy, while simultaneously avoiding the pursuit of short-term financial objectives. The transition to a green society, in its current form, indicates a long-term energy transformation and timetable.

On the other side the Japanese government invested approximately $1.8 trillion in fossil fuel imports between 2010 and 2022, representing a yearly average of over 3% of the country's GDP (METI, 2022b). The majority of these imports originated from Middle Eastern countries. Japan's Energy Strategy underscores the importance of fostering multifaceted collaboration with Middle Eastern oil-producing nations, extending beyond the realm of resources and energy to encompass political and security concerns. Takashi Endo (2023), General Manager of Mitsubishi Research Institute (MRI) points that "The Middle East is a key region that will have a tremendous impact on energy security as well as the Net Zero Challenge in Asia and around the world".

Concurrently, Middle Eastern energy suppliers have launched research and development programs to investigate zero-emission energy sources such as ammonia and hydrogen (Iwama, 2023, p. 21) and Qatar has 2050, Saudi Arabia 2050, and the UAE has 2060 Net Zero Vision (Iwama, 2023, p. 12). Regional policymakers have stressed the importance of fossil fuels in their energy programs, aided by Japan's sophisticated technology. This reflects a shared interest in maximizing the potential of both existing and future energy sources via the use of creative technologies. Japan has signed bilateral agreements with numerous nations, including the United Arab Emirates (UAE), Saudi Arabia, Brunei, and Australia, as part of its 2050 Vision (IRENA, 2022, p. 71). Australia, the UAE, and Saudi Arabia will be the main importers of blue and green ammonia into Japan's supply chain (IEEJ, 2020; METI, 2021a; MUFG, 2022, p. 105). The International Energy Agency (IEA) (2019) revealed that Gulf nations have set a goal of exporting one million tons of low-emission hydrogen by 2030.

In 2023, Japan initiated diplomatic negotiations with the UAE with the objective of ratifying a recent agreement pertaining to the transfer of defence equipment (Ministry of Foreign Affairs, 2023a). Furthermore, the two countries investigated prospective avenues for collaboration in the field of energy transition, with a particular focus on the advancement of the hydrogen and ammonia sectors. It is noteworthy that the UAE provides approximately 25 percent of Japan's crude imports, which serves to illustrate the significance of their energy relationship. Furthermore, the UAE has hosted the COP28 climate conference in 2023 and has expressed its readiness for a transition to new energy technologies (Michaelson & Greenfield, 2022).

As a major step to deepen their bilateral cooperation, Saudi Arabia and Japan decided in July 2023 to start a "strategic dialogue" between their foreign ministers. The signing of 26 memoranda of cooperation and understanding between Tokyo and Riyadh, in which the former committed to providing the latter with advanced technologies to enhance its solar power generation capabilities and to explore advancements in using hydrogen and ammonia as clean fuel sources, served to reinforce the decision (The Japan Times, 2023c). Following the meeting with Crown Prince Mohammed bin Salman, former PM Kishida underscored the necessity of transitioning from the conventional relationship between an oil importer and exporter to cultivate a novel global partnership in the context of the decarbonisation era (Koyama, 2023a).

In April 2020, the world's inaugural international hydrogen supply chain was established by the "Advanced Hydrogen Energy Chain Association for Technology Development in Saudi Arabia (AHEAD)". This project sought to produce methylcyclohexane (MCH) by removing hydrogen from natural gas. After that, the MCH is shipped to Japan, where the hydrogen is released through dehydration. By May 2020, the gas turbine at the "Mizue Thermal Power Plant" (Kanagawa, Japan) was powered by hydrogen that had been regenerated from MCH. Thus, in September 2020, Saudi Arabia shipped 40 tons of carbon-free ammonia to Japan, the first shipment of its kind in history (Global Status of CCS Report, 2020, p. 47). To improve research cooperation, the IEEJ and the "King Abdullah Petroleum Studies and Research Center (KAPSARC)" extended their Memorandum of Understanding on July 16, 2023. The

Saudi Arabia's pivotal role in the shift to carbon-neutral energy is what makes it significant. It actively contributes to the development of supply networks for ammonia and hydrogen, which lowers Carbon dioxide emissions. The promotion of environmentally friendly technology transfer has the potential to reinforce Japan's diplomatic ties with a Middle Eastern nation (Re-Sign of MOU with KAPSARC, 2023).

As was the case in the aftermath of the 1973 Oil Crisis, when Japan initiated a programme of resource diplomacy, this approach to securing resources has resulted in a heightened awareness of the religious, ethnic, political and policy issues that exist within the region (Yokota, 2023; Doğrul, 2019). Similarly, Japan has pursued a comparable strategy in response to its growing energy demands and expanding engagement "in the Middle East since the 1990s" (Evron, 2018). The Japanese government is keenly aware that the 2050 Vision requires the implementation of more robust measures to transform the relationship between Gulf states into a sustainable and environmentally responsible partnership. To achieve this, Japan is placing a high priority on expanding its commercial capacity in the region, which can be significantly enhanced through strategic investments in its animation, robotics, and space industries (Keidanren, 2022).

Japan's hydrogen diplomacy intersects with broader geopolitical dynamics, particularly in the context of China's expanding influence in the Middle East (Temiz, 2021). China represents a significant factor shaping Japan's prioritization of maintaining strategic ties with this region. Over the past two decades, Japan has observed a decline in its trade position, dropping from fourth to sixth place among Saudi Arabia's largest importers, while Chinese exports to the UAE have more than doubled, underscoring Beijing's growing dominance (Ninivaggi, 2023b). Despite the fact that Japan's vision for a "Free and Open Indo-Pacific (FOIP)" does not explicitly focus on the Middle East, the region's geographical significance and vast energy resources make it critical to China's Belt and Road Initiative (BRI) and an area of strategic concern for Japan (Ninivaggi, 2023b).

Japan's hydrogen strategy provides an opportunity to strengthen its influence in the region by positioning itself as a leader in clean energy technology. As China deepens its multilateral ties with the Gulf Cooperation Council (GCC), Japan closely monitors these developments to ensure it can compete effectively in fostering energy partnerships (Hui, 2016; JETRO, 2022). Expanding hydrogen diplomacy could enable Japan to counterbalance China's growing presence and solidify its role in the global energy transition, aligning its economic and strategic interests while addressing the competitive pressures posed by other global players.

Japan's foreign direct investment (FDI) has had a significant impact on the energy sectors in the Middle East. However, during the late 1980s and early 1990s, a phenomenon known as "Gulf phobia" constrained investment in the region. With the growing impact of climate change, it is increasingly anticipated that the region's economic transition from Japan to oil-producing nations will accelerate (Koyama & Krane, 2021, p. 10). Yet the Senior Manager at the Renewable Energy Institute Yuko Nishida was pointing out a shattering truth that "Historically, Japan has been highly dependent on fossil fuel imports. This is a security issue for the country, and plans to import hydrogen will only continue this trend" (Bassetti, 2022). Nishida emphasizes both the disadvantages of blue ammonia and the advantages of green ammonia as a matter of national security for Japan. She also expresses security concerns regarding China's developments in solar technology and renewable hydrogen electrolyzers. Because of this, the Japanese government is actively pursuing emerging hydrogen technologies, seeing them as promising prospects for the future.

The convergence of Japan's renewable energy objectives and the Middle East's emphasis on sustainable technology creates new opportunities for Japan's energy security policy. Japan's expertise in offshore wind energy, coupled with the Middle East's abundant fossil fuel reserves and growing interest in zero-emission technology, sets the groundwork for a thriving collaboration in energy research, development, and deployment. Such partnerships have the potential to affect the trajectory of energy systems in both regions, thereby fostering greater sustainability and resilience in the global energy landscape. While Japan's hydrogen-based diplomacy is indicative of its efforts to strengthen international partnerships and secure diverse energy sources, addressing the internal dynamics of energy politics remains crucial to ensure the feasibility of its energy transition and long-term sustainability.

THE CURRENT DYNAMICS OF ENERGY POLITICS IN JAPAN

The allocation of financial resources and the creation of policies aimed at resolving these issues are currently Japan's most important energy security concerns. Notwithstanding the government's laudable objective

of achieving net-zero emissions and the proposal by the former PM Kishida to secure $1 trillion in public and private investments for his major green transformation initiative (Japan Kantei, 2023), Japan's reliance on fossil fuels remains substantial. Shuji Hosaka, a member of the IEEJ's board of directors, underscores the pivotal function of these incentives and policies in ensuring Japan's energy security and facilitating its transition to more sustainable practices. Japan is vulnerable to geopolitical changes and variations in regional energy prices because of its reliance on Middle Eastern imports of fossil fuels (Ninivaggi, 2023b). This emphasizes how important it is for Japan to invest in domestic renewable energy resources and diversify its energy sources.

The fact that the US has a major influence on Japanese foreign policy gives rise to a second important factor in energy security policies. This restricts the nation's ability to implement autonomous policies amid Middle Eastern conflicts and crises. After the energy crises of the 1970s, there is a chance to develop a better Middle Eastern foreign policy in the long run that will secure energy demand (Doğrul, 2019). Given that energy is a key factor in strategic decision-making, it's possible that Japan's Middle East policy will eventually deviate from American policy (Ninivaggi, 2023b). Kishida, the former PM, is well-versed in the complexities of this procedure. In fact, from 2012 to 2017, he served as Foreign Minister for almost five years. He was given the duty of strengthening ties with the six "GCC members, Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE" during that time. The goal of this action was to ensure a consistent and dependable supply of natural gas and oil (The Japan Times, 2023c).

Japan's pursuit of an autonomous Middle Eastern policy is shaped by its intricate relationship with the US its principal ally and one of the globe's largest energy consumers, greenhouse gas emitters, and foremost oil producers in the wake of the shale revolution (Koyama, 2021a). While Japan's foreign policy has traditionally prioritised direct threats to national security, encompassing territorial integrity and regional stability, energy security has assumed heightened importance for Japan, given its energy dependency. For Japan, energy security is fundamental to national security and economic resilience. This perspective differs from that of the US, which has achieved greater energy independence. This dependency necessitates stable and independent relations with Middle Eastern oil producers for Japan, allowing it to secure its energy needs without being overly impacted by US policy shifts or global market fluctuations (Koyama, 2021b). Therefore, Japan's autonomous policy in the region is not merely a diplomatic preference, but rather a strategic imperative for its long-term security and economic stability.

Achieving carbon neutrality by 2050 is a significant challenge, particularly in light of Japan's high consumption of fossil energy sources. It is therefore essential to acknowledge the crucial part that renewable energy plays in enabling Japan to achieve significant growth in energy independence. Nevertheless, the transition to a decarbonised energy system requires a comprehensive strategy that encompasses enhancements to the electrical grid, advancements in renewable energy technologies and the development of energy-efficient storage batteries (Stein, 2022). Japan is actively engaged in research and development projects with the objective of increasing the use of renewable energy sources. A significant long-term objective is to achieve a 10 gigatonne offshore wind energy capacity, which would contribute 5% of the country's electricity production from renewable sources (Reuters, 2020). Japan is in a difficult position because of the complex dynamic created by the obvious oligopolistic nature of these essential materials in comparison to traditional fossil fuels (Ogawa et al., 2022, p. 11; Shiraishi, 2022). Reducing these vulnerabilities requires the development of a circular economy framework and the application of resource circulation principles. By adopting resource reclamation, wise procurement, and technological innovation practices, Japan can reduce its dependency on outside resources and promote a more resilient and sustainable energy landscape. These initiatives have global implications with regard to the mitigation of climate change and the assurance of energy security.

Japan's endeavors to embrace renewable energy sources as a transformative cornerstone are partially constrained by a substantial dependence on external resources necessary to achieve its energy transition objectives. Nevertheless, Japan's considerable technical capacity mitigates this potential barrier, positioning it as a potential leading actor in furthering energy transformation throughout the ASEAN region. Concurrently, Japan recognizes the utmost significance of establishing long-lasting institutional connections with Middle Eastern oil-producing states, a strategic approach designed to negotiate the intricate interplay of energy security, environmental transformation, and foreign policy dynamics. As these countries pursue new energy trade opportunities, their changing landscape is driving this strategic direction. Moreover, by engaging

major regional actors such as Israel and Türkiye (Doğrul, 2019), Japan's Hydrogen Society program may serve as an example of the operationalization of an energy-centered foreign policy, thereby enhancing the initiative's impact and significance. Essentially, the pursuance and dissemination of an energy-centered foreign policy emerge as decisive outcomes, harmonizing Japan's strategic imperatives with the evolving global energy landscape and diplomatic complexities.

CONCLUSION

This article has examined Japan's 2050 net-zero vision through the perspective of energy security, highlighting the strategic importance of hydrogen technology. While hydrogen offers Japan the opportunity to become a leader in the global green energy sector, significant challenges remain in reconciling these aspirations with the realities of energy security and geopolitical dependencies. The Nyman Energy Paradox has been used as a framework to illustrate the complexity of Japan's energy security challenges. Japan's 2050 vision embodies Nyman's concept of reconciling environmental sustainability with continued reliance on traditional energy sources. This contradiction, which Nyman identifies in the energy strategies of the US and China, is also evident in Japan's efforts to reconcile its bold net-zero goals with its heavy reliance on fossil fuels. For Japan, this contradiction is particularly acute because of its substantial reliance on energy imports and the systemic difficulties of transitioning away from entrenched conventional energy systems. A closer analysis of Nyman's framework provides valuable insights into the policy trade-offs facing Japan as it seeks to achieve its sustainability goals.

The political economy framework also highlights the complex interplay between Japan's energy policy and economic stability, particularly in its foreign relations with the ASEAN region and the Middle East. Strategic partnerships in these regions have been crucial in securing energy supplies and promoting technological cooperation, underscoring the importance of international cooperation in Japan's energy transition.

Japan's commitment to hydrogen technology is in line with its broader goals of achieving energy independence and reducing dependence on fossil fuels. However, this commitment faces significant obstacles, including continued reliance on gas and oil imports from the Middle East, the high cost of hydrogen production, and the challenge of integrating renewable energy sources while maintaining the role of nuclear power in the energy mix.

To address these challenges, Japan needs to adopt actionable strategies. First, strengthening its domestic energy infrastructure and accelerating the development of renewable energy technologies are essential steps. Second, reducing the cost of hydrogen production by promoting innovation and scaling up green hydrogen solutions will improve competitiveness. Third, diversifying partnerships with global suppliers and investing in hydrogen storage technology will mitigate market and geopolitical risks. In addition, addressing public concerns about nuclear energy and integrating renewables into broader public and policy frameworks can build confidence and support for the energy transition.

Japan's multi-faceted approach to hydrogen is critical to achieving its 2050 goals and positioning the nation as a leader in sustainable energy policy. As a leader in the hydrogen revolution, Japan has the potential to shape not only its energy landscape, but also the geopolitical dynamics of Asia and beyond. However, a rebalancing of priorities is needed to ensure that environmental and climate security are not secondary to economic security. By focusing on renewable infrastructure, diversifying hydrogen partnerships and fostering technological innovation, Japan can effectively align its economic and environmental goals while contributing to the global energy transition.

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