



Japan's Energy Transition: The Interplay of Renewables, Gas and Energy Security

Key insights

- Japan faces substantial challenges in managing its energy trade deficit and high end-user costs while aggressively pursuing decarbonization targets amidst geopolitical tensions. There are significant concerns about Japan's ability to meet its emissions targets, casting doubts on its broader 2050 decarbonization plans.
- The draft 7th Strategic Energy Plan proposes ambitious raised targets for renewable energy, nuclear power, and a reduction in fossil fuel use by 2040, while acknowledging that power demand will rise. However, the plan itself appears to acknowledge the challenges ahead, raising the question of just how realistic and achievable these new targets are.
- While solar power continues to show significant progress, becoming a dominant renewable energy source in Japan, other renewable sources including wind and geothermal are lagging. This slower pace in diversifying the renewable portfolio will make it more difficult for renewables to be the projected dominant component of Japan's energy mix by 2040.
- Despite strategic intention to revitalize nuclear energy alongside renewables, the continued restart of nuclear power plants faces challenges like rising safety costs, delayed approvals and wavering public acceptance, which could make it more difficult to meet targets.
- While Japan remains committed to decarbonizing its energy sector, any shortfalls in the nuclear and renewable sectors will elevate the role of LNG as a means of balancing energy supply security with decarbonization. LNG's long-term role does however keep Japan reliant on imported energy and thereby reliant on global LNG market dynamics and price volatility.
- The international market conditions and domestic policy shifts highlight the necessity for Japan to maintain a flexible and responsive energy strategy to balance its immediate energy security needs with long-term sustainability and climate commitments. The role of LNG and renewables is critical in the near term, while the future of nuclear power expansion remains uncertain.

1. Introduction

Japan's energy landscape is at a critical juncture as it approaches the 2030 climate target year, a pivotal moment for aligning ambitious goals with practical outcomes while also setting the stage for 2050. The past two years have seen soaring fuel prices and a weakening yen significantly increase the nation's fossil fuel import costs by 22.4 trillion yen, intensifying the outflow of national wealth and deepening the trade deficit.¹ This economic strain has been compounded by major global occurrences – the COVID-19 pandemic, the Russia-Ukraine and Middle East crises, and significant international climate negotiations such as COP29. Adding to this complexity is the appointment of new Prime Minister Shigeru Ishiba and his minority government, whose approach to the economy and energy policy will be crucial in defining Japan's path forward in this dynamic geopolitical landscape.

The Ministry of Economy, Trade and Industry (METI) is also currently developing the 7th Strategic Energy Plan (SEP), which aims to steer Japan's energy policy through 2035 and 2040. This plan is to focus on enhancing energy security, increasing the supply of energy to support the growth in AI and data centres, leveraging energy policy to bolster economic competitiveness, committing to updated Nationally Determined Contribution (NDC) targets under the Paris Agreement, and expanding the use of low carbon energy sources. The rise in technology and manufacturing sectors has led to an estimated increase in electricity demand by 5.37 GW by 2033, driven by data centre expansion and semiconductor production.² Thus, the draft SEP proposed in December 2024 outlines strategies for Japan to maintain its technological leadership while simultaneously advancing its decarbonization efforts.

Amid these strategic developments, the urgent need to transition away from fossil fuels and secure a stable supply of low-carbon energy sources becomes increasingly apparent. This shift is imperative not only for upkeeping Japan's climate targets but also for bolstering its global standing as a responsible member of the G7.

This insight examines the multifaceted energy strategy of Japan amidst evolving global dynamics and ambitious climate targets. Section 2 explores the landscape of key current energy policies and delves into Japan's energy transition goals, with a particular focus on the power sector. It critically assesses the efficacy and realism of these targets, probing the challenges and opportunities within the transition framework. Section 3 focuses on the critical role, dynamics, and challenges of natural gas in Japan's current and future energy mix, underscoring its significance as a transitional fuel amid broader efforts towards renewable integration and carbon reduction. As Japan navigates this complex energy transition, the interplay of renewables, natural gas, and overarching energy security concerns will be critical in defining its future energy landscape, balancing economy and technological advancements with the goal to decarbonize.

2. Japan's energy policy and transition goals

To understand how Japan aims to balance its complex objectives, it is crucial to delve into its energy policy landscape and set targets. While there are multiple cross ministerial policies that directly and indirectly guide the nation's energy transition, this paper will focus on some of the key guiding policies of Japan which play a critical role in creating Japan's energy vision.

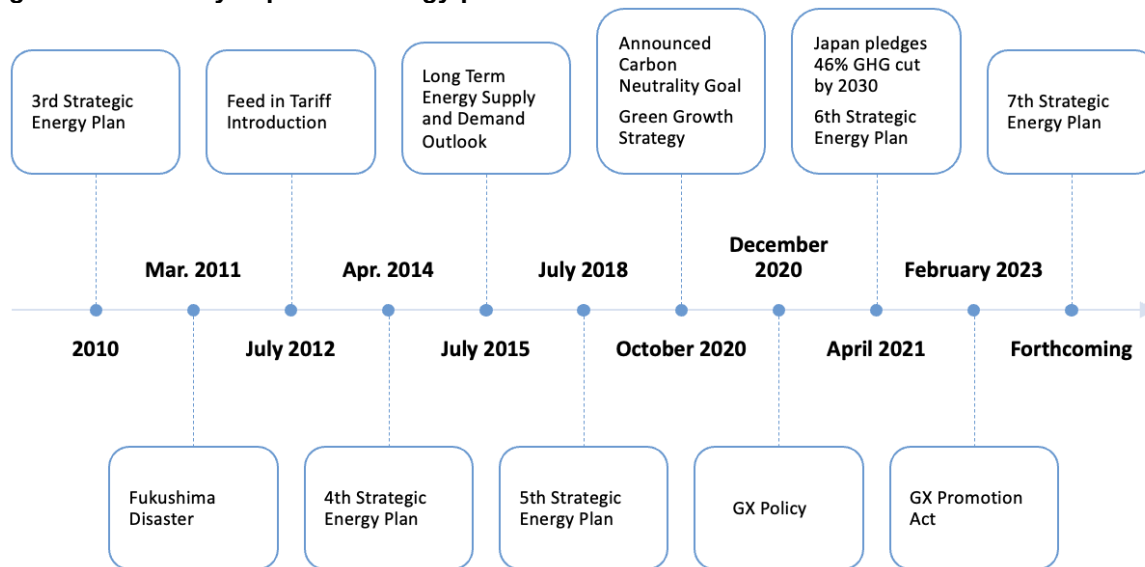
Japan's commitment to achieving carbon neutrality by 2050 is delineated in its Long-term Strategy under the Paris Agreement, which details actions and visions for reducing greenhouse gas (GHG) emissions. The execution of these goals is mapped out in the Plan for Global Warming Countermeasures, managed by the Ministry of Environment (MoE), and SEP, governed by METI. These documents, which are reviewed every three years, contribute to Japan's NDC, updated every five years. The next revision of these plans and Japan's NDC are scheduled for the fiscal year ending in March 2025.

¹ ANRE, 'Energy White Paper 2024'.

² The Japan Times, 'Japan Begins Review of Basic Energy Plan amid Spread of AI'.



Figure 1: Some key Japanese energy policies



Source: Author

In December 2022, Japan unveiled its Basic Policy for the Realization of GX, a ten-year strategic roadmap to integrate energy and environmental policies. The GX, standing for Green Transformation, is designed to shift Japan from a fossil fuel-centric structure to a clean energy model with zero CO₂ emissions.³ This policy highlights Japan's focus on leveraging decarbonization technologies to not only reduce CO₂ emissions comprehensively but also to boost industrial competitiveness and stimulate economic growth, embedding sustainable practices at the core of its economic strategy.

The following year, the Act on Promotion of a Smooth Transition to a Decarbonized Growth-Oriented Economic Structure (GX Promotion Act) was enacted under METI, setting up a framework for financing decarbonization through government bonds. It prioritizes technological innovation to achieve carbon neutrality by 2050, supported by the issuance of about ¥20 trillion in GX Economic Transition Bonds over the decade. Furthermore, to underpin these bonds, Japan plans to implement a voluntary emissions trading scheme by 2026, introduce carbon levies in 2028, and commence auctioning carbon-emission allowances to power generators by 2033.

Furthermore, the GX Vision 2040 aims to achieve both decarbonization and industrial development by 2040. It seeks to leverage Japan's robust engineering and industrial prowess to spearhead a broad green transformation, fostering synergies with digital transformation (DX) and encouraging global cooperative initiatives. The vision also focuses on optimizing industrial locations for energy efficiency, adjusting energy and data supply frameworks, and expediting regulatory reforms to bolster Japan's economic competitiveness through sustainable practices. These policy measures are supposed to aid Japan in meeting its climate ambitions while sustaining economic growth.

Japan also ambitiously revised its 2030 emissions targets to achieve a 46 per cent reduction from 2013 levels, in response to the urgent global climate goals. Progress toward this target is evident from the MoE's estimates for 2022, which show a drop in GHG emissions to 1,135 million tons of CO₂ equivalent, a 2.5 per cent decrease from 2021 and a 19.3 per cent decrease from 2013, with energy-related CO₂ emissions at 964 million tons, reflecting a 22 per cent reduction from 2013 levels.⁴ With the energy sector contributing approximately 87 per cent of Japan's CO₂ emissions in 2022, it remains a critical focus in the nation's climate strategy.⁵

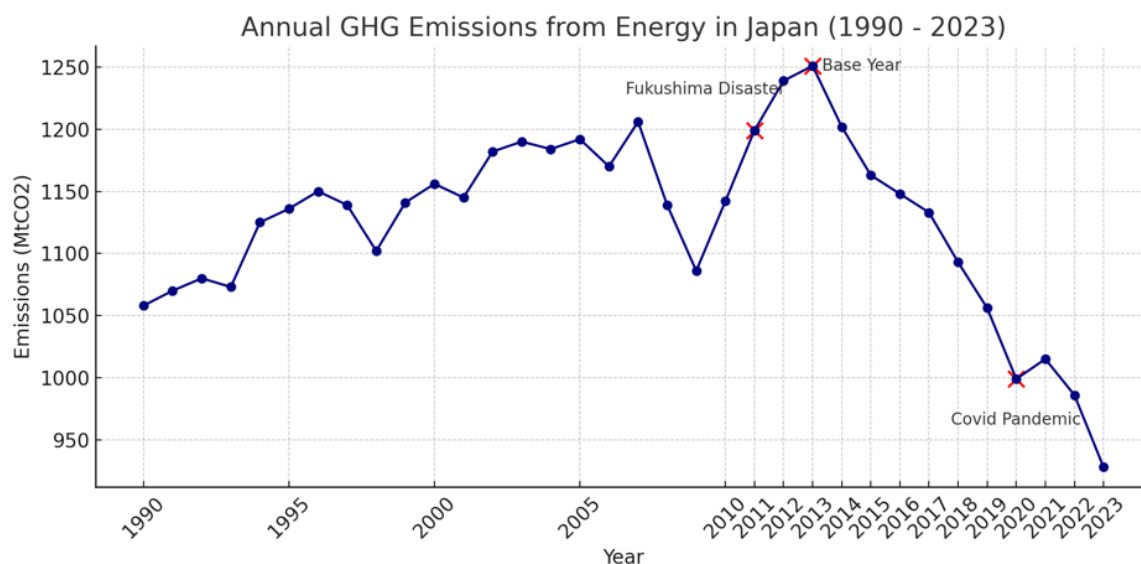
³ ANRE, 'Japan's Energy Policy toward Achieving GX (Part 1) Decarbonization Will Be Advanced on the Premise of Securing a Stable Supply of Energy'.

⁴ MoE, 'Japan's National Greenhouse Gas Emissions and Removals in Fiscal Year 2022'.

⁵ MoE, 'National Greenhouse Gas Inventory Document of JAPAN'.



Figure 2: Annual GHG emissions from the energy sector, Japan



Source: Author using IEA Data⁶

While the Japanese government maintains it is on track to meet its 2030 targets,⁷ this assertion is met with scepticism from both domestic and international observers. Critics point out that the post-Fukushima 2013 baseline witnessed a spike in fossil fuel reliance, significantly increasing the CO₂ emission factor (CO₂ emissions per kWh) which has since improved due to nuclear restarts and renewable energy growth, leading to a 281 million-ton CO₂ reduction between 2013 and 2022, with over 100 million tons attributed to emission factor improvements.⁸ Particularly contentious is Japan's methodology of using gross emission figures for 2013 – excluding forest carbon sinks – contrasted with net emissions in subsequent years, which include these sinks, potentially overstating progress. This methodological inconsistency, stemming from Japan's adaptation of the 'gross-net method' since the Kyoto Protocol, has raised doubts about the accuracy of reported emissions reductions.⁹

Further, the Institute of Energy Economics, Japan (IEEJ), reports that a third consecutive annual CO₂ emissions decline in 2024 to 909 million tons, marking a 26.4 per cent reduction from 2013, is still short of the 29.2 per cent required to align with the Paris Agreement.¹⁰ Projections by the Climate Action Tracker (CAT) suggest that without additional policy enhancements, Japan's measures will only achieve a 31-37 per cent reduction below 2013 levels by 2030, not accounting for land use changes (LULUCF).¹¹ This indicates a potential shortfall of about 10 per cent, feeding existing contentions that Japan's efforts are lagging behind other G7 nations in the race to net-zero by 2050. Amidst these challenges, METI is considering setting a target of a 60 per cent reduction by 2035 and 73 per cent in 2040 from the 2013 baseline.¹² Achieving this new target will thus be contingent on Japan's ability to substantially expand its low-carbon energy sources, reinforcing the need for strategic, actionable commitments to meet these rigorous climate benchmarks.

⁶ IEA, 'Greenhouse Gas Emissions from Energy Highlights - Data Product - IEA'.

⁷ ANRE, 'Energy White Paper 2024'.

⁸ Ohno, 'Are Japan's Emission Reduction Efforts Really "On Track"?'

⁹ Ohno.

¹⁰ Eto et al., 'Economic and Energy Outlook of Japan for FY2024'.

¹¹ CAT, 'Country Profile - Japan'.

¹² NHK, 'Japan to Set New Emission Cut Targets as Part of Plan to Fight Global Warming | NHK WORLD-JAPAN News'.



2.1 Target analysis

Power generation, including electricity and heat, remains a major source of CO₂ emissions globally and was responsible for 48 per cent of Japan’s energy-related emissions as of 2022.¹³ Recognizing its substantial impact, this Insight focuses on power generation as Japan advances towards key objectives in its energy strategy. This section critically examines the targets set by the Japanese government and evaluates the strides taken towards achieving them.

The draft 7th SEP, released in December 2024, sets forth ambitious renewable energy targets of 40–50 per cent by 2040, while aiming for nuclear power to contribute 20 per cent, and fossil fuel usage to reduce to between 30-40 per cent of the power generation mix. This draft plan is currently open to public comment and is expected to be finalized during the current fiscal year. Although the 6th SEP remains the latest confirmed plan and the primary focus for target assessment, the anticipated goals of the ongoing draft offer crucial insights into the evolving direction of Japan’s energy policy.

The 6th SEP outlines ambitious goals (Figure 3) to transform the energy sector by 2030, aiming to significantly increase the use of renewable resources while reducing reliance on fossil fuels.

Figure 3: Overview of 6th SEP targets

Electricity generated/Power source mix in FY2030

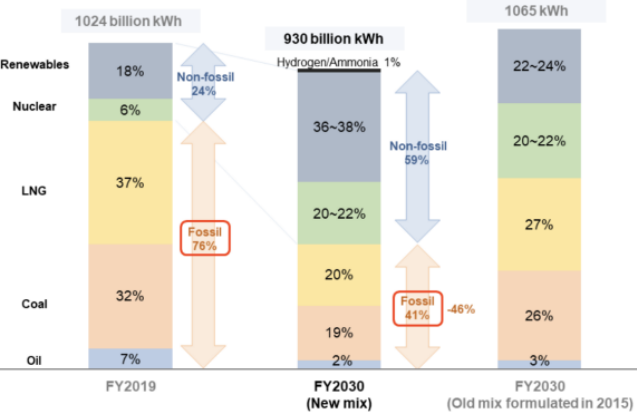
(billion kWh)	Electricity generated	Power source mix
Oil	19	2%
Coal	178	19%
LNG	187	20%
Nuclear	188-206	20-22%
Renewables	336-353	36-38%
Hydrogen/Ammonia	9	1%
Total	934	100%

(Note) Each figure is approximate and may not add up to the total figure due to rounding.

(billion kWh)	Electricity generated	Power source mix
Photovoltaic	129-146	14-16%
Wind	51	5%
Geothermal	11	1%
Hydro	98	11%
Biomass	47	5%

(Note) All figures are approximate d based on the current estimation.

Current power generation structure vs. new energy mix



Source: ANRE¹⁴

The plan targets renewable energy sources to contribute 36-38 per cent to the power generation mix by 2030, detailed as 14-16 per cent from solar photovoltaic, 5% per cent from wind, 11 per cent from hydro, 5 per cent from biomass, and 1 per cent from geothermal energy. It also introduces a new target for hydrogen/ammonia-fired power at about 1 per cent, underscoring Japan’s push to implement these new energy sources. Nuclear power is slated to provide 20-22 per cent of the energy mix, dependent on reactor restarts under strict safety measures. Conversely, fossil fuels are expected to decrease but remain substantial, with coal-fired power at about 19 per cent, LNG-fired at 20 per cent, and oil-fired maintained at a minimal 2 per cent as a last resort. These targets illustrate Japan’s strategic commitment to enhancing energy security, minimizing environmental impacts, and navigating the complexities of a global energy transition.

However, it is crucial to understand these targets temporally to comprehend the evolving vision and direction of Japanese energy policy. The table below provides an integrated overview of the SEP targets, tracing from the pre-Fukushima disaster, 3rd SEP in 2010 through to the current 6th plan. The last two columns highlight the current status of these targets as of 2023 from two different datasets, providing a snapshot of progress and areas needing focus:

¹³ IEA, ‘Renewable Energy Progress Tracker – Data Tools’.

¹⁴ ANRE, ‘Japan’s Newest “Strategic Energy Plan” toward Carbon Neutrality by 2050’.



Table 1: Overview of targets and current status

Energy Source	2010 3 rd SEP Targets	2014 4 th SEP Targets	2018 5 th SEP Targets	2021 6 th SEP Targets	2023 Current Status 1 (%)*	2023 Current Status 2 (%)**
Nuclear Energy	50%	20-22%	20-22%	20-22%	7.64%	7.5%
Renewable Energy Total	-	22-24%	22-24%	36-38%	23.96%	25.7%
- Solar PV	-	7%	7%	14-16%	10.79%	11.2%
- Wind	-	1.7%	1.7%	5%	0.90%	1%
- Hydro	-	8.8%	8.8%	11%	7.28%	7.5%
- Biomass	-	4.6%	4.6%	5%	4.86%	5.7%
- Geothermal	-	1.0%	1.0%	1.0%	(Not available)	0.3%
Fossil Fuels Total	50%	56%	56%	42%	68.53%	66.6%
- Coal	20%	26%	26%	19%	32.31%	28.3%
- LNG	20%	27%	27%	20%	32.84%	29%
- Oil	10%	3%	3%	2%	3.38%	9.3%
New Energy Sources	-	-	-	1%	(Not available)	(Not available)
- Hydrogen/Ammonia	-	-	-	1%	(Not available)	(Not available)

Source: *Ember (2024); Energy Institute - Statistical Review of World Energy (2024) from Our World in Data¹⁵

**Institute for Sustainable Energy Policies 2023 preliminary data¹⁶

As shown in the table, the Fukushima disaster of 2011 significantly reshaped Japan's energy strategy, reducing its nuclear reliance goal from 50 per cent to 20-22 per cent by 2014. A decade later, this target remains far from realization, with progress not even reaching halfway. In response to the disaster, there was a notable shift toward renewable energy, bolstered by the global movement toward climate goals epitomized by the 2015 Paris Agreement. However, the advancement in renewable sectors, particularly wind energy, has been sluggish reaching a mere 1 per cent share as of 2023. Regarding fossil fuels, the 2021 SEP aimed to reduce dependency to below 50 per cent for the first time. Yet, current trends suggest that even this adjusted target is ambitious, as the latest figures have yet to meet the benchmarks of 56 per cent target set in the 2018 SEP.

In 2023, reflecting a decreasing population and slow economic growth, electricity demand in Japan fell by 14 per cent from its peak 16 years earlier, and METI had projected a further decline of about 10 per cent by 2030.¹⁷ However, recent projections by the Central Research Institute of Electric Power Industry suggest that by 2050, additional electricity demand from data centres, etc. could increase total electricity needs by 2 per cent to 20 per cent.¹⁸ This anticipated growth underscores a significant dynamic in Japan's energy landscape, beyond the pursuit of current set targets. An Environment Ministry analysis from 2022 posited that Japan's potential is double what its total electricity generation was in 2020, including from nuclear energy and fossil fuels.¹⁹ This indicates that, theoretically, Japan has the capacity to meet its future energy requirements. Nonetheless, it prompts a critical question: Can this theoretical potential be realized in practical terms while balancing energy security and climate ambitions? The following sections delve deeper into the current status of energy targets and explore projections on how Japan might feasibly achieve them in the coming years.

¹⁵ Our World in Data, 'Electricity Production by Source'.

¹⁶ Institute for Sustainable Energy Policies, '2023 Share of Electricity from Renewable Energy Resources in Japan [Preliminary Report]'.

¹⁷ Bethune, 'The Role of LNG in the North Asian Energy Transition: Lagging Renewables Means More LNG for Longer? - Oxford Institute for Energy Studies', April 2024.

¹⁸ REI, 'Energy Transition Scenarios for Decarbonization: Based on 80% Renewables Electricity by 2035 | Renewable Energy Institute'.

¹⁹ The Japan Times, 'It's Time for Japan to Set up a Climate Change Agency'.

2.1.1 Renewables

According to the assessment by the Institute for Sustainable Energy Policies (ISEP), the share of renewable generation has consistently increased by more than one percentage point annually from 2016 to 2021, reaching 25.7 per cent in 2023 - a rise of three percentage points from the previous year (2021).²⁰ Specifically, solar power generation climbed to 11.2 per cent from 9.9 per cent, nearing the forecasted PV share for 2030 outlined in the 6th SEP. Notably, solar energy led the growth among renewable sources, followed by significant increases in biomass, which accounted for 5.7 per cent of the electricity generated, up from 4.6 per cent. Meanwhile, wind power made modest gains from 0.85-1.0 per cent, and geothermal energy slightly increased to 0.28 per cent. Hydroelectric power increased, contributing 7.5 per cent, up from 7.1 per cent the previous year. Remarkably, in May 2023, renewables (including hydro) achieved a peak share of 35.1 per cent of total electricity generated.²¹

The introduction of the feed-in tariff (FIT) scheme in 2012 has substantially accelerated the deployment of renewable energy, its ratio in the power mix was 10.4 per cent in 2011, which more than doubled by 2022 to reach 21.7 per cent.²² However, the growth has been predominantly driven by solar and biomass, with minimal increases in wind and geothermal capacities, 0.5 per cent and 0.1 per cent respectively.

Figure 4: Changes in the renewable energy ratios in the power source mix, Japan

	FY2011	FY2022	2030 New Mix
Ratio of renewable energy Electricity generated: billion kWh	10.4% (113.1 billion kWh)	21.7% (218.8 billion kWh)	36-38% (336-353 billion kWh)
Solar power	0.4%	9.2% 92.6 billion kWh	14-16% 129-146 kWh
Wind power	0.4%	0.9% 9.3 billion kWh	5% approx. 51 billion kWh
Hydropower	7.8%	7.6% 76.9 billion kWh	11% approx. 98 billion kWh
Geothermal	0.2%	0.3% 3 billion kWh	1% approx. 11 billion kWh
Biomass	1.5%	3.7% 37.1 billion kWh	5% approx. 47 billion kWh

(Note) Figures for FY2022 are taken from the FY2022 Energy Supply and Demand (Provisional Report)

Source: ANRE²³

By April 2022, Japan had achieved a significant milestone in solar energy, with 64 GW of operational solar PV capacity funded through the FIT scheme, plus an additional 13 GW installed but not yet operational, contributing 8 per cent to the electricity supply.²⁴ This is part of a broader goal to reach 104–118 GW (14–16 per cent of electricity) by 2030. However, the cost of the FIT scheme soared to approximately US\$28 billion by 2022, nearly double the cost in 2016,²⁵ prompting a gradual shift towards reducing these incentives as part of cost management and market maturation strategies.

²⁰ ISEP, '2023 Share of Electricity from Renewable Energy Resources in Japan [Preliminary Report] | Institute for Sustainable Energy Policies'.

²¹ ISEP.

²² ANRE, 'Japan's Strategy to Expand Renewable Energy Contributes to the World's Efforts toward Tripling Renewable Energy'.

²³ ANRE.

²⁴ CAT, 'Country Profile - Japan'.

²⁵ Bethune, 'The Role of LNG in the North Asian Energy Transition: Lagging Renewables Means More LNG for Longer?' - Oxford Institute for Energy Studies', April 2024.

Furthermore, as of 2022, only 6.6 per cent of homes in Japan, and 12 per cent of detached houses, have installed solar power systems.²⁶ This low adoption rate underlines a significant growth opportunity in the residential solar market, indicating a substantial untapped potential that could play a crucial role in Japan's shift towards greater sustainability. According to forecasts by RTS Corporation, even in the business as usual (BAU) scenario, annual installed capacity of residential solar PV in Japan is projected to more than double by 2035 compared to 2022.²⁷

As Japan addresses the maturation of its solar market, it also confronts challenges and potential advancements in wind energy. Unique geographic constraints, like limited availability of shallow sea areas and inconsistent westerly winds restrict the expansion of traditional wind power, but advancements in floating offshore wind technology now allow for the utilization of deeper waters, which were previously unsuitable for fixed-bottom turbines, significantly boosting the nation's wind energy potential. Estimates suggest that offshore wind power alone could produce up to eight times Japan's total electricity demand.²⁸ Following three auction rounds in 2021, 2022, and 2024, the IEA predicts that offshore wind capacity will escalate from less than 300 MW in 2023 to over 5 GW by 2030,²⁹ just shy of the government's target of 5.7 GW operational by the same year. But, given the long lead times, the 2030 capacity targets of 17.9 GW onshore and 5.7 GW offshore are considered 'unrealistic' by some experts.³⁰

Meanwhile, as per a report published by the Ministry of the Environment in 2022, Japan's total potential for wind power generation is 264 GW for onshore wind and 392 GW for offshore wind, for a total potential of 656 GW.³¹ As of February 2024, nearly 30 sea areas have been designated as either 'promotion zones' or 'promising zones', with operators assigned to eight of these areas.³² The success of these wind initiatives will hinge on overcoming regulatory complexities, technological integration challenges of intermittency, and grid capacity limitations, with the pace of progress defining Japan's ability to meet its ambitious wind energy targets.

Additionally, despite ranking third globally in geothermal potential, Japan has struggled to fully harness it due to regulatory hurdles in drilling in protected areas and resistance from onsen (hot spring) owners concerned about the impact on traditional hot springs. Nonetheless the government, has emphasized the strategic importance of leveraging Japan's volcanic activity for sustainable energy production.³³ Whether these efforts can significantly increase Japan's geothermal capacity remains a challenging prospect.

²⁶ REI, 'Energy Transition Scenarios for Decarbonization: Based on 80% Renewables Electricity by 2035 | Renewable Energy Institute'.

²⁷ RTS, 'RTS Forecasts the Annual PV Installed Capacity in Japan for FY 2030 and FY 2035 by Market Segment'.

²⁸ REI, 'Energy Transition Scenarios for Decarbonization: Based on 80% Renewables Electricity by 2035'.

²⁹ IEA, 'Renewables 2024'.

³⁰ Kikkawa, 'Toward an Eco-Friendly Future'. <https://www.nippon.com/en/in-depth/d01026/>

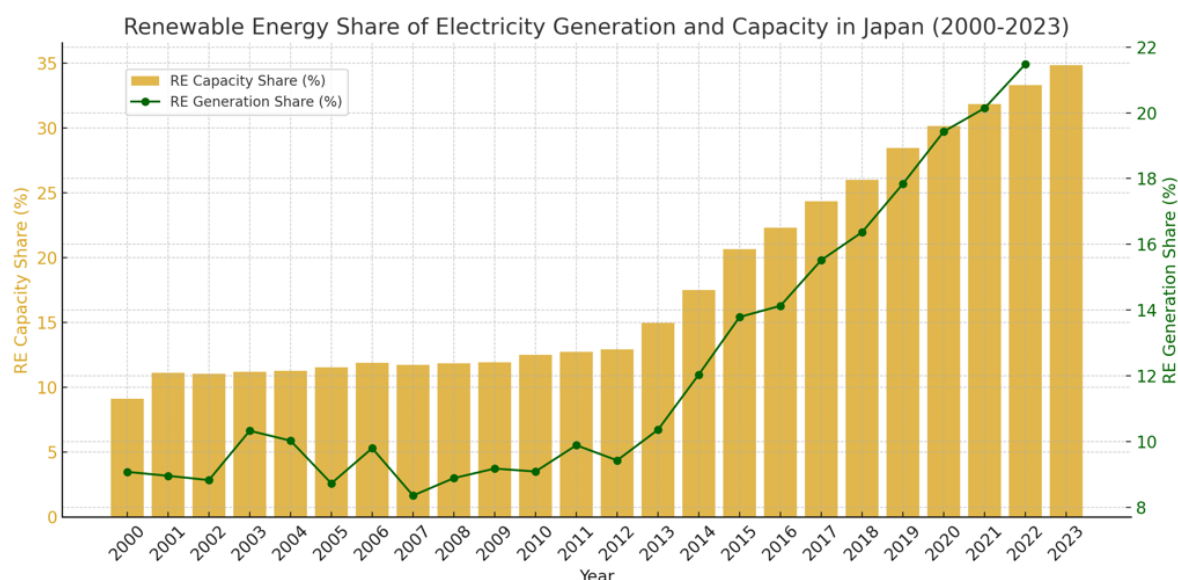
³¹ REI, 'Proposal for the 2035 Energy Mix (First Edition): Toward Decarbonizing Electricity with Renewable Energy'.

³² ANRE, 'Japan's Strategy to Expand Renewable Energy Contributes to the World's Efforts toward Tripling Renewable Energy'.

³³ Johnston, 'Where Does Shigeru Ishiba Stand on the Climate Issue?'



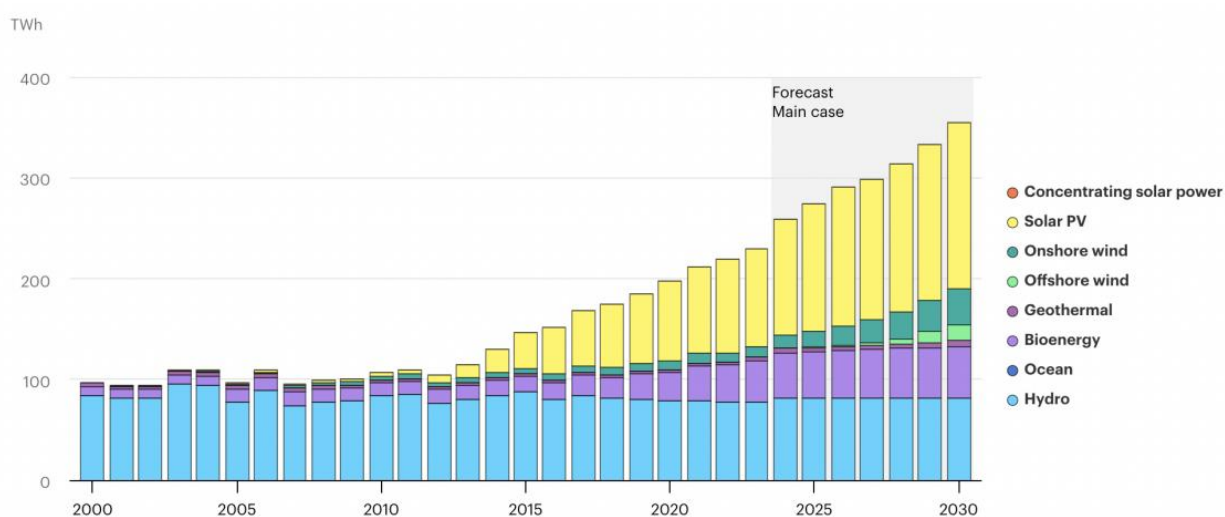
Figure 5: Renewable energy share of generation and capacity, Japan



Source: Author using IRENA data³⁴

Overall, there is a clear upward trend in both renewable energy (RE) capacity share and generation share especially post 2011 Fukushima disaster. This growth is particularly prominent in capacity, with capacity share increasing from 17.51 per cent in 2014 to 34.84 per cent in 2023, almost doubling in less than a decade. The generation share has also grown from 14.13 per cent in 2016 to 21.48 per cent in 2022, showing that Japan has managed to harness a higher proportion of its renewable capacity over time.

Figure 6: Japan's share of renewable generation, historical and forecast



Source: IEA³⁵

³⁴ IRENA, 'Renewable Energy Share of Electricity Capacity and Generation (%) by Region/Country/Area, Indicator and Year. PxWeb'.

³⁵ IEA, 'Renewable Energy Progress Tracker – Data Tools'.

The IEA's 'Renewables 2024' report projects that Japan's renewable energy installations will increase by 75 GW from 2024 to 2030, achieving a total capacity of nearly 250 GW. Solar PV is expected to drive 75 per cent of this expansion, supported by a newly implemented feed-in-premium scheme for both utility-scale and distributed projects starting in 2024. New specific targets for rooftop PV and a feed-in premium for distributed systems are also estimated to sustain capacity growth throughout the period.³⁶ Despite the optimism, the draft 7th SEP sets a lofty target of achieving 40–50 per cent renewable energy by 2040a - goal that necessitates substantial policy enhancement and infrastructure development to avert falling short without significant reforms.

Also, replicating the doubling of renewable capacity seen from 2011 to 2022 will pose significant challenges in the current decade. While technological advances, such as perovskite solar cells and floating offshore wind, could significantly boost renewable energy shares. Japan is already a global leader in solar capacity per square kilometre of flat land. Additionally, the inadequate firming capacity for intermittent renewables, such as open cycle gas, pumped hydro, and batteries, remains a critical barrier.³⁷ The sustainability of the FIT program and the necessity for substantial grid enhancements compound these challenges, further complicated by Japan's unique dual frequency grid system. This system impedes nationwide synchronization of power sources and necessitates sophisticated grid management and enhancements to ensure stability and efficiency.

There is an immediate need to further develop grid infrastructure and interconnections to facilitate the expansion and integration of renewables at the desired rate. As Japan continues to advance its renewable energy initiatives, it must also be prepared to utilize alternative low carbon resources to fill any gaps in meeting its climate targets. While not impossible, the path forward is certainly filled with substantial challenges, marking a complex yet crucial journey towards Japan's energy transformation.

2.1.2 Nuclear

Given Japan's decarbonization goals and increasing electricity demand, coupled with its significant number of currently idle nuclear reactors, it is no surprise that nuclear energy remains a topic of active discussion within the country. As of December 2024, 33 power plants are deemed operable; of these, 14 have resumed operations since 2011, and three are in the final stages of preparation for restarting. An additional 10 reactors are under inspection for potential reactivation, while nine have not sought approval for restarting. 24 reactors, including 10 operated by TEPCO in Fukushima Prefecture, are in the process of being decommissioned.³⁸ The discourse in Japan includes calls for various strategies to expand nuclear generation capacity - ranging from rebooting dormant reactors to constructing new facilities and developing next-generation nuclear technologies. Previous OIES assessment estimates that a restart of existing nuclear power plants by 2030 could generate around 200TWh per year, providing around 20 per cent of total generation requirements.³⁹

³⁶ IEA, 'Renewables 2024'.

³⁷ Bethune, 'The Role of LNG in the North Asian Energy Transition: Lagging Renewables Means More LNG for Longer?' - Oxford Institute for Energy Studies', April 2024.

³⁸ Johnston, 'Japan's Nuclear Power Plants Largely Undamaged Following Quake'.

³⁹ Lambert, 'Insight-104-Energy-Transition-in-Japan-and-Implications-for-Gas'.

Table 2: Japan's nuclear reactors status (as of December 2024)

S.No.	Power Station	Operational Units	Suspended Units	Decommissioning Units
1	Tomari	0	3	0
2	Higashidori	0	1	0
3	Onagawa	1	1	1
4	Kashiwazaki-Kariwa	0	7	0
5	Fukushima Daiichi	0	0	6
6	Fukushima Daini	0	0	4
7	Tokai Dai-ni	0	1	0
8	Tokai	0	0	1
9	Hamaoka	0	3	2
10	Shika	0	2	0
11	Tsuruga	0	1	1
12	Monju	0	0	1
13	Fugen	0	0	1
14	Mihama	1	0	2
15	Ohi	2	0	2
16	Takahama	4	0	0
17	Shimane	1	0	1
18	Ikata	1	1	2
19	Genkai	2	0	2
20	Sendai	2	1	0

Total:

- Operational: 14
- Suspended (under periodic inspection): 21
- Under Decommissioning: 23

Source: Japan Nuclear Regulation Authority

But, despite its ambitions, Japan faces significant hurdles in maintaining nuclear energy as a core component of its energy strategy. The financial implications are considerable, with projected costs for maintenance, restarting idled plants after safety upgrades, and decommissioning reaching approximately ¥13.46 trillion (\$123 billion).⁴⁰ From 2011 to March 2017, the cost to restart nuclear facilities across eight companies was around ¥1900 billion (\$17 billion), according to the Japan Atomic Industrial Forum.⁴¹ Electric utilities also contend with escalating expenses to upgrade plants to stringent new safety standards, further burdened by local opposition, lawsuits, prolonged regulatory reviews, and heightened anti-terrorism measures post-Fukushima, which now exceed ¥6 trillion (\$41 billion).⁴² Additionally, decommissioning costs for 17 reactors deemed too costly to upgrade have reached ¥849.2 billion.⁴³ Meanwhile, Japan's heavy reliance on fossil fuel energy imports, which cost about ¥27 trillion (\$172 billion) last year, underscores the economic stakes of its nuclear energy decisions.

⁴⁰ NEWS, 'Costs for Managing Japan's Nuclear Plants to Total 13 Trillion Yen'.

⁴¹ Wang, 'Japan Slowly Restarting Nuclear Reactors with Ongoing Financial and Environmental Costs | NextBigFuture.Com'. <https://www.nextbigfuture.com/2018/04/japan-slowly-restarting-nuclear-reactors-with-ongoing-financial-and-environmental-costs.html>

⁴² The Asahi Shimbun, 'Safety Costs for Nuclear Plants in Japan Now Stand at 6 Trillion Yen | The Asahi Shimbun: Breaking News, Japan News and Analysis'.

⁴³ NEWS, 'Costs for Managing Japan's Nuclear Plants to Total 13 Trillion Yen'.



Moreover, the operational lifespan of Japan's reactors is under increased scrutiny. Legislation passed in May 2023 allows periods when reactors are offline not to count towards their 60-year operational limits, potentially extending their use at a significant cost. The IEA estimates that extending a reactor's life by an additional 10 years could cost between \$500 million and \$1 billion per gigawatt.⁴⁴

Meanwhile, IEA also notes that Japan's carbon emissions from power generation would have been roughly 25 per cent higher without nuclear power.⁴⁵ Also, last year's reactor restarts contributed to an 8 per cent decrease in LNG imports, the lowest in 14 years,⁴⁶ underscoring the significant role of nuclear power in reducing both emissions and import expenses. Financial backing for nuclear energy is increasing, with fourteen leading global banks and financial institutions pledging substantial support following the objective set during the COP28 climate negotiations to triple global nuclear energy capacity by 2050. This commitment, endorsed by the World Nuclear Association, marks the first formal recognition of nuclear energy in a COP agreement as a crucial solution to climate change.⁴⁷

Despite these efforts, Japan is projected to miss its 2030 nuclear target, estimating only about 15 per cent nuclear power generation ratio by then.⁴⁸ However, the draft 7th SEP sets an ambitious target of 20 per cent nuclear power generation by 2040, which represents a substantial expansion from the 180 billion to 200 billion kWh target for 2030 to about 220 billion to 240 billion kWh.⁴⁹ Renewable Energy Institute (REI) posits, if all pending restarts and operational extensions are approved, and operate at a 70 per cent capacity factor, they could contribute up to a maximum of 11 per cent of Japan's electricity.⁵⁰ Further, it has been estimated that to maintain a 20 per cent ratio by 2050, between 37 and 50 reactors would need to be operational,⁵¹ a daunting challenge given the varying public opinion, stringent process, construction timelines and a lack of clarity on the way ahead from the Japanese government.

As Japan navigates these complexities, if nuclear restart does not materialize as planned the question of which energy source will bridge the anticipated gap remains open, highlighting the challenging road ahead for Japan in achieving its energy transition goals.

2.1.3 Fossil fuels

Despite targets set in the 6th SEP to reduce reliance on fossil fuels to below 50 per cent for the first time, Japan remains heavily dependent on fossil fuels, with over 60 per cent of its electricity generation in 2023 still sourced from coal and liquefied natural gas (LNG).

Japan intends to close or suspend about 90 per cent of its inefficient coal-fired power plants, which includes approximately 100 facilities. The US Energy Information Administration (EIA) estimates that the closure or suspension of the 100 oldest plants, representing around 24 GW of coal-fired capacity, could reduce Japan's total installed coal capacity by roughly 40 per cent, with only 1.2 GW of new coal capacity currently under construction.⁵² JERA, one of Japan's largest energy companies, has hence committed to phasing out inefficient coal-fired power plants by 2030 and aims to convert all remaining coal plants to utilize ammonia by the 2040s, ultimately eliminating coal use entirely.⁵³ On the other hand, Japan notably is the only G7 nation still planning to construct new coal-fired plants, a move that contrasts sharply with the 2022 G7 pledge to achieve 'fully or predominantly' decarbonized electricity sectors by 2035.⁵⁴

⁴⁴ IEA, 'Nuclear Power in a Clean Energy System – Analysis'.

⁴⁵ IEA, 'Nuclear Power and Secure Energy Transitions – Analysis'.

⁴⁶ Golubkova, 'Japan to Keep Nuclear and Boost Renewables, New Industry Minister Says'.

⁴⁷ ANRE, 'Nuclear Energy Utilization Attracts Global Attention under the Spotlight at COP28'.

⁴⁸ Obayashi and Golubkova, 'In Japan, Energy Security Fears Put Nuclear Back in Favor for 2040 Plan'.

⁴⁹ Koyama, 'Japan Drafts 7th Strategic Energy Plan'.

⁵⁰ REI, 'Energy Transition Scenarios for Decarbonization: Based on 80% Renewables Electricity by 2035 | Renewable Energy Institute'.

⁵¹ Suzuki, 'Japan's Changing Nuclear Energy Policy'.

⁵² EIA, 'Japan's Energy Policies Aim to Reduce Use of Fossil Fuels in Electricity Generation - U.S. Energy Information Administration (EIA)'.

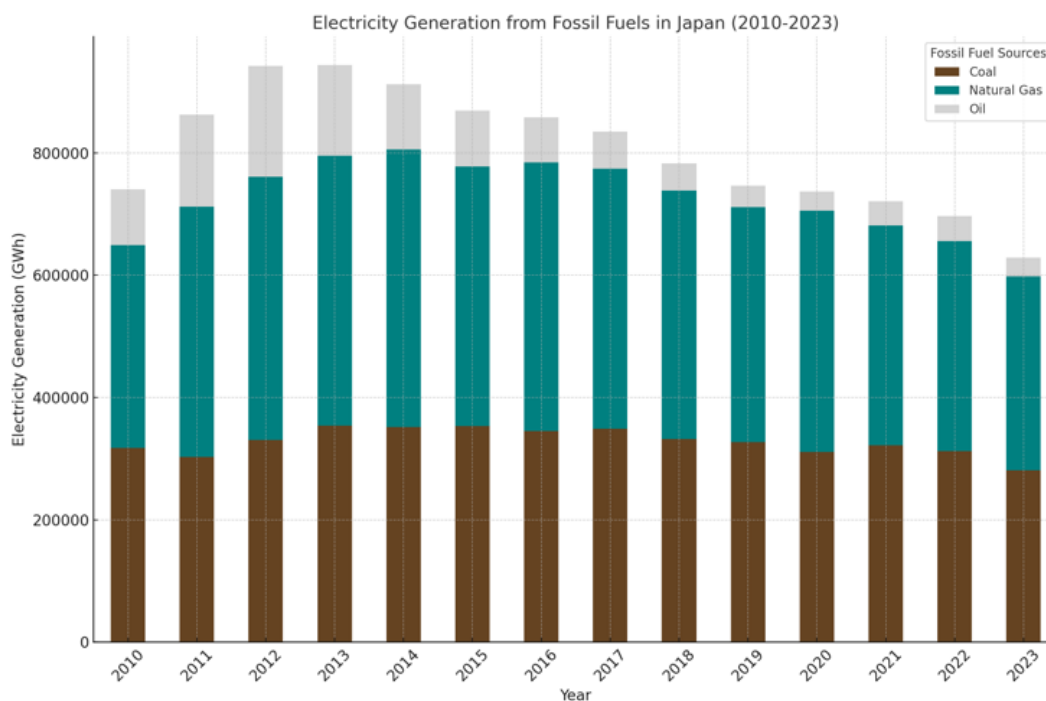
⁵³ The Japan Times, 'Jera Warns of Switching Investment from Australia over Lack of Support - The Japan Times'.

⁵⁴ CAT, 'Country Profile - Japan'.

To potentially maintain up to 12 GW of existing coal-fired capacity post-2030, Japan is considering two proposals: mixing at least 20 per cent ammonia with the coal supply or blending at least 25 per cent wood pellets into the coal boilers.⁵⁵ These methods aim to reduce CO₂ emissions sufficiently to keep the plants operational. While the wood pellet initiative is advancing, ammonia integration is still in the experimental stages, raising concerns about the feasibility of this technology and the potential need to keep older plants operational or build new ones - both of which could compromise Japan's and global climate objectives.

Oil usage, on the other hand, spiked significantly in 2011 and 2012, which could be attributed to immediate needs post-nuclear shutdowns in the aftermath of Fukushima disaster. However, there has been a consistent decline in the reliance on oil for electricity, indicating a substantial move away from oil as a primary electricity source.

Figure 7: Electricity generation from fossil fuels, Japan



Source: Author using IEA Data

The ongoing reduction in coal and natural gas usage (as seen in Figure 7) is theoretically supported by the expansion of nuclear and renewable energy capacities. However, concerns persist about Japan's continued reliance on fossil fuels and the associated emissions if nuclear and renewable sources cannot meet growing energy demands. The draft 7th SEP aims to reduce fossil fuel usage to between 30-40 per cent of Japan's power generation mix. However, the plan notably lacks detailed breakdowns of fossil-fired power generation shares within this range, raising questions about the transparency and specifics of managing this significant portion of Japan's energy strategy. This omission highlights areas in the policy framework needing clearer governance to effectively meet Japan's energy transition goals. This critical assessment of the present and projected role of natural gas within the Japanese energy system is further explored in Section 3.

⁵⁵ EIA, 'Japan's Energy Policies Aim to Reduce Use of Fossil Fuels in Electricity Generation.'

2.1.4 Emerging technologies

The 6th SEP outlines ambitious targets for integrating hydrogen and ammonia into Japan's energy mix, aiming for a 1 per cent share by 2030 and to ramp up consumption to 20 million tons per year by 2050. To underpin this vision, Japan introduced the 'Hydrogen Society Promotion Act' and the 'CCS Business Act' in early 2024, providing robust support for hydrogen technologies and establishing a framework for the safe operation of carbon capture and storage (CCS) projects. Additionally, the government has pledged ¥15 trillion to enhance the annual hydrogen supply to 12 million tons by 2040.

Despite these plans, Japan faces significant challenges, including technological uncertainties, economic constraints, and dependence on international supply chains. The recent failure of the Japan-Australia hydrogen cooperation, a critical part of Japan's hydrogen strategy, due to technical and economic issues exemplifies the complexities of relying on international partnerships for a stable hydrogen supply.⁵⁶ The policy has also been criticized for favouring low-priority applications and fossil-fuel-based hydrogen over domestic green hydrogen production, highlighting severe flaws in strategy execution.⁵⁷

Moreover, while ammonia combustion does not produce CO₂, its production is energy-intensive and accounts for 1.3 per cent of global CO₂ emissions. The environmental impact of ammonia's lifecycle emissions, especially on air and water quality, raises concerns as Japan targets consumption of 3 million tons by 2030 and 30 million tons by 2050.⁵⁸ Research based on data from JERA's Hekinan plant indicates that lifecycle air pollution from ammonia increased by 67 per cent when used at a 20 per cent co-firing ratio due to emissions from shipping and combustion.⁵⁹

Japan also possesses a theoretical CO₂ storage potential of 146 billion tonnes, enough to offset over 100 years of its current annual CO₂ emissions, primarily located in waters less than 200m deep around its coast. Although significant seismic surveys have identified several major storage sites, identifying three major locations each with 1-5 billion tonnes of storage capacity, realizing this potential requires extensive infrastructure development, for capturing, transporting, and potentially storing CO₂.⁶⁰ The Tomakomai demonstration project in Hokkaido, which has successfully stored 300,000 tons of CO₂ offshore, demonstrates Japan's commitment to CCS, although it remains a minor contributor in the face of extensive industrial emissions.⁶¹ In an effort to expand its carbon management strategies on an international scale, Mitsubishi Heavy Industries launched the world's first CO₂ carrier in 2023, enhancing Japan's ability to transport captured carbon across maritime networks and supporting decarbonization efforts in Asia.⁶² But, the Intergovernmental Panel on Climate Change ranks CCS as a less effective and costly method for avoiding emissions in the near term compared to other energy supply strategies.⁶³

Despite the focus on 'clean coal' technologies, CCS, and the co-firing of ammonia and hydrogen, these initiatives lack the scale and cost-effectiveness necessary for significant emissions reductions, particularly when juxtaposed with the more economical and environmentally friendly renewable energy solutions.⁶⁴ There is a concern that these efforts may inadvertently extend reliance on fossil fuels, delaying investments in renewable technologies that could expedite Japan's transition to a carbon-neutral future. Moreover, the draft SEP under its 'risk scenario' also acknowledges uncertainties over the development pace and costs of technologies like CCS and hydrogen, which could hinder meeting targets and lead to increased procurement of LNG to compensate for the shortfall. The current impact of these technologies on Japan's 2030 energy targets is minimal, casting doubt on their significant role by 2050, while the specific mechanisms and strategies to enhance CCS implementation remain vague within the current framework.

⁵⁶ Akimoto, 'The End of Japan's Hydrogen Rush in Australia?'

⁵⁷ Collins, "'A Complete Failure' | Japan's "Fantasy" Hydrogen Strategy Does Nothing for Decarbonisation'.

⁵⁸ Giseburt, 'Japan Sticks with Climate Solution That Critics Say Is Far from Clean'.

⁵⁹ Giseburt.

⁶⁰ Lambert, 'Insight-104-Energy-Transition-in-Japan-and-Implications-for-Gas'.

⁶¹ Coca, 'Can You Really Just Sweep Your CO₂ Emissions Underground?' <https://www.vox.com/future-perfect/353432/can-you-really-just-sweep-your-co2-emissions-underground-japan-is-about-to-find-out>

⁶² Coca.

⁶³ Otake, 'Japan Pushes Fossil Fuel Tech in Asia Carbon Neutrality Initiative - The Japan Times'.

⁶⁴ CAT, 'Country Profile - Japan'.

3. Placing natural gas in Japan's energy transition

As Japan confronts the challenge of meeting its energy and climate goals, several gaps are anticipated due to nuclear power not meeting its projected contribution, potential delays in the scalability of wind energy, and uncertainties surrounding the commercial deployment of emerging technologies like CCS. In this context, natural gas remains essential to Japan's energy strategy, largely due to its pivotal role in the global LNG ecosystem. Despite its dependency on LNG imports and limited domestic reserves, Japan has strategically positioned itself as a major player in the global LNG market. With ownership of the world's largest LNG fleet and frequent shipments every six hours, Japan's influence on the \$250 billion LNG market is significant, demonstrating its critical role over the last five decades.⁶⁵

Amidst ambitious emission reduction and decarbonization targets, while the role of renewables is undeniably crucial, Japan also recognizes natural gas as a vital transition fuel. Political and corporate leaders in Japan view it as a key intermediary in the energy transition, particularly for its capacity to reduce dependence on coal and to support the intermittent generation from renewable sources. Advocates highlight that gas-fired plants emit roughly half the CO₂ of coal-fired plants.⁶⁶

3.1 Current status and future role of gas in Japan

In the wake of the 2022/23 gas supply shock, global natural gas markets have rebounded with demand poised to reach record levels in 2024 and 2025, primarily driven by Asian markets. Despite these IEA growth forecasts – with a projected increase of 2.5 per cent to 4,200 billion cubic meters by the end of 2024 and an additional 2.3 per cent by 2025 – the global gas balance remains precarious due to limited LNG supply growth, currently the slowest since 2020 at 2 per cent, and ongoing geopolitical tensions.⁶⁷ However, supply is expected to surge by nearly 6 per cent in 2025 as major LNG projects commence operations. This is part of a broader rapid expansion in global LNG production capacity anticipated by the Institute for Energy Economics and Financial Analysis (IEEFA), projecting an increase from 474 MTPA in 2024 to 666.5 MTPA by 2028 – a 40 per cent growth within five years, marking the fastest in the industry's history.⁶⁸

Contrastingly, long-term projections for gas demand vary significantly: the Gas Exporting Countries Forum expects a 30 per cent increase from 2022 levels by mid-century, reaching 5,360 billion cubic meters, while the IEA contends that achieving climate goals would necessitate a drastic cut in gas consumption by 78 per cent to 900 billion cubic meters by 2050.⁶⁹ Even under less stringent conditions, a 42 per cent reduction to 2,400 billion cubic meters is anticipated. Complicating the future market dynamics, the IEEFA also warns of a potential LNG oversupply by 2026, as new export capacities might exceed the slower-than-expected growth in demand.⁷⁰ As global natural gas markets face uncertain futures, Japan's energy strategy will play a pivotal role in navigating these international dynamics. The following sections will delve deeper into the specific demand and supply trends affecting Japan, assessing how these factors shape Japan's ability to meet its energy needs and climate commitments in an increasingly complex global landscape.

3.1.1 Demand

Japan, once the world's largest LNG importer, saw an 8 per cent drop in LNG demand in 2023, reaching its lowest levels since 2009 (67 MTPA), and marking a 20 per cent decline in annual LNG imports since 2018.⁷¹ Historically, gas demand in Japan grew steadily from 1990, with a surge following the 2011

⁶⁵ Stapczynski, Chen, and Wu, 'Japan's Global Gas Empire Fuels Worries About Climate Change'.

⁶⁶ Stapczynski, Chen, and Wu.

⁶⁷ IEA, 'Global Gas Security Review 2024'.

⁶⁸ IEEFA, 'Global LNG Outlook 2024-2028'.

⁶⁹ Clark and Stapczynski, 'Is Natural Gas a Fossil Fuel Trap or a Bridge to Clean Energy? - Bloomberg'.

⁷⁰ IEEFA, 'Global LNG Outlook 2024-2028'.

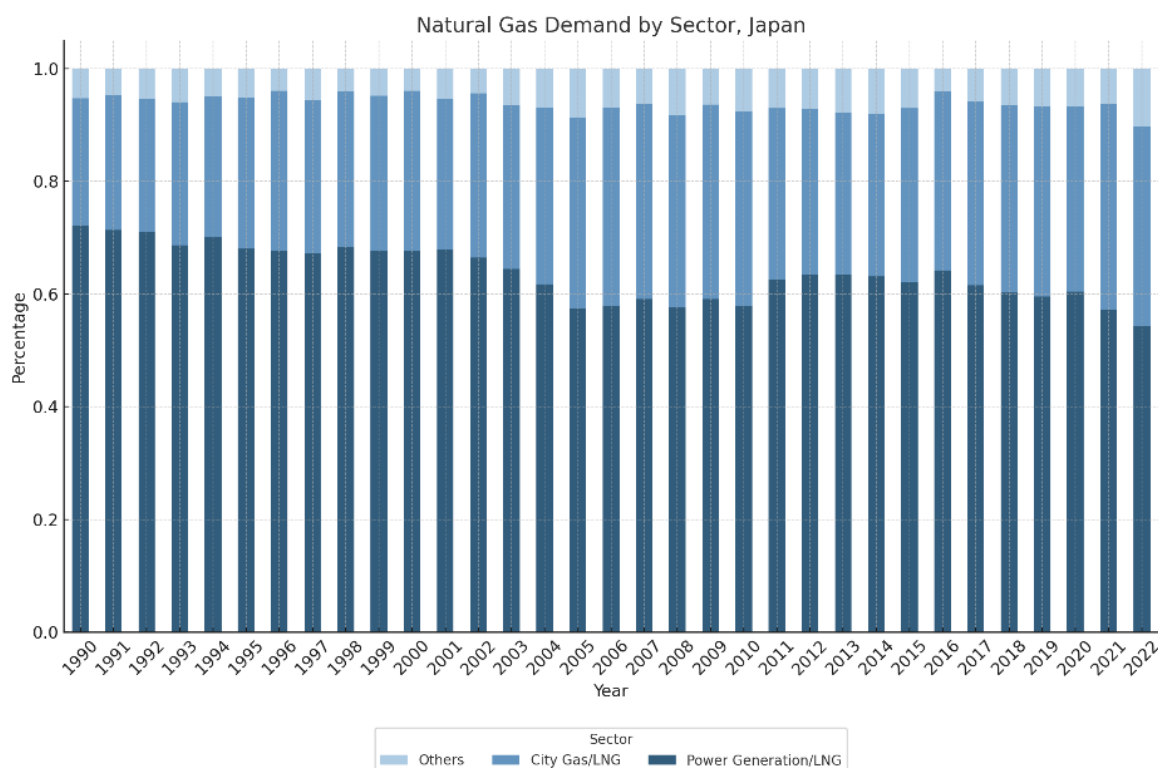
⁷¹ IEEFA.



earthquake, peaking at 4,409 PJ in 2014, which accounted for 23 per cent of the primary energy supply. However, demand has since dropped by 21.6 per cent, down to 3,455 PJ in 2022, reducing gas's share of primary energy to 21 per cent.⁷²

In 2024, Japan's gas demand remained mostly stable year-on-year. The industrial sector saw a 3 per cent decline in demand from January to June, primarily due to economic sluggishness, but this was balanced by slight growth in the residential and commercial sectors (0.5 per cent) and a 3 per cent increase in gas-fired power generation from January to May, prompted by colder-than-usual temperatures in March.⁷³

Figure 8: Natural gas demand by sector, Japan



Source: Author using JOGMEC data

Gas use in Japan is primarily driven by power generation, which consumes about two-thirds of the gas supply, with the remainder split across industrial, residential, and commercial sectors.⁷⁴ The future of gas in Japan thus depends heavily on its role in electricity generation. In 2022, the electric power and industrial sectors consumed 82 per cent of the natural gas used in the country.⁷⁵ However, over the decade leading up to 2023, while coal consumption decreased at an average annual rate of 1.1 per cent, natural gas usage saw a much steeper average annual decline of 2.9 per cent, likely driven by lower costs of coal.⁷⁶ This shift towards coal, despite its lower cost, exacerbates the challenge of reducing emissions, as coal combustion is significantly more carbon-intensive than natural gas.

⁷² Bethune, 'The Role of LNG in the North Asian Energy Transition: Lagging Renewables Means More LNG for Longer?' - Oxford Institute for Energy Studies', April 2024.

⁷³ IEA, 'Global Gas Security Review 2024'.

⁷⁴ Bethune, 'The Role of LNG in the North Asian Energy Transition: Lagging Renewables Means More LNG for Longer?' - Oxford Institute for Energy Studies', April 2024.

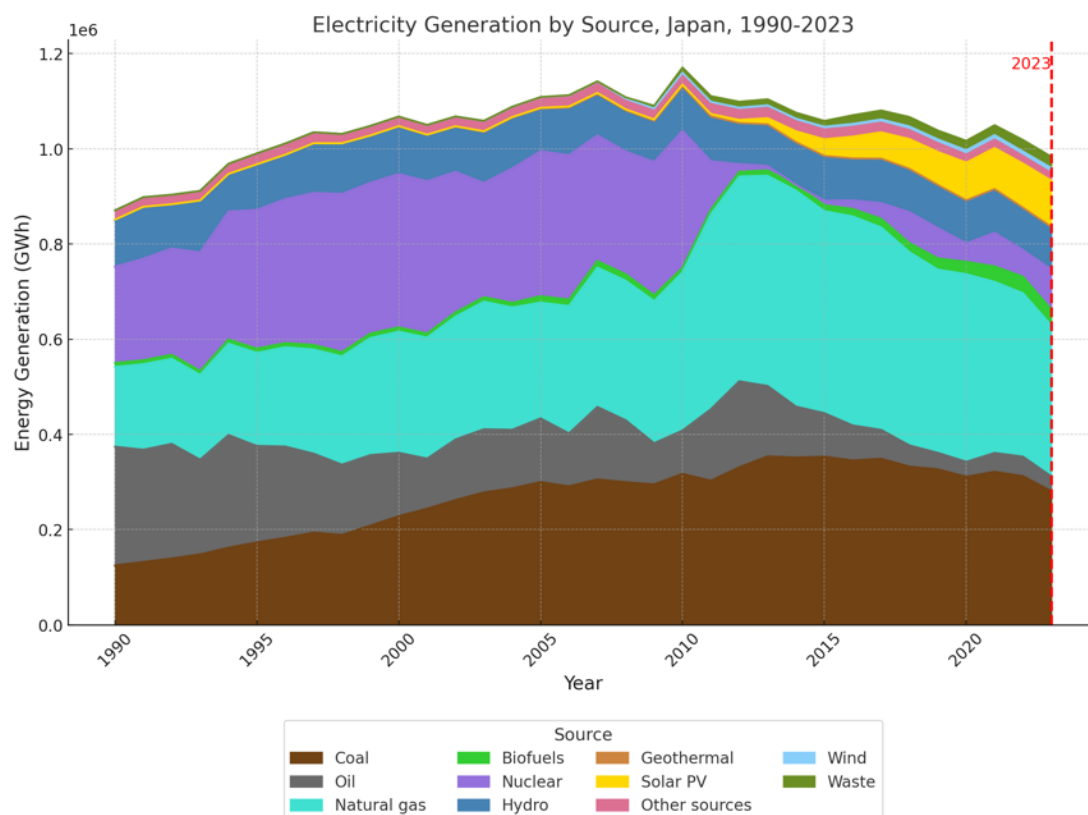
⁷⁵ EIA, 'Japan's Energy Policies Aim to Reduce Use of Fossil Fuels in Electricity Generation - U.S. Energy Information Administration (EIA)'.

⁷⁶ Bethune.

In line with its ambition to reduce reliance on fossil fuels, Japan aims to reduce LNG's share in power generation to 20 per cent by 2030. LNG's contribution to power generation, which was 409 TWh in 2019 (requiring about 50 MTPA of LNG), is expected to decrease to as low as 187 TWh by 2030, or roughly 24 MTPA, according to METI's plan.⁷⁷ OIES Insight 148 projects that this shift would mean a decline in LNG imports from 66 Mt in 2023 to around 47 Mt by 2030.⁷⁸ IEEFA estimates that the 6th SEP projected reduction in LNG-fired generation could decrease LNG imports by between 25.7 MTPA and 31.6 MTPA from 2019 levels.⁷⁹

Since 2019, LNG consumption in Japan's power sector has steadily declined as more nuclear reactors have resumed operation. In 2022, Japan's natural gas consumption fell below 2009 levels, primarily due to slower economic growth, reduced industrial demand, high LNG prices, and continued energy efficiency improvements. US EIA highlights that the restart of five nuclear reactors in 2018 alone contributed to a 7 per cent reduction in LNG imports in 2019, with another 7 per cent drop from 2019 to 2022; while anticipating that this decline would continue.⁸⁰

Figure 9: Electricity generation by source, Japan



Source: Author using IEA Data

Japan's planned increase in nuclear and renewable generation, coupled with elevated LNG prices and policy-driven climate objectives, is expected to further reduce LNG demand. By 2025, nuclear restarts at Shimane Unit 2 (already restarted in December 2024) and Kashiwazaki-Kariwa Units 6 and 7 are projected to bring Japan's operable nuclear capacity to 15.9 GW, with IEEFA estimates suggesting

⁷⁷ Lambert, 'Insight-104-Energy-Transition-in-Japan-and-Implications-for-Gas'.

⁷⁸ Bethune.

⁷⁹ IEEFA, 'Global LNG Outlook 2024-2028'.

⁸⁰ EIA, 'Japan's Energy Policies Aim to Reduce Use of Fossil Fuels in Electricity Generation - U.S. Energy Information Administration (EIA)'.

these restarts alone could cut LNG imports by 5.3 MTPA. Should the additional 11 reactors currently under review resume operations, LNG demand could potentially fall by another 12.5 MTPA.⁸¹ Similarly, according to IEA, a 3 per cent reduction in gas demand is anticipated by 2025, largely due to heightened nuclear availability and renewable energy contributions.⁸²

However, delays in nuclear restarts, along with recently renewed government subsidies for gas and electricity consumers, could temporarily increase gas consumption in both city gas and power sectors. Bloomberg notes that if the restarts of the upcoming five reactors are delayed even by a few months, it could increase average system prices by 1 per cent in the year leading up to July 2025 and necessitate approximately 20 additional cargoes of LNG to meet the country's power sector demands during this period.⁸³

Nevertheless, the trajectory of LNG in energy transition is highly variable, influenced by sectoral needs, regional differences, and evolving timelines. Emerging technologies, especially the rise of data centres and artificial intelligence (AI) and related semiconductor value chain, could potentially increase demand for gas-fired power due to its reliability and cost-effectiveness as a stable energy source, positioning it favourably alongside nuclear and hydro power. The draft SEP already anticipates a significant rise in Japan's electricity demand, projecting an increase to between 1.1 and 1.2 trillion kWh by 2040, up 10-20 per cent from 984.4 billion kWh in 2023.⁸⁴ Wood Mackenzie estimates that assuming gas will account for 40 per cent of requirements, total gas demand for data centres and semiconductor manufacturing across Japan and Korea will claim around 3 per cent of the regional LNG demand by 2030.⁸⁵

Thus, the future demand for natural gas in Japan will hinge on the scale of renewable energy growth and the pace of nuclear restarts. Additionally, fluctuations in LNG prices, given Japan's dependence on imports, along with varying economic recovery phases could significantly sway demand patterns. This will likely lead to short-term spikes or drops in natural gas consumption, depending on industrial output and energy prices, shaping a landscape where energy strategies must remain flexible and responsive to evolving conditions.

3.1.2 Supply

Japanese government officials and industry leaders emphasize the importance of maintaining robust LNG supplies to keep the nation's energy strategy flexible. This necessity is also partly driven by competitive pressures, especially from China, which recently surpassed Japan as the world's largest LNG consumer.⁸⁶ As Chinese firms expand their long-term LNG contracts and trading operations, Japan faces escalating competition from China and India in a tightening market, posing significant risks to its energy security and economic efficiency.⁸⁷

To mitigate these risks, Japan has enhanced its strategic reserves, introducing the Strategic Buffer LNG (SBL) in December 2023. This initiative ensures preparedness against supply disruptions, starting with at least one LNG cargo each month during peak winter demand from December 2023 to February 2024.⁸⁸ Keidanren, Japan's major business lobby, has advocated for the expansion of the SBL program, reinforcing its significance for both industry and the broader economy.⁸⁹ Additionally, while Japan lacks underground gas storage, it maintains about 12 billion cubic meters of LNG storage capacity across

⁸¹ IEEFA, 'Global LNG Outlook 2024-2028'.

⁸² IEA, 'Global Gas Security Review 2024'.

⁸³ BloombergNEF, 'Power Market Outlook'.

⁸⁴ Koyama, 'Japan Drafts 7th Strategic Energy Plan'.

⁸⁵ Omarali, 'Will Gas Fuel Asia's Data Centre Boom?'.

⁸⁶ Stapczynski, Chen, and Wu, 'Japan's Global Gas Empire Fuels Worries About Climate Change'.

⁸⁷ ANRE, 'Here's More about the 6th Strategic Energy Plan -Thermal Power Generation to Be Decarbonized While Ensuring a Stable Supply of Electricity-'.

⁸⁸ Bethune, 'The Role of LNG in the North Asian Energy Transition: Lagging Renewables Means More LNG for Longer?' - Oxford Institute for Energy Studies', April 2024.

⁸⁹ Bloomberg, 'Japan's Biggest Business Lobby Calls For Nuclear Power Expansion'.



more than 30 receiving terminals, equivalent to over a month's consumption.⁹⁰ But METI is exploring financial incentives for companies to expand this capacity domestically and abroad, strengthening the SBL program and Japan's overall energy security.⁹¹

Internationally, Japanese companies are proactively investing in overseas energy projects to secure LNG supplies. For instance, JERA has invested \$1.4 billion in an Australian LNG project and established agreements with US-based LNG projects, such as a partnership with Freeport LNG in Texas. Similarly, Mitsui & Co. is involved in projects in Vietnam, the US, and the UAE, reflecting Japan's strategic pursuit of reliable energy resources.⁹² These long-term agreements are considered crucial for ensuring Japan's energy security, enabling the country to diversify its supply sources and reduce vulnerability to price volatility and geopolitical disruptions.

Australia has historically been a major LNG supplier to Japan, but it is believed that its dominance is waning. Even though Japanese companies like LNG Japan and JERA recently invested in Woodside's Scarborough LNG project, these remain tentative, with non-binding offtake agreements, and Japan is increasingly exploring alternative suppliers from Asia, the Middle East, and the United States, with Australian LNG exports peaking and facing regulatory and environmental challenges.⁹³ This shift is also influenced by the Australian government's lacklustre support for hydrogen and ammonia production compared to more favourable US policies, making other regions more attractive for Jera's investments.⁹⁴

Japan's LNG imports from the US surged by 34 per cent in the past year, totalling 5.5 million metric tons or 8 per cent of Japan's total LNG imports.⁹⁵ This trend aligns with significant financial commitments from Japanese banks, including Mitsubishi UFJ Financial Group (MUFG), Mizuho, and Sumitomo Mitsui Banking Corp. (SMBC), each investing between \$10.7 billion and \$13.8 billion in US LNG projects since 2012.⁹⁶ Meanwhile, Japan's LNG purchases from Russia have decreased by 11 per cent last year to 6.1 million metric tons, although Russia remains Japan's third-largest supplier with a 9 per cent share.⁹⁷ This shift in Japan's LNG sourcing strategy underscores a broader geopolitical and economic recalibration, reflecting the country's efforts to enhance energy security and adapt to global energy market fluctuations.

Japan's natural gas supply security is closely tied to geopolitical stability and its relationships with major LNG exporting countries. Shifts in geopolitical dynamics or disruptions in supply chains, as exemplified by recent supply shocks and ongoing geopolitical tensions, have prompted Japan to reassess its dependency on natural gas and aggressively pursue energy diversification. The 2023 GX policy underscores this strategic shift, incentivizing Japanese companies to continue investing in gas infrastructure and LNG power projects, with nearly 60 per cent of fossil fuel financing directed towards gas infrastructure and 45 per cent into upstream projects.⁹⁸ This reflects the government's intent to maintain a significant role for gas in the nation's energy mix while navigating the challenges of an evolving global energy landscape. The sustained investment underscores the continued relevance of gas yet highlights the emergence of new paradigms as Japan adapts to changing dynamics.

⁹⁰ Golubkova, 'Exclusive: Japan could boost LNG buys for emergency reserve to nearly 1 mln T a year, METI official says'.

⁹¹ Obayashi, 'Japan Considers Company Support Measures for Long-Term LNG Contracts'.

⁹² Stapczynski, Chen, and Wu, 'Japan's Global Gas Empire Fuels Worries About Climate Change'.

⁹³ Bethune, 'The Role of LNG in the North Asian Energy Transition: Lagging Renewables Means More LNG for Longer?' - Oxford Institute for Energy Studies', April 2024.

⁹⁴ The Japan Times, 'Jera Warns of Switching Investment from Australia over Lack of Support'.

⁹⁵ The Japan Times, 'Japan Fuels U.S. LNG boom even as climate targets and impacts loom'.

⁹⁶ The Japan Times, 'Japan Fuels U.S. LNG boom even as climate targets and impacts loom'.

⁹⁷ Pipeline&Gas Journal, 'Japan Becomes Top Buyer of LNG from Russia's Sakhalin 2'.

⁹⁸ James, 'Japan's Overseas Oil and Gas Financing Threatens the Global Energy Transition'.

3.1.3 Strategic shift in LNG contracting

As Japan shifts towards intermittent renewable energy sources, this necessitates more flexible LNG procurement strategies to accommodate the variable nature of renewable energy production. Thus, it is likely to favour more adaptable long-term contracts or increasingly rely on short-term and spot LNG markets to meet its fluctuating energy needs.⁹⁹ Already in 2023, nearly 40 per cent of Japan's total LNG trade comprised spot and short-term volumes, reflecting a 12 per cent-point increase from 2015, as noted by GIIGNL.¹⁰⁰ In 2023, 5.4 MTPA of long-term contracts expired and a recent survey of Japanese importers suggests that the annual contracted quantity of fixed-term LNG contracts could fall from 79 MTPA in 2022 to 55 MTPA in 2030.¹⁰¹

Japanese utilities, which rank among the world's largest LNG buyers, are pushing for more flexible supply contracts. They are actively challenging the restrictive destination clauses traditionally imposed by state-owned producers that limit the resale of LNG, driven by the uncertainties of future demand patterns. This has led to significant changes in contract terms, with major firms like JERA and Tokyo Gas opting not to renew agreements with Qatar in 2021 over such terms. Fiscal contracts with resale bans accounted for 42 per cent, a drop from 53 per cent fiscal in 2021, facilitated by securing more flexible agreements, notably with the United States and Australia.¹⁰² As a result, Qatar's market share in Japan fell to 4 per cent in 2023 from 12 per cent in 2018, while the United States' share rose from 3 to 8 per cent, and even Russia's share inched up from 8 to 9 per cent.¹⁰³

Despite ongoing challenges, about 40 per cent of Japan's long-term LNG contracts are projected to retain destination clauses until 2030.¹⁰⁴ However, the global trend is moving towards destination-free contracts. IEA anticipates that the proportion of global destination-free LNG contracts will increase to 51 per cent by 2027 as older agreements expire and new, flexible contracts come into effect.¹⁰⁵ In Japan, the percentage of LNG contracts without destination restrictions is expected to rise significantly, reaching 66 per cent by 2030, up from 25 per cent in 2016.¹⁰⁶

Japan's strategic transition towards more flexible LNG contracting and increased reliance on spot markets is intended to enhance its energy security, allowing for a more responsive and resilient gas supply system in an era of significant energy transitions.

3.1.4 Strategic LNG management

Despite a significant 8 per cent drop in domestic demand over the past year and projections for a one-third decline by 2030, Japan is actively increasing its LNG reserves. The aim is to boost emergency stock from three to at least twelve annual cargoes, ensuring a flexible supply to respond to market fluctuations.^{107,108}

Japan frequently sells excess LNG to nations in South and Southeast Asia, including Bangladesh, Thailand, and Vietnam, thereby reinforcing its role in regional energy security. Since 2019, Japanese firms have been expanding their LNG infrastructure in Asia, investing in new terminals with a combined capacity of 16.2 million tons in Bangladesh, Indonesia, and the Philippines, with plans to add another 13 million tons per year in Vietnam and India by 2030.¹⁰⁹ Tokyo Gas, the country's top city gas supplier, has set a target of trading 5 million tons of LNG annually by 2030, up from about 3 million.¹¹⁰

⁹⁹ Lambert, 'Insight-104-Energy-Transition-in-Japan-and-Implications-for-Gas'.

¹⁰⁰ METI and IEA, 'Future of LNG Security, Affordability, and Decarbonization, Discussion Paper for the LNGPCC 2024'.

¹⁰¹ IEEFA, 'Global LNG Outlook 2024-2028'.

¹⁰² Golubkova and Obayashi, 'Japan Builds Gas Markets in Asia to Boost LNG Trading, Energy Security | Reuters'.

¹⁰³ Mills et al., 'Exclusive: Qatar LNG sales to key Asian markets confronted by US, UAE rivalry'.

¹⁰⁴ Bloomberg, 'Japan's LNG Lobby Urges Government to Help Break Open Contracts'.

¹⁰⁵ IEA, 'Global Gas Security Review 2024'.

¹⁰⁶ Reynolds and Doleman, 'Japan's LNG Resales into Overseas Markets Hit Record High in FY2023 as Domestic Demand Plummeted'.

¹⁰⁷ The Japan Times, 'Japan Fuels U.S. LNG Boom Even as Climate Targets and Impacts Loom'.

¹⁰⁸ Golubkova, 'Exclusive: Japan could boost LNG buys for emergency reserve to nearly 1 mln T a year, METI official says'.

¹⁰⁹ Golubkova and Obayashi, 'Japan Builds Gas Markets in Asia to Boost LNG Trading, Energy Security | Reuters'.

¹¹⁰ Golubkova and Obayashi.

Additionally, companies like Mitsui OSK and Nippon Steel are expanding their LNG fleets and infrastructure, further supporting Japan's strategy to balance domestic needs with a role in the international LNG landscape.¹¹¹ Moreover, a revised METI ordinance allows Nippon Export and Investment Insurance (NEXI) to insure loans for overseas projects by Japanese companies, enhancing their ability to secure LNG and fortify supply chains.¹¹² This shift reflects Japan's strategic response to global disruptions, particularly the Russia-Ukraine war, which led to heightened investments in gas development as Japan sought to reinforce its energy security amid volatility.

Given the uncertainties of Japanese demand, Japanese companies are strategically positioned to sell into other markets. Japan's New International Resource Strategy for Enhancing LNG Security set a 2030 LNG handling target of 100 MTPA for Japanese companies despite declining domestic demand. In line with this, JERA, plans to invest ¥5 trillion (\$32 billion) by 2035 to maintain its annual LNG procurement at over 35 million tons.¹¹³ As a result of this strategy, Japanese companies are likely to continue cultivating LNG demand elsewhere in Asia by investing in downstream infrastructure and pursuing trading and resale opportunities.¹¹⁴ Japan's LNG sales to other countries have almost tripled since 2018; with sales increasing from 14.97 Mt in 2018 to 38 Mt in 2021 according to JOGMEC (Japan Organization for Metals and Energy Security), now making up nearly 50 per cent of Japan's domestic consumption volumes.¹¹⁵ As of 2023, 37 per cent of the total LNG volume handled by Japanese companies was resold abroad, a significant increase from 16 per cent five years ago.¹¹⁶

However, rising costs associated with new gas projects may financially strain Japanese operators and, indirectly, electricity consumers in South and Southeast Asia – regions already contending with post-Ukraine fuel price volatility. Japan's pivot from coal to gas brings into question its underlying objectives with regional allies, as high project costs and evolving LNG dependencies may affect the affordability and stability of energy resources across these interconnected markets. Furthermore, the Asian Zero Emission Community (AZEC) initiative, led by Japan, has faced international criticism for its encouragement of substantial LNG trading with emerging markets, purportedly to foster sustainable energy practices and reduce carbon emissions across Asia.¹¹⁷

While these investments emphasize Japan's integration within global energy supply chains, they don't directly signal an increasing role of LNG in Japan's domestic energy supply. Rather, they could indicate Japan's emerging role as a potential LNG re-exporter to regional markets, thereby maintaining its presence in the global LNG arena. Japan's energy strategy is evolving, balancing its internal energy needs with a strategic, flexible approach to global market shifts, highlighting the complexity and adaptability required as it redefines its role in energy transitions.

3.2 Challenges

Despite its lower particulate emissions compared to coal, the environmental benefits of natural gas are mitigated by the emissions-intensive LNG process, which includes liquefaction, transportation, and regasification. This energy-intensive sequence reduces its overall environmental advantage, particularly when assessing the full lifecycle of gas management. For instance, each LNG shipment managed by a Japanese company significantly contributes to global CO₂ emissions, with individual vessels emitting over 250,000 tons of CO₂.¹¹⁸

¹¹¹ Stapczynski, Chen, and Wu, 'Japan's Global Gas Empire Fuels Worries About Climate Change'.

¹¹² ANRE, 'Toward a Promising Future for LNG, Japan Leads the World in Ensuring Its Stable Supply and Addressing Environmental Issues'.

¹¹³ The Japan Times, 'Jera Warns of Switching Investment from Australia over Lack of Support'.

¹¹⁴ IEEFA, 'Global LNG Outlook 2024-2028'.

¹¹⁵ Bethune, 'The Role of LNG in the North Asian Energy Transition: Lagging Renewables Means More LNG for Longer? - Oxford Institute for Energy Studies', April 2024.

¹¹⁶ Reynolds and Doleman, 'Japan's LNG Resales into Overseas Markets Hit Record High in FY2023 as Domestic Demand Plummeted'.

¹¹⁷ CAT, 'Japan: Policies & Action'.

¹¹⁸ Stapczynski, Chen, and Wu, 'Japan's Global Gas Empire Fuels Worries About Climate Change'.



Recent satellite data reveal that methane emissions from the natural gas industry are much higher than previously estimated. Given that natural gas is composed of 70 – 90 per cent methane, a greenhouse gas approximately 80 times more potent than CO₂ in trapping heat over 20 years, these emissions pose a severe threat to the climate.¹¹⁹ This underscores the urgency of reducing methane emissions by 40-45 per cent by 2030 from 2010 levels to meet global climate targets and maintain the average temperature increase within 1.5°C. In 2023, the oil and gas sectors were responsible for over 60 per cent of energy-related methane emissions, contributing to a total of 120mt from fossil energy sources, with oil, coal, and natural gas accounting for 49mt, 40mt, and 29mt respectively.¹²⁰

To address these challenges, the Coalition for LNG Emission Abatement toward Net-zero (CLEAN) was launched in 2023 by Japan's JERA and Korea Gas Corporation (KOGAS), under the coordination of JOGMEC. CLEAN aims to lower methane emissions along the LNG value chain by fostering transparency and best practices among stakeholders. It facilitates dialogue between major LNG buyers from Japan and South Korea and producers to encourage methane reductions, with plans to expand participation to more private companies.¹²¹

Moreover, the logistics of LNG in Japan, unlike in Europe and the USA where pipeline gas is more economically distributed, pose additional challenges. LNG must be stored at temperatures below -162°C, necessitating costly specialized facilities and preventing long-term storage, thereby adding substantial costs to its utilization. Additionally, Japan's reliance on imported LNG heightens its power prices' sensitivity to global commodity market fluctuations, particularly as LNG sets the marginal generation technology for pricing during most hours.¹²²

While Japan strategically exports excess LNG to other Asian countries to provide the flexibility needed to manage its domestic energy supply effectively, this approach carries the risk of inadvertently slowing the transition toward renewable energy in the region. By supplying LNG, Japan meets the immediate energy needs of neighbouring countries but may reinforce their dependence on fossil fuels, potentially at the expense of renewable energy investments. In some cases, new gas infrastructure could not only replace coal but might increase overall emissions if it diverts focus from renewable sources, complicating efforts to reduce global greenhouse gas levels. Thus, it is crucial for Japan to support and encourage its trading partners to enhance their renewable capacities, ensuring that LNG exports complement, rather than compete with, regional goals for carbon emission reduction and sustainable energy practices.

The complexities of Japan's energy policy underscore the delicate balance required between economic interests, energy security, and environmental sustainability, highlighting the significant challenges Japan faces as it transitions within an interconnected global energy landscape. Despite criticism, Japan remains committed to its role in the LNG market, as part of a broader multifaceted strategy to ensure domestic energy security and maintain a competitive edge in the global natural gas market.

In light of the tight power supply-demand situation during the winter of 2020, as highlighted in Japan's 6th SEP, the risks of over-dependency on LNG became evident. This situation reiterated the need for Japan to build a balanced energy portfolio that not only leverages LNG for its reliability and flexibility but also intensifies efforts towards decarbonization and grid stability. This calls for a pragmatic mix of energy sources, emphasizing the transitional role of LNG in achieving energy stability and advancing Japan's decarbonization goals, thereby ensuring a sustainable and secure energy future.

¹¹⁹ Clark and Stapczynski, 'Is Natural Gas a Fossil Fuel Trap or a Bridge to Clean Energy? - Bloomberg'.

¹²⁰ CLEAN, 'Coalition for LNG Emission Abatement toward Net-Zero Annual Report 2024'.

¹²¹ ANRE, 'Toward a Promising Future for LNG, Japan Leads the World in Ensuring Its Stable Supply and Addressing Environmental Issues'.

¹²² BloombergNEF, 'Power Market Outlook'. <https://about.bnef.com/blog/power-market-outlook-east-meets-west-as-japan-prices-cool/>

4. Conclusion

Within Japan's energy transition, the integration of renewable energy sources and existing nuclear power presents significant opportunities yet exposes noticeable gaps. With a projected increase in energy demand, ensuring energy security becomes increasingly critical, highlighting the necessity for a resilient energy strategy that accommodates growth while prioritizing sustainability.

The rapid expansion of renewable energy is essential to meet Japan's climate objectives. However, significant challenges such as the scalability of wind energy and the requisite enhancements in grid infrastructure and energy storage highlight the urgent need for substantial investment and enhanced policy support. These improvements are critical not only to achieving the established targets but to further enhancing new targets realistically and ensuring a smooth transition to a sustainable energy framework.

Similarly, while the current government promotes the use of nuclear power as a means to secure a stable energy supply, the potential for new reactors to contribute to short-term or medium-term energy targets appears limited. This necessitates an interim reliance on natural gas and coal, with prolonged reliance on the latter jeopardizing Japan's ability to meet net-zero targets and align with global climate commitments.

Natural gas remains a cornerstone of Japan's energy mix, serving as a vital transitional fuel. It bridges gaps left by slower-than-expected growth in renewables, the challenges of scaling nuclear power, and the delayed feasibility of alternatives like CCS and hydrogen. Offering flexibility and comparatively lower carbon emissions than coal, natural gas supports Japan's decarbonization objectives. However, the uncertainty surrounding future gas demand is reflected in Japan's growing shift toward short-term contracts, destination-free agreements, and reliance on the spot market to meet fluctuating energy needs.

In an optimistic scenario, accelerated renewable integration, nuclear restarts, and advancements in CCS, hydrogen and ammonia technologies could substantially reduce LNG demand. Conversely, delays in these areas could prolong reliance on LNG, pushing imports by the decade's end. High LNG prices and geopolitical uncertainties could further complicate energy planning, increasing costs for industry and households. Additionally, insufficient decarbonization of the LNG value chain could undermine Japan's climate goals, necessitating urgent efforts to reduce methane emissions and promote low-carbon LNG products. Furthermore, to ensure that natural gas complements rather than hinders the advancement of renewables, both domestically and across Asian markets where Japan is deeply involved via its LNG ecosystem, proactive measures must be implemented to align gas use with long-term renewable goals.

Energy security remains a cornerstone of Japan's energy policy, particularly as global political dynamics, including evolving US energy policies and rising geopolitical tensions, continue to influence LNG markets. The political landscape in Japan, shaped by the October 2024 elections, also underscores the pressing need for a resilient and adaptable energy policy. The minority government requires robust political commitment to further the momentum on energy transition goals while avoiding the pitfalls of leadership instability.

Finally, the forthcoming 7th Strategic Energy Plan must rise above political fluctuations, domestic as well as international, to guarantee Japan's steady progress toward energy stability and decarbonization. Equally important is fostering diverse and inclusive policymaking that ensures public engagement is meaningful, influencing tangible outcomes rather than serving as a procedural formality.

The enduring interplay of renewable energy, natural gas, and energy security remains a central theme in Japan's energy policy. Robust policy frameworks, inclusive policymaking, and strategic international cooperation remains essential for meeting Japan's ambitious energy and climate objectives.