semi | ENERGY COLLABORATIVE

Risks and Opportunities for Decarbonising Japan's Power Sector

From the perspective of Japan's semiconductor industry

CARBON TRUST

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Contents

Abbreviations

BESS	Battery Energy Storage Systems
CCUS	Carbon Capture and Storage
CfDs	Contracts for Difference
DLR	Dynamic Line Rating
EAF	Electric Arc Furnace
EIA	Environmental Impact Assessment
EEZ	Exclusive Economic Zone
FiT	Feed in Tariff
FLOWRA	Floating Offshore Wind Renewable Energy Association
GX	Green Transformation
GX-ETS	GX Emissions Trading Scheme
IBR	Inverter-based resources
LBNL	Lawrence Berkely National Laboratory
LCOE	Levelized Cost of Electricity
LTDA	Long-Term Decarbonisation Auction
MAFF	Ministry of Agriculture, Forestry and Fisheries
METI	Ministry of Trade and Industry
NESO	National Energy System Operator
NFC	Non-Fossil Certificates
OCCTO	Organisation for Cross-regional Coordination of Transmission Operators
PPA	Power purchase agreement
SCL	Short Circuit Level
TWh	Terawatt-hours

Executive Summary

I. Setting the context

A call for urgent action on Japan's energy transition

This position paper calls for a more proactive and balanced approach to Japan's energy transition, with a focus on supporting the country's globally important semiconductor industry. Japan is already a global leader in key parts of the semiconductor value chain, particularly in materials (56% of global market share) and manufacturing equipment (32% of global market share). Recent government investment in next-generation chip manufacturing, such as the support for Rapidus, has laid a strong foundation. However, without equally strategic planning for clean energy supply, there is a growing risk that energy constraints could limit sustainable industrial expansion and weaken Japan's global competitiveness.

Industry momentum requires policy alignment

Japan's semiconductor industry, worth over USD 40 billion in 2024[1] and projected to grow rapidly, is both economically vital and highly energy-intensive. As international markets shift toward low-carbon supply chains, clean and reliable power is becoming a competitive differentiator. However, there are growing concerns that Japan's energy system is not yet evolving quickly enough to support these goals. Since the previous engagement between Japan's Ministry of Trade and Industry (METI) and SEMI, semiconductor companies and their value chain have made real progress in planning for decarbonisation. Many are now actively working toward 2030 and 2040 emissions targets and reviewing their options. The feedback has been that achieving these goals in Japan is becoming increasingly difficult due to:

- A fossil fuel-heavy power grid
- Slow progress on renewable energy deployment
- Uncertainty around Japan's future energy mix

Uncertainty around Japan's energy mix poses planning risks

A clear and predictable future power mix is critical for energy-intensive industries like semiconductors to meet their 2030 and 2040 decarbonisation targets. Currently, however, projections for the future energy mix vary considerably, with scenarios from government, industry, and civil society producing divergent outlooks. Uncertainty around timelines, market access, and infrastructure investment is creating avoidable risks, especially as other major economies rapidly scale clean energy to meet industrial demand.

In particular, progress in areas such as grid modernisation, clearer market mechanisms for renewables (including PPAs and auctions), and scalable renewable deployment is not yet evident, but these are widely seen as critical enablers of future industrial growth.

[1] Japan Semiconductor Market Size, Industry Outlook, 2033

Stakeholder insights reveal growing industry concern

To better understand these challenges, this report draws on input from 28 stakeholders, including: (i) semiconductor manufacturers, and supply chain partners (ii) energy-intensive companies, (iii) the grid operator and renewable energy developers, (iv) think tanks and NGOs, (v) investor networks.

The feedback is consistent: while there is recognition of METI's leadership in launching the Green Transformation (GX) initiative and supporting innovation, there is also concern that energy policy has not yet adapted to the pace and scale of industrial demand for decarbonisation. There is a strong opportunity to build on existing progress, but only if energy planning is better aligned with the needs of Japan's clean manufacturing future. A more coordinated and ambitious approach, linking energy system reform to industrial policy, can help secure both economic resilience and Japan's climate commitments.

II. Key insights from industry: Systemic energy challenges impacting industrial decarbonisation

Japan's semiconductor sector, and energy-intensive industries more broadly, are central to the national economic strategy. However, as companies commit to long-term decarbonisation targets, there is growing concern that the energy system is not evolving quickly or predictably enough to support them. Through stakeholder engagements, five recurring and interlinked challenges emerged. These barriers are not technical or financial alone, and reflect a widening gap between Japan's current energy system and the strategic needs of globally exposed industries that are under pressure to decarbonise fast. **Industry leaders shared a clear message: they are ready to act, but face uncertainty about the cost, credibility, and availability of clean electricity in the medium term.**

The following five challenges were most consistently raised:

Grid constraints are slowing clean energy integration

Aging and fragmented grid infrastructure, combined with limited battery deployment and constrained interconnection processes, emerged as a top concern across sectors. Stakeholders noted that even where renewables are available, grid capacity limitations and lack of transparency are hindering uptake and delaying project development.

Companies with ambitious energy transition plans are held back by curtailment, lack of visibility on grid planning, and limited ability to integrate renewables.

Limited role in global clean energy supply chains

Industry leaders emphasised that access to clean, cost-effective electricity is now a competitive requirement, not a long-term aspiration. However, companies in Japan face slower domestic scale-up of solar, wind, and enabling technologies, putting them at a disadvantage compared to peers operating in the US, EU, South Korea, or Taiwan. As clean electricity becomes a key input in export supply chains, Japan's positioning in industries like green steel, advanced materials, and semiconductors is impacted.

Companies face rising pressure from global customers to meet international Scope 2 standards, but have limited access to credible, affordable clean energy domestically.

Structural barriers to renewable energy deployment

Stakeholders consistently pointed to permitting delays, grid congestion, regulatory complexity, and limited land access as key factors increasing the cost and reducing the availability of renewable electricity, even for companies ready to invest. While Japan's technical potential is strong, these barriers are inflating timelines and costs for new capacity.

High costs and bottlenecks prevent companies from procuring clean electricity at the volume, speed, and quality required to meet decarbonisation commitments and maintain competitiveness.

Fossil fuel dependence creates long-term cost and security concerns

Many industrial stakeholders highlighted rising energy cost volatility and strategic uncertainty due to Japan's reliance on imported fossil fuels. While technologies like hydrogen and ammonia offer decarbonisation options worth exploring for specific industrial activities, current deployment patterns tend to reinforce fossil-based systems that remain exposed to cost volatility rather than accelerate a renewables-led transition. This creates risks of cost lock-in and limits progress toward energy self-sufficiency.

Companies fear being tied to high-cost and high-volatility energy pathways, while competitors in other markets gain access to cheaper, more stable renewable power.

Market instruments are falling short of international expectations

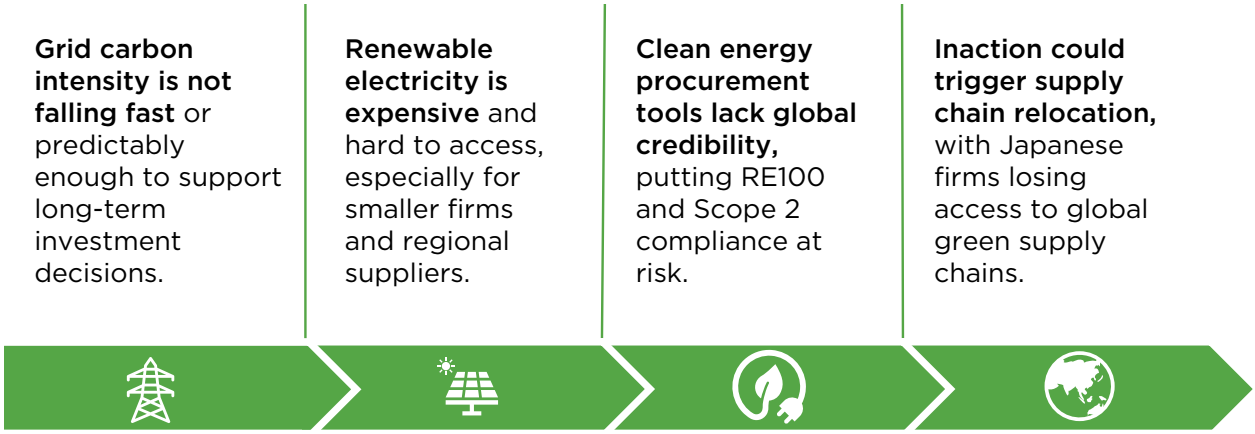
Many multinational manufacturers and digital infrastructure providers flagged the need for more credible, transparent, and flexible procurement options. Current Non-Fossil Certificates (NFCs) and PPAs are viewed as administratively complex, high-risk, and lacking in environmental integrity when compared to global standards. This complicates compliance with corporate net-zero strategies.

Without improvements in procurement tools, companies risk falling short of Scope 2 targets or shifting investment overseas to access more robust clean energy ecosystems.

Overall, stakeholder views suggest that the timeline of Japan's energy transition is out of sync with the investment cycles and decarbonisation timelines of energy-intensive companies. Firms are making capital commitments now, many with 2030 or 2040 targets in view, but face uncertainty about the availability and credibility of clean electricity over that period. **While stakeholders broadly support Japan's clean energy goals, they are calling for more predictable and accessible pathways to secure low-carbon electricity.**

III. Clean energy access is a strategic priority across the whole semiconductor value chain

Stakeholders across the semiconductor ecosystem identified clean electricity access as essential for remaining globally competitive and compliant with international climate standards. Shared concerns across the value chain include:



IV. Japan's energy transition pathway could undermine industrial competitiveness

Japan's current energy transition is not aligned with the pace, credibility, and cost expectations of its most strategic industries. Without targeted and system-level actions, especially around renewable energy access and grid upgrades, Japan risks falling behind in green industrial leadership. If current clean energy gaps remain unresolved, Japan also faces serious risks to its energy security, economic resilience, and industrial competitiveness:

Energy security

- Heavy reliance on fossil fuel imports (90%) leaves Japan highly exposed to price shocks.
- Hydrogen and ammonia strategies may increase, not reduce, energy dependence.
- Nuclear restarts are too slow and uncertain to fill the gap.

Industrial competitiveness

- Without credible clean energy access, Japan risks losing export markets in semiconductors and electronics.
- Current focus on expensive technologies like hydrogen and CCS may delay scalable solutions like renewables.
- Global buyers may shift to countries with clearer, cheaper decarbonisation pathways.

Economic resilience

- Japan's fuel-switching strategy (hydrogen, ammonia) may fail to gain traction in emerging markets that prefer local renewables as costs fall more rapidly.
- Export ambitions for ammonia and hydrogen face cost and demand uncertainties.
- Investor confidence is weakening due to lack of credible, globally aligned clean energy policies.

V. Opportunities for decarbonising Japan's power sector

We identify 7 key opportunities grouped by impact timeline and designed to address stakeholder concerns around Japan's energy security, industrial competitiveness, and economic resilience, while supporting decarbonisation of the semiconductor sector. Where relevant, UK best practices are highlighted to illustrate potential pathways and proven solutions, reflecting strong structural and strategic parallels between the UK and Japan - such as both being island nations with significant offshore wind potential, shared challenges around grid capacity, and reliance on legacy nuclear infrastructure.

Immediate, quick win opportunities to 2030

For rapid renewable acceleration

Immediate, challenging opportunities to 2030

For implementation now, with effects by 2030

Opportunities to be realised post 2030

For implementation now, to secure long-term competitive-ness and resilience

Immediate, quick win opportunities to 2030

Three priority actions ready for immediate implementation can deliver quick, tangible benefits. These focus on accelerating renewable energy deployment by removing permitting delays, overcoming land-use challenges, and reducing market uncertainties. Implementing these will boost local economies, enhance power system resilience, and reduce costs in the near term.

(i) Accelerating Solar PV deployment by streamlining permitting and consenting

Japan's permitting and consenting processes for solar PV remain a major barrier, with project timelines frequently exceeding 18 months. A key quick win is the development of a centralised, digital one-stop permitting platform - similar to the UK's Planning Portal, which consolidates environmental, land use, and grid approvals into a streamlined workflow. In the UK, early digitalisation of permitting systems significantly reduced average approval timelines and improved investor confidence**. In Japan, establishing such a platform, backed by national guidelines and digital tracking, could reduce approval timelines by up to 25-50%[2] and lower PPA costs.** Key next steps include mapping the current permitting landscape, evaluating the economic impact of reforms, and piloting a digital, GenAI-enabled approval platform to support faster, more predictable outcomes.

(ii) Unlocking renewable energy potential through community-based land use

Japan faces geographic constraints for large-scale renewable deployment, yet pilot agrivoltaic projects and recent reforms to the Farmland Act have demonstrated the feasibility of dual-use land strategies. **By incentivising local governments and communities to co-own renewable projects, especially on underutilised land and farmland, Japan can build social acceptance and create new rural income streams.** Drawing from successful models in the UK, the government could offer financial incentives such as preferential GX funding, tax breaks, and low-interest loans for community-led projects. Critical next steps include assessing municipal readiness, developing training and guidance, and designing equitable financing models that encourage local participation and ownership. Quick wins include scaling existing pilots in Chiba and Nagano by providing municipalities with technical guidance, national co-location standards, and templates for revenue-sharing arrangements with local farmers and cooperatives.

(iii) Accelerate the modernisation of the electricity market by prioritising low-cost, low-carbon technologies

Japan's Simultaneous Market, planned for FY2028, aims to co-optimise energy, balancing, and capacity services, improving price signals and integration of low-cost, low-carbon technologies. However, uncertainty around market design and timelines is slowing investment in renewables and battery storage. **Advancing this reform to the Simultaneous Market on a faster, more transparent schedule could significantly reduce emissions, improve grid flexibility, and unlock new**

[2] The 25-50% improvement in permitting timelines is based on comparisons with international best practices. For instance, while Japan's permitting and EIA processes can take 4–8 years, many projects in countries like Germany achieve permitting within 1-2 years - roughly 25-50% of the total timeline.

investment. Best practices from Australia and the UK show that transparent roadmaps, clear price signals, and open access to market data drive innovation and private sector confidence. Immediate actions include publishing learnings from the Simultaneous Market's pilot phase, releasing a full market reform roadmap, and enhancing pricing mechanisms to reward flexibility and location-specific efficiency.

Immediate, challenging opportunities to 2030

Essential investments are needed now in grid infrastructure, energy storage, and system flexibility – including the ability to balance variable renewable output through demand response, flexible generation, and interconnection - to enable reliable large-scale integration of renewables by 2030. These opportunities address key challenges such as limited grid capacity, fragmented access to clean electricity, and slow market reforms. They align with Japan's existing policy frameworks, including the GX initiative, and promise measurable impact within the current regulatory landscape.

(iv) Use GX funding and market reform to target a smarter and more flexible electricity grid

Japan's grid remains highly fragmented, with weak interconnection between its 10 regional operators, constraining renewable energy flow and causing regional curtailment. **Battery energy storage systems (BESS), grid-forming inverters, demand-side response, and dynamic transmission upgrades are all essential tools to improve grid flexibility, and should be prioritised for GX funding.** However, current market rules limit participation and scale. For example, profit-sharing requirements under the Long-Term Decarbonised Power Source Auction make BESS projects financially unviable.

Internationally, the UK's cap-and-floor model and Ofgem's reforms to support long-duration storage provide useful templates. Japan can benefit from applying outcomes of stakeholder consultations to guide clear GX funding priorities, publish a roadmap for BESS market access, and accelerate the creation of national technical standards for advanced grid technologies. Regulatory sandboxes and open-data platforms should also be introduced to foster innovation, while grid code reform must be inclusive, transparent, and aligned with long-term decarbonisation goals.

Opportunities to be realised post-2030

Looking past 2030, the focus shifts to early investments in breakthrough technologies and clean energy ecosystems. These efforts aim to sustain Japan's global competitiveness and leadership in industrial decarbonisation. Aligned with global trends, these initiatives will help foster clean technology development, expand export potential, and strengthen long-term energy security and economic growth.

(v) Developing a competitive advantage in Floating Offshore Wind

With over 1,200 GW of high-potential offshore wind capacity, and legal access to the Exclusive Economic Zones following recent amendments to the Ocean Energy Utilisation Act, Japan is well-placed to lead in floating offshore wind. However, commercial-scale deployment is stalled

by unclear permitting, grid constraints, and lack of stable revenue frameworks. **Drawing on the UK's success with Contracts for Difference (CfDs), Japan should assess the applicability of CfD schemes to floating wind and fast-track grid upgrades in high-resource areas such as Hokkaido.** These areas could also be linked to emerging data centre hubs through integrated regional planning. Supporting domestic manufacturing, particularly by repurposing shipyards for floating platform production, will also be key to reducing costs and building local supply chains.

(vi) Promote the phase out of Coal-Fired Power Plants to attract private investment for replacing or repowering sites

Coal remains around 30% of Japan's electricity mix, but without a clear retirement timeline or supportive financial mechanisms, plants may remain operational longer than economically or environmentally justifiable. **Policy certainty, through mechanisms such as a carbon price floor or strengthened GX Emissions Trading Scheme (ETS), can drive early retirement while protecting affected workers and communities.** Global precedents like Germany's coal exit payments and the UK's Powering Past Coal Alliance show how a just transition can be achieved through a mix of regulation, incentives, and community support. Japan has the opportunity to explore compensation mechanisms for early closures, ensure accurate carbon credit accounting in the GX-ETS, and develop a national just transition plan to support affected regions.

(vii) Target the use of low carbon fuels to decarbonise hard-to-abate sectors through deployment in industrial clusters

Japan's industrial sector accounts for over a third of national emissions, particularly in hard-to-abate sectors like steel, chemicals, and cement. These sectors face challenges in electrification due to high-temperature and continuous process demands. Japan has taken early steps under its GX strategy, with pilot hydrogen and CCS projects and regulatory guidance for cluster-based deployment. However, implementation remains fragmented, and large-scale infrastructure for hydrogen transport and carbon storage is not yet in place. **Best practices from the UK and the Netherlands show that cluster-based models, paired with targeted contracts and carbon pricing, can accelerate deployment.**

For Japan, the priority can focus low-carbon hydrogen and CCS deployment in clusters where demand is concentrated and infrastructure can be shared. A quick win is to establish local cluster support hubs offering permitting assistance, funding guidance, and regulatory advisory services to reduce development risk. Japan can also pilot CfD-like support schemes for hydrogen production, linked to emissions reductions from end-users, and align the GX-ETS to reward early industrial decarbonisation.

VI. Shaping decarbonisation as an economic priority

Japan faces a set of interlinked systemic challenges that are slowing industrial decarbonisation and threatening its competitiveness in key sectors like semiconductors.

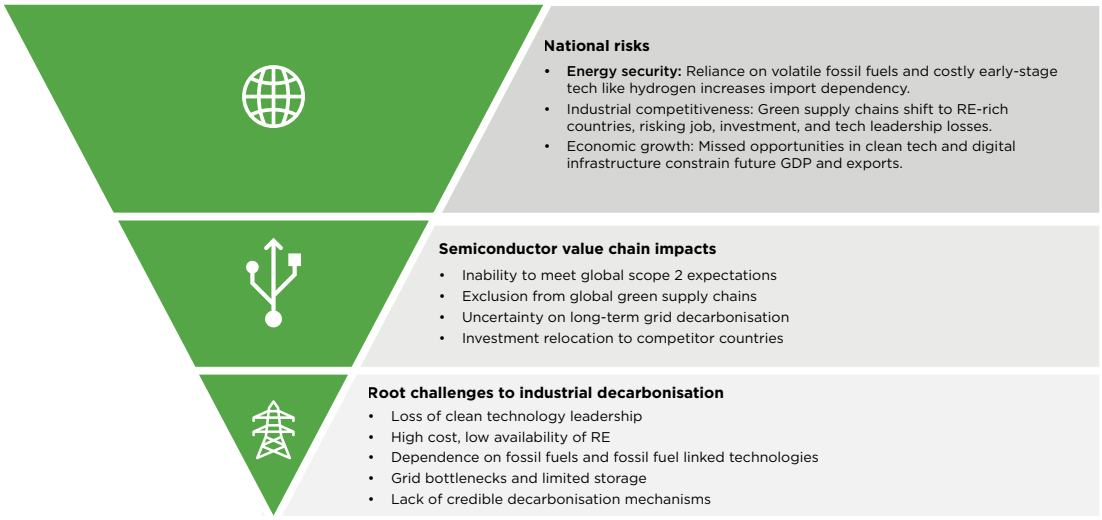


Figure 1: Industrial decarbonisation challenges, and their contribution to semiconductor concerns and national level risks

As noted in Figure 1, the country has lost ground in clean energy supply chains, while persistent grid bottlenecks, slow renewable integration, and overreliance on fossil fuels keep energy costly and unreliable. Regulatory and market instruments such as NFCs and PPAs lack the credibility and efficiency needed to support global corporate decarbonisation goals. **These issues are particularly significant for the semiconductor industry, which depends on stable and affordable clean electricity to meet its emission reduction targets and remain globally competitive.**

Without faster reform, the semiconductor sector could face rising costs and difficulties attracting investment due to energy insecurity and credibility gaps in emissions reporting. **At the national level, slow decarbonisation could lead to trade penalties like the EU's Carbon Border Adjustment Mechanism (CBAM), reduce Japan's control over key technologies, and make it more vulnerable in future energy or industrial crises.** Overcoming these challenges is a strategic priority for preserving Japan's economy and global influence.

For Japan, decarbonisation is not just a climate goal - it's a strategic economic imperative. Clean energy is essential to:

- Maintain global competitiveness
- Reduce long-term industrial energy risks
- Secure Japan's role in future clean-tech value chains

By closing the gap between energy policy and industrial needs, Japan has an opportunity to lead in high-value, low-carbon manufacturing while securing long-term economic growth and resilience.

1. Introduction

This position paper aims to highlight the urgent need for a more proactive and balanced approach to Japan's energy transition, emphasising the opportunities for immediate action. While the government has focused on future technologies and the expectation that their costs will decrease, insufficient attention has been given to deploying and scaling available solutions today. This creates significant challenges for energy-intensive industries, such as semiconductor manufacturing, which are working towards ambitious 2030 and 2040 decarbonisation targets.

Since the last engagement between the Ministry of Economy, Trade and Industry (METI) and SEMI, many of SEMI's member companies have made notable progress on decarbonisation. They are now more informed, engaged, and advanced in their decarbonisation efforts than before. As a result, companies across the semiconductor value chain are increasingly concerned about the feasibility of meeting their ambitious targets, given the current trajectory of the government's renewable energy goals.

The uncertainty and lack of clarity about Japan's future energy mix are impacting corporate and industrial planning, making it harder for businesses to align their operations with national decarbonisation goals. This presents an opportunity for METI to lead in fostering a transparent, stable energy environment. By addressing these gaps and focusing on practical, near-term solutions, Japan can strengthen its industrial competitiveness, support innovation, and drive the sustainable growth of key sectors.

2. Background and context

Japan's semiconductor industry is a key part of its advanced manufacturing sector, with strengths in memory devices, logic chips, sensors, microcontrollers, and analogue integrated circuits. These components are essential for technologies like consumer electronics, electric vehicles, industrial robots, and communication networks.

Market overview[3] [4]

In 2024, Japan's semiconductor market was valued at USD 40.4 billion and is expected to grow to USD 61.6 billion by 2033, driven by demand for next-gen vehicles, 5G/6G technologies, and industrial automation. In response, the government made the industry a national priority.

In 2021, METI launched major funding programs such as the Post-5G Fund (JPY 200 billion) for technological innovation and the Green Innovation Fund (JPY 2 trillion), which focuses on developing semiconductors for electrification and carbon neutrality. METI also updated its strategy to further support energy-efficient semiconductors and expand domestic manufacturing capacity, including efforts to attract foreign investment.

The government aims to boost semiconductor-related sales to JPY 15 trillion by 2030, three times the 2020 level. Japanese companies also hold a strong global position in semiconductor materials (56% market share) and manufacturing equipment (32% market share). The industry is responsible for significant employment across manufacturing, research and equipment production, with the largest semiconductor companies in Japan employing up to 24,000 people. The industry provides significant high-skilled employment, with the largest companies employing up to 24,000 people each. Public investment in the sector reached JPY 3.9 trillion (USD 25.7 billion) over three years, equivalent to 0.71% of Japan's GDP. By comparison, the US invested equivalent of 0.21% of its GDP, Germany 0.41%, and France 0.20%, demonstrating how central semiconductors are to Japan's strategy for industrial competitiveness and innovation.[5]

Strategic importance

The semiconductor industry is crucial for Japan's economic competitiveness and technological leadership. Government investments, like support for Rapidus and partnerships with international firms, are strengthening supply chain resilience and technological independence. With growing global demand and strategic competition in the semiconductor sector, there is growing recognition that strengthening Japan's domestic semiconductor industry is vital for securing the country's technological and economic future.

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[3] Japan Semiconductor Market Size, Industry Outlook, 2033

[4] How Japan's semiconductor industry is moving into the future | World Economic Forum

[5] https://asia.nikkei.com/Business/Tech/Semiconductors/Japan-outspends-U.S.-Germany-on-chip-subsidies-as-share-of-GDP

Decarbonisation as an economic opportunity

While essential to Japan's economy, the semiconductor industry is energy-intensive, requiring large amounts of electricity, water, and high-purity materials. As multinational companies seek low-carbon supply chains, Japanese semiconductor players that can offer energy-efficient and low-emission chips will be better positioned to secure international contracts. As such, decarbonisation is critical for the sector's competitiveness.

Investing in energy efficiency, clean energy procurement, and emissions reduction technologies will help companies reduce costs, lower carbon footprints, and meet rising environmental and social governance expectations. Additionally, innovations like low-power chips and sustainable materials can create new market opportunities, reinforcing Japan's reputation for producing high-quality, eco-friendly technology.

Challenges from power sector emissions

A key challenge to decarbonising Japan's semiconductor industry is the country's carbon-intensive power grid, still reliant on fossil fuels. This results in significant Scope 2 emissions from electricity use, which hinder efforts to meet net-zero goals and risk reputational damage, especially for export-focused companies.

To remain competitive, semiconductor firms must work with the government and utilities to secure low-carbon energy sources, through direct renewable energy procurement, energy efficiency improvements, and being supportive of grid decarbonisation efforts. Collaboration between the semiconductor industry and the power sector is essential to make industrial decarbonisation both technically and economically feasible.

3. Our approach

Given the importance of the semiconductor industry for the Japanese economy and the urgent need to decarbonise Japan's power sector, this report explores the challenges, risks and opportunities from the perspective of the semiconductor industry and other power sector actors. This report also provides a high-level assessment of the potential decarbonisation pathways for Japan's power sector and the uncertainties surrounding these. This approach can be broken down into the following categories:

3.1 Understanding Japan's energy transition pathway

Understanding the likely future power generation mix and how it will impact industries like semiconductors, which are highly energy-intensive and have ambitious decarbonisation targets by 2030 and 2040, is crucial. A clear, predictable energy mix is essential for corporate and industrial planning and risk management. However, there is significant uncertainty surrounding Japan's energy future, primarily due to the wide range of projections offered by various stakeholders. These studies revealed significant variation in projections for 2035 and 2040, with substantial differences when compared to Japan's 7th Strategic Energy Plan.

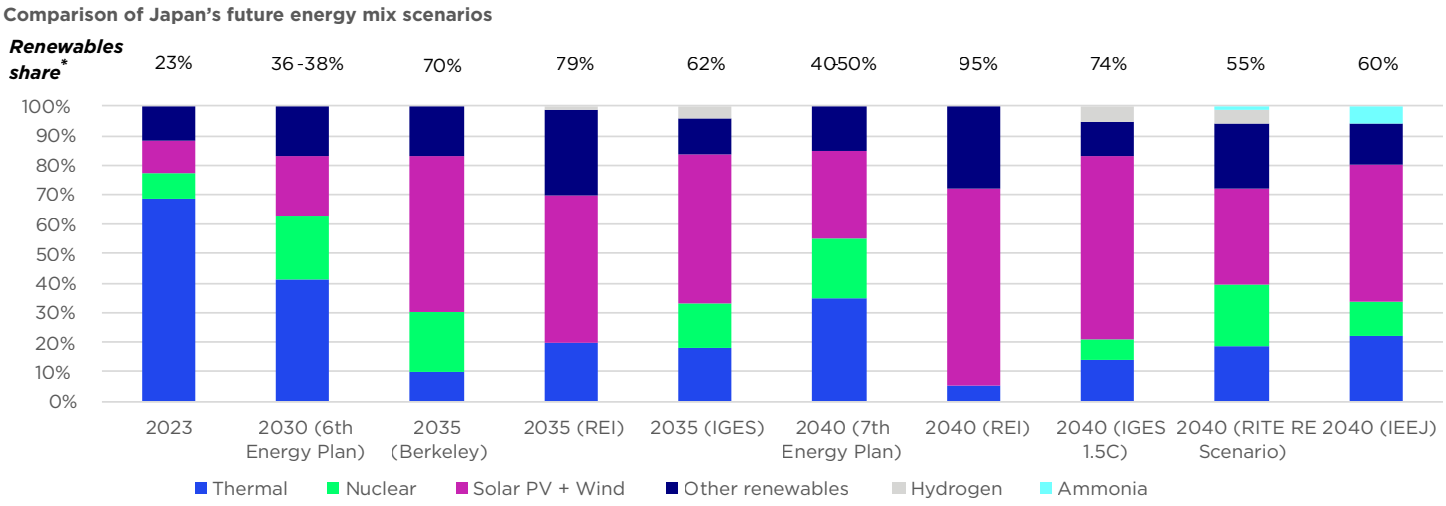


Figure 2: Comparison of Japan's future energy mix scenarios[6]

** These projections represent the renewable-focused scenarios developed by each institution (with the exception of the 7th Energy Plan) - and are only one of multiple pathways explored by each organisation.*

[6] *Source: Berkeley Lab, The 2035 Japan Report; Renewable Energy Institute (REI), Energy Transition Scenario through Renewables: Prospects toward 2040; Institute of Energy Economics, Japan (IEEJ), Model calculation for Japan's Energy mix in 2040 and 2050; METI, Seventh Strategic Energy Plan Summary, IGES, A 1.5°C Roadmap for Japan,, RITE, Towards carbon neutrality by 2050*

The discrepancies in Figure 2 highlight the complex trade-offs that Japan faces in aligning its energy system with its decarbonisation goals. These differences are shaped by multiple factors, including technological assumptions, political priorities, and risk tolerance regarding emerging technologies. However, Japan's position increasingly appears as an outlier internationally — particularly in areas like grid openness, market design, and renewable integration. This divergence may create uncertainty for investors and developers who are seeking clearer, more aligned policy signals, potentially making Japan a less attractive destination for clean energy investment unless these gaps are addressed.

3.2 Key drivers of divergence in power mix projections

The differences in these energy mix projections can be attributed to several factors:

Technological feasibility

The scalability and cost of key technologies, such as solar, wind, hydrogen, and CCS, are uncertain and lead to diverging assumptions about the future energy mix.

Public acceptance

Local community approval and regulatory challenges play a key role in the deployment of technologies like nuclear and CCS, which impacts their future role in the energy mix.

Policy preferences

The Japanese government's prioritisation of energy security and stability influences the reliance on nuclear and thermal power, even as renewable technologies continue to mature.

Energy security

Japan's limited domestic energy resources make energy security a critical consideration, influencing the government's cautious approach to adopting renewables at scale.

Economic assumptions

Varying assumptions about the cost of renewables, hydrogen, and CCS technologies result in different pathways for achieving decarbonisation. The projected costs for technologies like offshore wind and hydrogen exhibit considerable uncertainty.

These divergent assumptions underscore the challenge in predicting Japan's energy future, and point to the need for clearer, more aligned projections to reduce risks for industries.

3.3 Engaging stakeholders: Understanding industry challenges

We engaged directly with a broad range of stakeholders to better understand the challenges they face regarding decarbonisation and the risks associated with these challenges if left unaddressed. Our aim was to capture a diverse set of perspectives on the potential impact of Japan's energy transition, particularly for energy-intensive industries.

We interviewed **28 stakeholders** from various sectors to get a more granular view of the obstacles and opportunities they foresee as part of Japan's energy transition. The stakeholders we engaged included:

- Semiconductor value chain companies
- Corporates from energy-intensive sectors
- Think tanks
- Industry associations
- Civil society organisations
- Other stakeholders including investor networks, renewable energy developers, grid operators

The next section of the report elaborates on the key challenges, risks, and opportunities that we identified through stakeholder engagement and analysis. These industries, which are particularly sensitive to energy costs and reliability, have expressed concerns that the government's energy transition strategy may not align with the speed and scale necessary to meet 2030 decarbonisation targets. This misalignment poses challenges not only to the semiconductor industry but also to Japan's broader economic stability and global competitiveness.

In response to these challenges, we have identified key asks from stakeholders, which we believe can serve as mutually beneficial opportunities for both METI and industry. These requests are designed to help Japan achieve energy security, capitalise on its national strengths, promote domestic economic benefits, and enhance the competitiveness of its industries. By addressing these asks, METI can ensure that Japan's energy transition supports both its climate goals and its industrial ambitions, fostering a more resilient and competitive economy.

4. Five systemic challenges limiting industrial decarbonisation

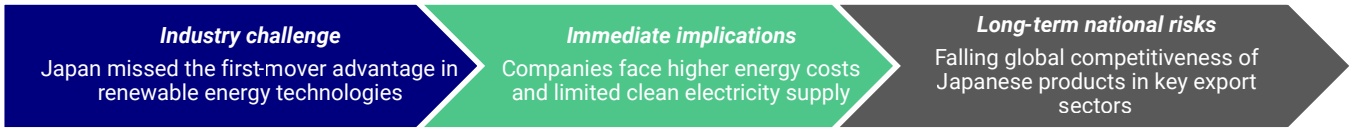
Through engagement with 28 stakeholders across the semiconductor value chain, other corporate sectors, think tanks, civil society organisations, industry associations, and energy market experts, we identified several recurring challenges facing energy-intensive industries in Japan.

These challenges reveal systemic constraints in Japan's energy transition approach that undermine the competitiveness, resilience, and environmental performance of industry, particularly in high-growth, strategically important sectors such as semiconductors.

These challenges are presented alongside supporting evidence to substantiate the concerns raised across stakeholder groups.

4.1 Limited role in global clean energy supply chains

Japan did not capitalise as early as some other countries on the rapid global growth of renewable energy technologies, particularly solar PV and offshore wind. As a result, much of the manufacturing, installation expertise and leadership in innovation has been established elsewhere. As a result, Japanese firms now face higher costs and limited access to domestic clean electricity, compared to competitors in more renewable-integrated markets.



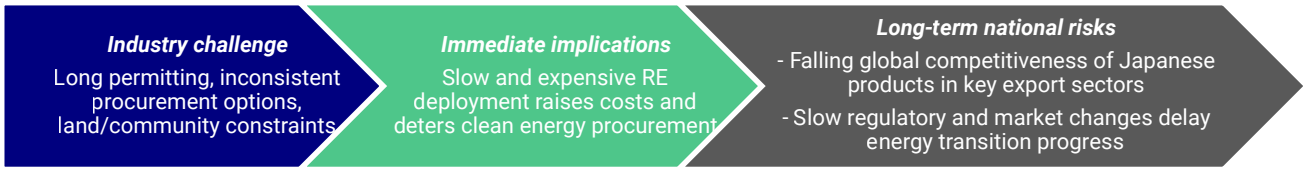
Supporting evidence:

- **Japan's early leadership in solar PV has fallen from around** 50% of global PV production in the early 2000s to just 1% by 2019.[7] Offshore wind developers face market complexity and supply chain bottlenecks such as limited access to key drilling equipment, which delay project timelines.
- **Leading companies in steel and semiconductors report difficulty in accessing renewable power,** affecting their ability to comply with RE100 and other Scope 2 targets. For example, Japan's early adoption of Electric Arc Furnaces (EAFs) positions it as a leader in low-carbon steelmaking, but this advantage is at risk due to slow progress on clean electricity. Without faster grid decarbonisation, Japan's steel sector may fall behind peers, where rapid renewable growth is enabling deeper emissions cuts.

[7] https://www.meti.go.jp/shingikai/energy_environment/perovskite_solar_cell/pdf/001_02_00.pdf

4.2 Barriers keeping renewable energy costly and inaccessible

Japan has the technical potential to scale up renewable energy, but deployment is being held back by long permitting timelines, grid congestion, restrictive regulations, and supply chain constraints. These challenges are increasing the cost and risk of renewable energy development, hurting industries that need clean power to remain globally competitive.



Supporting evidence:

- **Environmental Impact Assessments (EIAs) in Japan take 4–8 years**, far longer than the 12–24 months typical in Germany or other advanced economies, delaying project timelines and deterring investment.[8] To mitigate delays, developers often reduce project size to stay just below mandatory EIA thresholds, cutting timelines to around one year, but at the cost of project scale.
- **Japan's grid bottlenecks and opaque connection processes are causing renewable curtailment and underutilised capacity.** However, countries like France maintain grid stability at 40%+ renewable penetration with low integration costs ($0.08–$0.09/kWh)[9]. Japan has the technical potential to reach at least 45% renewables by 2030 with integration costs under ¥1.5/kWh (~$0.01), rising only modestly at 66% renewables. [10]
- **Japan's renewable costs remain higher than many peers but remain below the cost of new fossil fuels or nuclear when factoring in full system costs.**
    - **Lazard global LCOE (2030–2040)[11]:** Solar with storage at USD 60–210/MWh, onshore wind with storage at USD 45–133/MWh, offshore wind at USD 74-139/MWh
    - **BNEF Japan-specific LCOE[12]:** Solar with storage at USD 75–85/MWh, onshore wind with storage is USD 60-75/MWh, offshore wind at USD 85–120/MWh
- **Access to renewable energy is tightening,** especially in industrial hubs. In some regions, large semiconductor facilities dominate procurement, leaving others unable to secure

[8] Offshore wind development and regulation in Japan | DLA Piper https://www.eeas.europa.eu/sites/default/files/documents/Japanese%20OWP%20Tenders_Aquilo%20Energy%20GmbH_publication102022.pdf

[9] https://montelnews.com/news/1dc2ac3a-b778-4917-a313-e7c72c78dce8/battery-storage-survival-demands-complex-balancing-act

[10] https://www.agora-energiewende.org/fileadmin/Projekte/2014/integrationskosten-wind-pv/A EW_198_Minimizing_Integration_costs_in_Japan_WEB.pdf

[11] Lazard LCOE+ (June 2024)

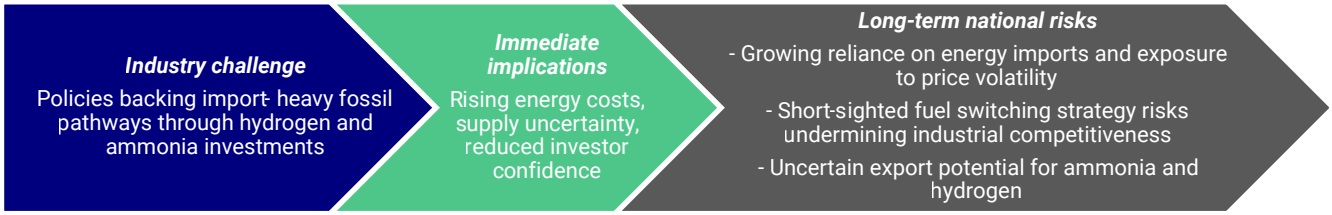
[12] Strategic opportunities to advance affordable, secure, and clean energy in Japan amid evolving technology trends. 技術動向の進展を踏まえ、日本における手頃で安全かつクリ⊠ンな エネルギ⊠の推進に向けた戦略的機会

renewable supply, raising concerns about future availability and fair access.

- **Land constraints persist**, but community acceptance is a bigger barrier than physical space. While suitable land near grid infrastructure is limited, developers are turning to agrivoltaics and co-location models that appeal to aging farmers given the opportunity for supplementary income. Unlocking idle or underused land hinges on flexible municipal governance and community engagement more than land-use regulation.

4.3 Fossil fuel dependence creates strategic and economic risks

Japan's heavy reliance on imported fossil fuels, especially LNG and coal makes its energy system vulnerable to global price shocks and geopolitical instability. In response, government and industry actors are increasingly investing in hydrogen and ammonia as alternative fuels. However, these investments often serve to preserve existing fossil fuel infrastructure rather than accelerate a full transition to renewables. This risks locking Japan into high-cost, low-efficiency energy pathways that do little to improve energy self-sufficiency or long-term competitiveness.



Supporting evidence:

- **Japan imports nearly 90% of its energy**, making it vulnerable to global shocks. LNG import prices jumped from $7.78/MMBtu in 2020 to over $20/MMBtu, with spot prices reaching as high as $70/MMBtu.[13] due to events like the Ukraine war and Middle East tensions.
- **Energy policy contradictions persist, with capacity markets supporting fossil fuels**, and GX funding flows to both green and fossil infrastructure, raising credibility concerns. GX bonds are financing hydrogen and ammonia supply chains despite high costs and unclear scalability.
- **Heavy reliance on high-cost technologies like hydrogen, ammonia, and CCS limits self-sufficiency and inflates costs**. A renewables-led transition could increase self-sufficiency to over 70% by 2040[14], compared to just 30–40% under current policy. Studies also show that installing "solar sharing" on just 10% of Japanese farmland could supply up to 37% of national electricity needs (equal to 53 nuclear reactors) with faster deployment timelines than utility-scale solar, despite a modest 10–20% cost premium.[15]

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[13] https://www.marketforces.org.au/campaigns/asia/japan-lng-expansion/

[14] IGES 1.5C RM

[15] Strategic opportunities to advance affordable, secure, and clean energy in Japan amid evolving technology trends. 技術動向の進展を踏まえ、日本における手頃で安全かつクリ⊠ンなエネルギ⊠の推進に向けた戦略的機会

4.4 Grid constraints are blocking renewable energy growth

Japan's aging and regionally fragmented grid is a major bottleneck to scaling low-cost renewable energy and connecting it to industrial load centres.

Supporting evidence:

- **Japan experienced 1.76 terawatt-hours (TWh) of solar and wind energy curtailment** in 2023, over twice the levels in Australia and California, with Kyushu curtailing 6.7% due to weak interconnection and inflexible nuclear operations.[16]
- **Japan had connected only 6.2GW of battery storage as of 2023, which is far behind the 88GW proposed.** This disparity highlights the slow pace of integrating energy storage solutions that are crucial for balancing intermittent renewable generation.[17]
- **Grid access is often prioritised to nuclear and thermal power**, while the lack of transparency in grid connection processes and stalled applications deter new renewable energy projects. The lack of real-time dispatch and curtailment data further limits developers from making informed investment decisions.
- **Stakeholders noted that grid-enhancing technologies, such as battery co-location, could help ease grid constraints, but deployment remains limited.** Developers are actively exploring battery energy storage systems (BESS), particularly alongside solar PV projects, yet high costs continue to deter many offtakers. Additionally, concerns over Chinese battery suppliers have surfaced, with some offtakers requiring extra due diligence around security and sourcing.

[16] https://www.renewable-ei.org/en/activities/column/REupdate/20240411.php

[17] Strategic opportunities to advance affordable, secure, and clean energy in Japan amid evolving technology trends. 技術動向の進展を踏まえ、日本における手頃で安全かつクリ⊠ンなエネルギ⊠の推進に向けた戦略的機会

4.5 Decarbonisation instruments are misaligned with global standards

Japan's current mechanisms for supporting clean electricity procurement, especially Non-Fossil Certificates (NFCs), are not meeting international expectations. These instruments lack transparency, traceability, and additionality, creating a growing credibility gap for Japanese firms seeking to meet global Scope 2 emissions targets.

Supporting evidence:

- **NFCs do not link to specific renewable energy projects,** making it difficult to verify carbon impact or match energy use on an hourly basis.
- **NFCs are mostly issued from existing Feed-in Tariff (FiT) projects** and so they do not incentivise new renewable buildout. This arrangement questions the additionality of these certificates as generation would occur regardless.
- **Japanese corporates face major barriers to scaling renewables due to a fragmented procurement landscape,** with regional PPA cost disparities, inflexible contracts, and no standardised or centralised platform. Flexible models like regional demand aggregation are needed to avoid pushing energy-intensive industries overseas.

5. Decarbonisation priorities across the semiconductor value chain

The five systemic challenges identified in Section 4 are especially true for the semiconductor sector, where access to reliable and affordable clean energy is essential for investment, operations and global competitiveness. This section shows how these challenges affect different parts of the semiconductor value chain:

- Materials and chemicals suppliers
- Semiconductor equipment suppliers
- Semiconductor manufacturers
- Data centres and digital infrastructure providers

Each segment plays a critical role in Japan's technology competitiveness, and each has distinct concerns regarding the short- and long-term nature of challenges posed by energy policy, investment signals, and renewable electricity access. Japan's global leadership in materials (48% market share) and equipment (30%) is tied to client-led decarbonisation pressures, while energy-intensive manufacturers and data centre operators require long-term certainty on grid decarbonisation to guide capital allocation. With electricity demand expected to rise sharply, especially from AI and cloud infrastructure, progress toward 2030 renewable targets and visibility on the 2040 grid carbon trajectory are essential for maintaining Japan's competitive advantage in this strategic sector. The table below summarises key energy concerns by segment.

Summary Table: Strategic Risks Across Semiconductor Value Chain

Value chain segment	Primary energy concern	Challenge driving the concern	Policy gap	Risks if unaddressed
Materials and chemicals	Ability to meet 2030 renewable energy targets to stay compliant with Scope 2 standards required by customers.	Barriers to renewable energy access and cost (4.2) and lack of credible decarbonisation instruments (4.5) are preventing suppliers from sourcing clean power at the scale and quality required by international buyers.	Most companies rely on grid electricity, but grid emissions remain high due to slow coal phaseout. Current clean power mechanisms like PPAs are expensive for SMEs	Companies risk non-compliance with international procurement standards, affecting access to green supply chains and weakening Japan's export position in materials

Equipment suppliers	Decarbonising energy-intensive production to meet customer scope 3 targets	Barriers to renewable energy access and cost (4.2), lack of credible decarbonisation instruments (4.5), and loss of position in clean energy supply chains (4.1), as these directly hinder their ability to decarbonise operations and meet the Scope 3 emissions standards	Lack tailored incentives and support for equipment suppliers, especially SMEs, to adopt clean energy and improve efficiency. There is also insufficient integration of their needs into broader decarbonisation strategies, limiting coordinated value chain emissions reductions.	Equipment suppliers misaligned with OEMs' net-zero goals risk losing key partnerships and market access as green procurement standards tighten
Chip Manufacturing	Chip manufacturers require long term visibility on declining grid emissions through 2040 to support significant investment decisions.	Loss of position in clean energy supply chains (4.1), grid constraints (4.4), and fossil fuel dependence (4.3) are making Japan's grid carbon trajectory unclear, weakening investor confidence.	Japan's current energy transition pathways rely too heavily on uncertain new nuclear projects and underinvest in diverse clean power solutions.	Without clean power certainty, Japan risks losing future investments to countries with more robust decarbonisation strategies and faces reputational risks with buyers.
Data centres	Data infrastructure providers need low-carbon, reliable electricity and access to hourly-matched renewables.	Grid bottlenecks (4.4), limited access to affordable RE (4.2), and mistrust in decarbonisation tools (4.5) are creating major obstacles to building green data centres at the pace needed.	The lack of compliant hourly RE options, grid congestion near urban demand centres, and the lack of credibility of NFCs as Scope 2 instruments limit the scalability of clean energy solutions for data centres.	AI and data centre roll out may be delayed or cancelled, putting Japan's role as an AI infrastructure hub at risk due to a lack of clean, scalable power solutions

All parts of the value chain are converging around a shared concern: Japan's current clean energy strategy is misaligned with the timeline, scale, and credibility required to support semiconductor-led industrial growth.

6. Risks of Japan's current energy transition path

If current industry challenges such as limited access to low-cost, credible, domestic renewable electricity are not resolved, Japan faces significant systemic risks to energy security, industrial competitiveness, and economic resilience. These risks intensify as the global energy transition accelerates.

Energy Security Risks [18,19]

90%+	of Japan's energy is imported — the highest reliance among G7 countries
65%	of energy imports come from just three countries: Australia, SaudiArabia, and the UAE
41% and 71%	of LNG and coal imports respectively come from Australia alone
$140–230 billion	was spent on fuel imports in 2022

Japan's dependence on energy imports leaves it highly vulnerable to external shocks and market volatility. With two-thirds of its energy sourced from just three nations, supply disruptions or price swings in those countries can directly impact Japan's economy. Despite ambitions to diversify via hydrogen and ammonia, this could increase exposure to unstable global markets. Meanwhile, the slow return of nuclear power, with only 12 of 33 reactors operational, limits Japan's energy independence. Studies indicate that domestic renewables, especially solar paired with battery storage, are a far more cost-effective and secure long-term solution (USD 40 billion in solar and battery investment could offset $300 billion in fossil fuel imports)[20].

Industrial Competitiveness Risks [21,22,23]

Over 40%	of Japanese manufacturing SMEs face financial barriers to adopting low-carbon technologies
157.5 TWh by 2030	and 1,050 TWh by 2050 is the renewable electricity needed for Japan's hydrogen targets - exceeding total electricity generation in 2022 (~1,000 TWh)
Less than 10%	of the national energy budget is allocated to renewables, while ~38% supports fossil fuels andhydrogen/ammonia under the GX plan

[18] https://ieefa.org/resources/japans-persistent-fossil-fuel-subsidies-threaten-industry-competitiveness-and

[19] https://www.straitstimes.com/business/how-great-is-japan-s-reliance-on-the-middle-east-for-energy

[20] **Strategic opportunities to advance affordable, secure, and clean energy in Japan amid evolving technology trends.** 技術動向の進展を踏まえ、日本における手頃で安全かつクリ⍰ンなエネルギ⍰の推進に向けた戦略的機会

[21] https://www.jetro.go.jp/en/news/releases/2024/fb39b6cf59b998d5.html

[22] Based on the assumption that producing 1 kg of green hydrogen requires 50–55 kWh of renewable electricity, Japan's hydrogen targets - 3 Mt by 2030 and 20 Mt by 2050 - would require 157.5 TWh and 1,050 TWh of renewable electricity, respectively. The 2050 requirement alone exceeds Japan's total electricity generation in 2022 (~1,000 TWh).

[23] https://climateintegrate.org/wp-content/uploads/2025/04/GB25_EN.pdf

Japan's manufacturing sector, particularly in export-oriented, high-tech industries like semiconductors and electronics face growing global pressure to decarbonise. However, limited access to affordable clean energy is putting firms at risk of being excluded from low-carbon global supply chains. Despite ambitious targets for hydrogen, Japan's current energy strategy prioritises expensive, early-stage technologies over cost-effective renewables, creating a gap between ambition and feasibility. Conservative government assumptions, slow regulatory reforms, and under investment in renewables and grid infrastructure further delay progress. Without corrective action, Japan risks losing its industrial competitiveness, investor confidence, and future leadership in the clean energy economy.

Economic Resilience Risks [24,25,26]

USD 43 billion (Vietnam) and USD 20 billion (Indonesia)

These are the planned investments in solar and wind projects by 2030, signalling Southeast Asia's growing renewable energy ambitions. Indonesia also targets 23% renewables in its energy mix by 2025, directly challenging Japan's assumptions about future fuel export demand

< $40/MWh (solar and wind), $4–6/kg (green hydrogen), > $700/ton (ammonia)

Renewable energy and fuel costs in Southeast Asia are already highly competitive. Locally produced solar and wind are now cheaper than imported fuels, while hydrogen and ammonia face additional costs from transport and infrastructure needs.

Japan is banking on future demand for its hydrogen, ammonia, and fossil-decarbonisation technologies from Southeast Asian economies. But the region is investing heavily in their own renewable capacity, which is already cheaper and more scalable than imported alternatives. This undermines Japan's assumptions about stable export markets for its fuels and technologies. Combined with international investor concerns over credible climate disclosure and transition planning in Japan, the result could be underutilised infrastructure, stranded assets, and missed industrial opportunities if there is no immediate shift toward direct, low-cost renewables.

[24] https://www.energy-box.com/post/new-power-plan-vietnam-to-invest-136b-in-energy-infrastructure-by-2030#:~:text=New%20Power%20Plan:%20Vietnam%20to,in%20Energy%20Infrastructure%20by%202030

[25] https://www.businesstimes.com.sg/international/indonesia-launches-us20-billion-renewable-energy-investment-plan

[26] https://www.irena.org/Innovation-landscape-for-smart-electrification/Power-to-hydrogen/Status

7. Opportunities for decarbonising Japan's power sector

This section presents seven key opportunities responding to stakeholder concerns around Japan's energy security, industrial competitiveness, and economic resilience, while supporting semiconductor sector decarbonisation. They are grouped by urgency and expected impact timeline:

- **Immediate, quick win opportunities to 2030:** Three no-regret actions ready for implementation now to accelerate renewables, boost local economies, and improve power system resilience and cost-effectiveness.
- **Immediate, challenging opportunities to 2030:** Essential investments that must begin now in grid infrastructure, storage, and flexibility to enable large-scale renewable integration by 2030.
- **Opportunities to be realised post-2030:** Early investments in breakthrough technologies and clean energy ecosystems to keep Japan globally competitive and lead industrial decarbonisation after 2030.

Summary of opportunities for Japan to address industrial decarbonisation challenges and their impacts on semiconductor competitiveness

	Opportunity	Challenge Addressed	Description	Impact on semiconductor value chain	Wider Implications	Risks Addressed
			Immediate, quick win opportunities to 2030			
1	Accelerate **solar PV** deployment by streamlining permitting and consenting	Barriers to RE deployment	Introduce digital platforms, set clear timelines, and reduce redundant approvals	• **Materials/Chemicals:** Easier access to low-cost solar power for green manufacturing. • Manufacturing: Quicker access to clean power enables flexible production planning.	Unlock faster deployment of solar energy	√ Energy Security √ Industrial Competitiveness
2	Unlock renewable energy potential through **community-based land use**	Barriers to RE deployment	Target unutilised land for renewable energy by expanding co-location models like agrivoltaics or solar with fisheries	• **SMEs & Local Suppliers:** Opportunities to join community energy projects lowering costs.	Stimulate local economies and job creation in the clean energy sector	√ Energy Security √ Industrial Competitiveness
3	Accelerate the **modernisation of the electricity** market by prioritising low-cost, low-carbon technologies	Barriers to RE deployment	Implement the Simultaneous Market to co-optimise procurement of energy, balancing, and capacity services in real time	• **Manufacturing:** More efficient power procurement models enable better cost controland load balancing. • **Data Centres:** Hourly market pricing supports demand response and flexible operations.	Improve grid efficiency, enhance flexibility, and support the integration of renewable energy and battery storage	√ Energy Security √ Industrial Competitiveness

Immediate, quick win opportunities to 2030						
4	Use GX Funding and market reform to target a **smarter and more flexible electricity grid**	Grid constraints; Misaligned decarbonisation instruments	Prioritise funding and market reform for: – Battery energy storage systems – Grid forming technologies – Flexibility and smart grid technologies – Demand-side response	• **Equipment Suppliers:** Access to reliable, verifiable clean electricity (hourly PPAs) supports Scope 3 decarbonisation. • **Manufacturing:** Greater certainty on grid capacity and clean energy sourcing. • **Data Centres:** Enhanced RE-backed infrastructure supports semiconductor design and testing hubs.	Enables RE100/ SBTi-compliant PPAs and traceable RE use, attracting institutional investors	√ Energy Security √ Industrial Competitiveness √ Economic Resilience
Opportunities to be realised post-2030						
5	Develop a competitive advantage in **Floating Offshore Wind**	Loss of strategic position in clean energy supply chains	Support the industry through policy frameworks, including the designation of offshore wind zones, transmission connectivity, and incentives for domestic manufacturing	• **Materials & Equipment:** Potential to supply offshore wind tech domestically. • **Manufacturing:** New clean energy supply source stabilises long-term cost base. • **Data Centres:** Secure clean power supply for expansion plans.	Position Japan as a leader in the global offshore wind market; attract private investment	√ Industrial Competitiveness
6	Promote the **Phase out of Coal-Fired Power Plants** to attract private investment for replacing or repowering sites	Fossil fuel dependence creates strategic and economic risks	Introduce an aggressive carbon price or tax; enhance the GX Emissions Trading Scheme to recognise and credit the early retirement of coal-fired plants	• **Materials:** Encourages shift to low-carbon inputs. • **Manufacturing:** Reduced fossil fuel risk improves cost and carbon footprint predictability.	Reduce reliance on fossil fuel-based peaking plants; support economic diversification in coal-dependent regions	√ Energy Security √ Industrial Competitiveness √ Economic Resilience
7	Target the use of **Low Carbon Fuels to Decarbonise Hard-to-Abate Sectors** through deployment in Industrial Clusters	Fossil fuel dependence creates strategic and economic risks	Focus efforts and funding on hydrogen and CCUS use in hard-to-abate sectors; establish clear regulatory frameworks and targeted incentive schemes	• **Manufacturing & Materials**: Opportunity to transition energy-intensive processes to low-carbon fuels. • Semiconductor fabs co-located with other industries benefit from shared clean fuel infrastructure.	Ensure deep decarbonisation in energy-intensive industries; maintain global competitiveness	√ Industrial Competitiveness √ Economic Resilience

Where relevant, we draw on UK examples to illustrate potential pathways and proven solutions. This is informed by the strong structural and strategic parallels between the UK and Japan: both are island nations with a reliance on energy imports; both have significant offshore wind potential due to extensive coastlines and favourable wind conditions; and both have legacy nuclear infrastructure that plays a central role in decarbonisation plans. In addition, both countries face similar challenges in grid capacity, and integration of variable renewables. As a UK-headquartered organisation with over 20 years of experience in the UK energy sector, we draw on this expertise to highlight what may be relevant and adaptable to Japan's context.

7.1 Immediate, quick win opportunities to 2030

The following opportunities have been selected for immediate implementation because they can deliver fast, tangible benefits to Japan's economy, industry, and energy system. They tackle key bottlenecks such as permitting delays, land-use challenges, and market uncertainty that currently slow renewable energy growth and increase costs.

7.1.1. Accelerate Solar PV Deployment by Streamlining Permitting and Consenting

Context

- Since the 2012 Feed-in Tariff (FiT), Japan has scaled up renewable energy, with solar PV now representing ~9% of the electricity mix in 2023. However, solar PV installations declined for the third consecutive year in 2023, with 5GW added - a 19% drop from 6.2 GW in 2022 - due to reduced subsidies and policy uncertainty.[27]
- Complex, fragmented permitting and consenting processes cause significant project delays, often exceeding 18 months for mid-scale solar projects, increasing costs.
- METI has acknowledged these challenges and introduced reforms, including standardised grid applications and limited digitalisation via the "Next Generation Energy System" initiative.

Despite improvements, implementation is inconsistent, and a centralised permitting platform is still lacking.

Opportunity: Build on existing policy to unlock deployment

Japan can significantly increase the pace of solar PV deployment by addressing regulatory bottlenecks. By introducing digital platforms for project applications, setting clear timelines, and reducing redundant approvals, Japan can unlock faster deployment of solar energy. Providing clearer national guidance and standardised procedures for municipalities and application reviewers, including on land use, grid connection, and environmental assessments, can help improve the consistency and speed of local decision-making. Additionally, reforming consenting processes to reduce uncertainty and duplication across agencies will be key to accelerating deployment. This would support the national target of achieving 36–38% renewable energy by 2030, while also stimulating local economies and job creation in the clean energy sector.

Quick win: Pilot centralised digital permitting platform

Launch a digital pilot in 1-2 high-solar-potential prefectures that consolidates all permits, grid access, and environmental clearances into a single application process. This would align with Japan's existing Digital Government Strategy and demonstrate early success to drive national scale-up.

[27] Solar stocks remain on the defensive, but solar demand remains very strong - Mac Solar Index

Next steps for consideration:

- **Conduct a comprehensive mapping of existing permitting and consenting processes** across national, prefectural and municipal levels to identify specific barriers contributing to project delays and benchmark against international best practices in solar permitting.
- **Analyse the potential economic, environmental, and grid-related impacts of accelerated solar deployment under different permitting reform scenarios,** and evaluate potential benefits in terms of PPA cost reductions, job creation, land use optimisation and carbon emission reductions.
- **Assess feasibility and readiness for a centralised digital permitting platform (e.g. GenAI-enabled),** including integration of environmental and grid access approvals, and real-time project tracking. Evaluating whether the technical and administrative capacity of relevant agencies exists to manage this platform will be necessary to inform its design.

Best practices from the UK

Rooftop Solar Deregulation: By removing the requirement for planning permission on solar panels installed on flat-roof homes, the UK made it easier for households and businesses to adopt small-scale solar, boosting distributed generation and public participation in the energy transition.

Grid Connection Reform: Comprehensive reforms focus on unlocking large-scale solar by improving transparency around connection queues, enhancing communication between developers and grid operators, and implementing faster, more efficient approval processes. This has helped unlock capacity for up to 65GW of utility-scale solar projects.

7.1.2 Unlock Renewable Energy Potential through Community-Based Land Use

Context

- Japan faces land constraints for utility-scale renewable energy due to high population density, mountainous terrain, and agricultural land protection policies.
- Japan's Ministry of Agriculture, Forestry and Fisheries (MAFF) permits dual-use of farmland under specific conditions through its Farmland Act, amended in 2013.
- Pilot agrivoltaics projects have been trialled in prefectures such as Chiba and Nagano, with support from local governments.
- The GX initiative references community participation in clean energy, but lacks direct mechanisms to enable local ownership or support co-location models at scale.
- The Land Ministry is introducing subsidies to convert vacant residential land into community

assets, supporting new opportunities for local renewable energy development.[28]

- Despite these efforts, agrivoltaics uptake remains limited due to lack of national standards, case-by-case permitting, insufficient technical guidance, municipal capacity gaps, and risk-averse local governance.

Opportunity: Scale community-based renewable models by incentivising ownership

Building on existing pilots and MAFF permissions, Japan can target both dual-use farmland and underutilised or unused land for renewable energy development, while empowering municipalities to co-own projects to boost local acceptance and support. Co-location projects are especially attractive to rural communities as they offer new income streams without displacing agriculture or fisheries. To scale this approach, the government can direct funding to local pilot programs, provide technical guidance for municipalities, and establish national standards to streamline approval. Incentives to support community ownership could include preferential access to GX funding for co-owned or community-led projects, tax credits or revenue-sharing mechanisms for local governments and cooperatives, and low-interest loans or grants to help cover upfront capital costs. Strengthening municipal capacity alongside these incentives will be critical to building trust, encouraging local participation, and accelerating deployment in underutilised rural areas.

Quick win: Develop national agrivoltaics standards and permitting guidelines

Developing technical standards for agrivoltaics installations and standardising permitting templates that municipalities can adopt builds directly on existing MAFF and METI efforts to develop local pilot projects. It would not require changes in laws and involves issuing guidance to remove ambiguity and reduce delays for developers.

Best practices from the UK

The UK is increasingly embracing community-based approaches to the deployment and ownership of renewable energy. These examples offer valuable lessons in empowering communities to reap the rewards while contributing to national decarbonisation efforts.

Funded by the Scottish Government, the **Community and Renewable Energy Scheme** (CARES) helps community groups and local organisations develop low-carbon projects focusing on renewable energy generation, sustainable transport, or heat decarbonisation. CARES offers tailored support throughout the project lifecycle, including expert advice on legal, financial, and technical matters, as well as access to grants and low-interest loans.

On a working farm in the South of England, the **Westmill Wind Farm Co-Operative and Westmill Solar Co-Operative** are community-owned co-operatively run onshore wind and solar farms respectively. Profits generated through these projects are distributed to co-operative members and community funds, providing economic benefits to its members and environmental educational activities locally.

Sources: Funding advice for renewable energy projects in Scotland; Energy Service (for public sector and community groups) | GOV.WALES; Westmill Wind Farm Co-operative - Westmill Wind Farm Co-op; Power of Places, A vision for local energy in the UK,

[28] https://www.japantimes.co.jp/news/2024/08/15/japan/society/empty-land-utilization/

Next steps for consideration:

Evaluate the readiness of local government to support and oversee community-based renewable projects, identifying gaps in stakeholder coordination processes and planning to develop suitable training to strengthen capabilities.

Design incentive structures for community ownership and participation, exploring financing models and community benefit-sharing to ensure equitable returns from renewable energy projects.

7.1.3 Accelerate the Modernisation of the Electricity Market by Prioritising Low-Cost, Low-Carbon Technologies

Context

- Japan is developing a Simultaneous Market to co-optimise energy, balancing, and capacity in real time, with implementation targeted by FY2028.
- The goal is to improve dispatch efficiency, strengthen price signals, and better integrate low marginal cost technologies (e.g. renewables, BESS, nuclear).
- However, there is a lack of clarity on market design, timelines, and revenue mechanisms is delaying investment from renewable and storage developers.

Opportunity: Build on ongoing market reform to accelerate low carbon integration

Speeding up the deployment of the Simultaneous Market could drive rapid change in Japan's generation mix before 2030, accelerating the deployment of renewables. This planned integrated market is designed to co-optimise energy, capacity, and balancing services in real time, using half-hourly intervals. It aims to improve grid efficiency, enhance flexibility, and prioritise the dispatch of low-cost, low-emissions resources like renewables and battery storage. Faster implementation, paired with greater transparency on design, timelines, and revenue streams, would reduce investor uncertainty and unlock clean energy investment. As part of Japan's broader GX2040 Vision, a well-executed Simultaneous Market could lower emissions, reduce costs, and create a more competitive and resilient electricity system.

Quick win: Publish findings from the Simultaneous Market findings and develop an implementation roadmap

This involves summarising pilot results such as improvements in dispatch efficiency and balancing performance, and publishing a detailed timeline outlining design phases and key milestones through FY2026. The necessary data and insights already exist, making this a low-cost and politically low-risk action. Interactive dashboards could also be developed to present this information as this would significantly improve market transparency, reduce uncertainty for investors and developers, and help build trust in the ongoing reform process. This, in turn would accelerate stakeholder readiness and engagement ahead of full market implementation.

Next steps for consideration:

- **Compile and review key insights and data from the Simultaneous Market pilot phase and draft a report to share learnings** to improve awareness of this fundamental yet critical market change with key actors in the sector. This will help improve the transparency of future changes and reduce the risk for investors and developers.
- Enhance the transparency of market changes by **publishing detailed roadmaps of designs, plans, and implementation processes.**
- **Promote greater competition through electricity market reforms,** which could include improving price signals through real-time and locational pricing, or fostering innovation through open data and digital platforms.

Case Study: UK National Energy System Operator (NESO)

- Japan could take inspiration from the UK's National Energy System Operator (NESO), which provides a clear model for market transparency and structured reform. NESO's **Electricity Markets Roadmap** outlines phased reforms and timelines, while the **Future Energy Scenarios (FES)** offer unified projections for industry planning. Together, they align stakeholder expectations and guide investment.
- Interactive dashboards, regular updates, and the **Holistic Network Design** further boost market confidence by making complex information accessible and outlining long-term pathways. Complementing this, the **Strategic Innovation Fund (SIF)** supports network innovation through targeted funding.
- Adopting a similar, transparent approach using Japan's pilot data could reduce policy uncertainty, attract investment, and accelerate readiness for electricity market reform.

7.2 Immediate, challenging opportunities to 2030

The 2030 decarbonisation opportunities for Japan's power sector were selected based on their potential to address critical challenges: limited grid capacity and flexibility, fragmented access to clean electricity, and slow market reforms that hinder low-carbon technology adoption. Opportunities were prioritised for their feasibility, alignment with existing policy frameworks such as the GX initiative, and potential to deliver measurable impact by 2030 within Japan's current regulatory and political landscape.

7.2.1 Use GX funding and market reform to target a smarter and more flexible electricity grid

Context

- The GX initiative is central to Japan's decarbonisation but has primarily targeted industrial sectors, with limited investment in grid infrastructure. In FY2025, GX funding shifted to increase support for fossil fuels and nuclear power, while investment in battery storage declined.[29]
- Japan's electricity grid remains fragmented into 10 regional utilities with low interconnection capacity, especially between eastern and western grids. This limits renewable energy integration in resource-rich regions such as Hokkaido, Tohoku, and Kyushu.
- Global investors seek clear policy frameworks, large-scale funding, and transparent project pipelines for grid transformation projects conditions Japan currently lacks. METI and OCCTO have launched early-stage initiatives like the Long-Term Decarbonised Power Source Auction (LTDA) and Transmission Planning Strategy, but these remain small in scale and not fully aligned with GX funding priorities.
- Battery Energy Storage Systems (BESS) deployment is increasing in some regions but remains insufficient for system-wide stability. Existing support measures include subsidies and tax incentives, but market participation rules are restrictive. Notably, the LTDA requires BESS participants to return 90% of profits[30] from other market transactions to OCCTO, undermining economic viability and discouraging scalability. Without mechanisms to fully value BESS's role in grid flexibility, Japan risks a gap in its clean energy strategy.
- Advanced grid technologies such as grid-forming inverters, dynamic line rating, synchronous condensers, and demand-side response programs exist but face deployment barriers due to limited market access clarity.

Opportunity: Align GX funding with grid infrastructure to unlock bottlenecks

To accelerate Japan's transition to a low-carbon power sector, it is essential to prioritise GX funding towards projects that enhance grid connectivity, upgrade transmission infrastructure, and integrate renewable energy. This includes prioritising:

[29] https://climateintegrate.org/wp-content/uploads/2025/04/GB25_EN.pdf

[30] Japan's Long-Term Decarbonization Power Source Auction - Lexology

- Battery Energy Storage Systems (BESS)
- Grid forming technologies
- Flexibility and smart grid technologies
- Demand-side response

Reforming market participation rules to allow BESS and flexible resources to stack multiple revenue streams such as frequency response, inertia provision, and grid balancing will improve economic incentives for investors. Revising LTDA's profit-sharing rules or creating parallel merchant market mechanisms can make BESS deployment more financially viable and encourage sustained participation beyond pilot phases.

Developing clear, consistent national technical standards and certification processes for advanced inverter-based resources will accelerate large-scale deployment, ensuring interoperability and grid safety. Enhanced transparency in market access, pricing, and dispatch timelines will reduce investor uncertainty, attract private capital, and boost innovation.

Regulatory sandboxes, open data platforms, and public consultation forums can foster innovation by allowing developers, utilities, and regulators to collaboratively test new technologies and business models in a controlled environment. Supporting domestic BESS manufacturing and supply chains will also be critical to reduce reliance on imports and meet the scale of deployment needed by 2030.

Quick wins

Revise GX funding guidelines to prioritise grid infrastructure
The GX programme is already a strong vehicle for accelerating clean energy investment, with fund allocation guidelines administratively controlled. However, to maximise its impact, more funds need to be allocated specifically for grid-related projects, such as transmission upgrades, storage, and digital controls. Encouraging grid projects to apply for GX funds through updated guidelines can be achieved without requiring new legislation, making it a practical and immediate opportunity to strengthen Japan's energy transition.

Develop a roadmap for BESS market access
A quick win to accelerate BESS deployment in Japan is the publication of a clear, publicly available roadmap outlining when and how battery storage projects can access key electricity markets such as frequency control, balancing, and capacity services. This action builds on existing pilot programs and policy commitments under the GX framework, requiring only the consolidation of current plans and timelines by METI, OCCTO, and utilities. By improving transparency and reducing investor uncertainty, this step would boost market confidence, enable better project planning, and signal strong government support for grid-stabilising technologies.

Develop guidance for technical standards related to grid-forming technologies
The publication of a national roadmap for technical standards related to grid-forming technologies, supported by guidance on performance expectations would build investor confidence, help manufacturers and developers align with Japan's evolving grid requirements, and allow early-stage projects to move forward without waiting for full regulatory clarity. The roadmap could draw on international best practices and lessons from domestic pilot projects.

Next steps for consideration:

To reduce import dependency and achieve the scale of grid infrastructure and BESS deployment required by 2030, Japan must take a coordinated approach that aligns funding, market reform, technical standards, and innovation support. The following steps can help unlock investment, accelerate technology adoption, and enhance grid resilience:

- **Translate stakeholder consultations into funding priorities:** Building on existing dialogue with utilities, developers, regulators, and local governments, Japan should formalise insights into clear prioritisation criteria for GX funding. This will help direct capital to the most critical grid and renewable infrastructure projects and give investors visibility on where support will be focused.
- **Map current BESS participation and develop a deployment roadmap:** Compile and analyse data on existing BESS activity across ancillary services, frequency control, and capacity markets, including outcomes from pilot programs. Use this evidence base to create a public-facing roadmap outlining when and how BESS will gain access to different markets, along with the associated revenue models
- **Establish national technical standards and certification processes:** Accelerate the development of technical standards for grid-forming inverters and other flexible technologies to ensure interoperability, safety, and reliable grid integration. This will reduce project uncertainty and streamline deployment.
- **Reform market access for flexible resources:** Enhance and simplify participation in ancillary and balancing markets for technologies such as BESS and demand-side response. Introducing co-optimised mechanisms that reward fast frequency response, inertia provision, and voltage support will allow these resources to stack revenues, improve business cases, and unlock private investment.
- **Support grid operators through training and guidance:** Provide clear technical guidance and training for utilities and system operators to build operational readiness for integrating more flexible and non-synchronous technologies into the grid.
- **Foster innovation through regulatory sandboxes and open platforms:** Create controlled environments where new technologies and business models can be tested without full regulatory compliance. This will help identify and resolve barriers early. At the same time, launch open-access data platforms to improve transparency and enable researchers, start-ups, and corporates to develop, pilot, and scale grid solutions.
- **Enable transparent, inclusive grid code reform:** Establish public forums and working groups for proposing and reviewing grid code modifications. Ensure participation is open to all stakeholders—not just incumbents—so developers and innovators can help shape the regulatory environment. This will promote broader industry alignment, foster trust, and accelerate adoption of advanced grid technologies.

Best practices from the UK

Strategic Grid Planning and Investment

- **Holistic Network Design (HND):** A coordinated plan to connect offshore wind and other generation sources using shared infrastructure instead of radial designs. This approach has saved UK consumers an estimated **£5.5 billion by 2030** through reduced constraint costs and more efficient grid buildout.
- **Strategic Spatial Energy Planning (SSEP):** Identifies optimal sites for future generation and infrastructure based on long-term targets, helping to **reduce grid connection delays** and ensure better alignment with national energy policy.

Adopting a **long-term, coordinated grid design** approach can reduce costs, avoid congestion, and accelerate renewable integration—particularly in resource-rich but under-connected regions like Hokkaido and Kyushu.

Battery energy storage market development

- **Accessible, Multi-Revenue Markets:**
  UK BESS assets can **stack revenues** by participating in a range of ancillary service markets (frequency response, reserve, balancing), and increasingly in wholesale trading and capacity markets.
- **Flexible Contracting Models:**
  As the frequency response market matured and returns declined, UK operators shifted toward new business models including **profit-share, floor agreements, and tolling contracts**, increasing financial resilience.
- **LDES Cap and Floor Regime:**
  Provides a **minimum revenue floor** to de-risk long-duration energy storage investment while capping profits to protect consumers—drawing on the UK's successful interconnector.

Instead of relying solely on subsidies, Japan can enable BESS growth by creating **transparent, flexible market frameworks** that reward grid services and support new business models.

Innovation, Market Access, and Regulatory Flexibility

- **Regulatory Sandboxes (Ofgem):**
  Time-limited, monitored environments where innovators can trial new tech and services **without full regulatory compliance**, helping identify needed reforms.
- **Open Grid Code Modification Process:**
  Any market player, not just utilities, can propose rule changes via inclusive technical working groups, with transparent timelines and regulatory oversight.
- **Open Data Platforms:**
  Initiatives like the Energy Data Taskforce have improved **data availability and standardisation**, accelerating innovation across the grid and energy services sector.

To unlock innovation in grid tech, Japan could replicate the UK's **inclusive sandboxes, open rulemaking**, and **data-sharing platforms** to support start-ups, storage providers, and local governments in shaping future energy reforms.

Source: Britain's grid operator asked to provide energy infrastructure plan | Reuters; Holistic Network Design: A key step for achieving 50 GW offshore wind in the UK by 2030 - REGlobal - Mega Trends & Analysis; Offshore Transmission Network Review: summary of outputs - GOV.UK; The Buildout Report GB: Q4 2024 sees highest increase in energy capacity in a single quarter ever - Research | Modo Energy; Long Duration Electricity Storage: cap and floor application window 1 | Ofgemwindow 1 | Ofgem

7.3 Opportunities to be realised post-2030

These decarbonisation opportunities focus on advancing scalable, innovative solutions that support Japan's long-term competitiveness and industrial leadership with actions required today. These initiatives are aligned with global decarbonisation trends and aim to position Japan as a leader of clean technology development, fostering export potential, energy security, and economic growth beyond 2030.

7.3.1 Develop A Competitive Advantage in Floating Offshore Wind

Context

- Japan has an estimated 3,000 GW of offshore wind potential, including 1,200 GW with capacity factors over 40%. National goals include 10 GW of offshore wind by 2030 and 45 GW by 2035 (25 GW fixed-bottom, 20 GW floating).
- The 2025 amendment to the Ocean Energy Utilization Act allows offshore wind development in Exclusive Economic Zones (EEZs), crucial for scaling floating wind.
- NEDO's Green Innovation Fund Phase 1 created working groups on key floating wind innovations, while Phase 2 includes site demonstrations. However, these have yet to translate into clear, long-term policy signals or a defined commercialisation pathway.
- Environmental impact assessments and permitting remain lengthy and fragmented across agencies, with unclear pathways for floating wind projects. Limited policy clarity around curtailment, revenue certainty, and support mechanisms hinders investor confidence.
- Demonstration projects (e.g. Goto, Nagasaki; Noshiro, Akita) are in early stages, and commercial-scale production of floating structures is not yet defined.
- The Floating Offshore Wind Renewable Energy Association's (FLOWRA) establishment is a positive step, but structured engagement mechanisms (e.g. innovation sandboxes, working groups) are lacking, slowing technology and project development.

Opportunity: Positioning Japan as a global leader in floating offshore wind

To accelerate offshore wind deployment, Japan can build on the Ocean Energy Utilisation Act by streamlining permitting and environmental impact assessments (EIAs) and fast-tracking seabed leasing. Transmission investment and grid upgrades, particularly in high-resource areas like Hokkaido, where projects show 50% capacity factors and potential for 8 GW of wind are essential to integrate new capacity and support national energy targets. Aligning these efforts with incentives for domestic manufacturing and port infrastructure can also strengthen Japan's industrial competitiveness in the offshore wind supply chain.

To attract investment and reduce project risk, the government can expand the use of revenue-stabilisation mechanisms such as Contracts for Difference (CfDs), which have proven effective in other mature markets. Offshore wind's seasonal generation profile also complements solar

output and peaks during high-demand months, improving overall grid reliability. Taken together, coordinated action across permitting, grid development, and market design will be critical for scaling Japan's offshore wind sector, especially floating wind, and ensuring long-term cost reductions and energy security.

Quick win: Launch a national consultation and publish interim permitting guidance for floating offshore wind

A realistic and high-impact step within the next 12 months is for METI to publish interim guidance on permitting and environmental review for floating offshore wind, alongside launching a national consultation on the design of a floating wind-specific CfD mechanism. This quick win does not depend on commercial-scale deployment readiness but directly addresses a major developer concern: regulatory uncertainty. It would clarify expectations for early-stage project siting, streamline EIA procedures, and gather input to tailor CfD design to the technical and financial factors related to floating wind.

Next steps for consideration:

- **Assess the applicability of CfD price guarantee models to Japan's floating offshore wind market,** building on existing market insights and prior financial assessments. This should consider local regulations, grid conditions, and costs, to enhance bankability, reduce investor risk, and accelerate deployment.
- **Assess opportunities for Japan's shipbuilding industry to expand into floating offshore wind platform manufacturing**, leveraging existing skills, facilities, and coastal infrastructure. Rather than full transition, this would support diversification into a growing clean energy market, helping to build domestic supply chains. The assessment should identify technology gaps, workforce needs, and potential policy incentives to support this expansion.
- **Develop and standardise permitting and licensing processes specifically for floating wind**, including environmental impact assessments tailored to the unique challenges of floating wind platforms.
- **Prioritise regional energy planning that explicitly aligns OSW development with digital infrastructure growth, particularly in areas targeted by the Bit-Watt Alliance.** This includes fast-tracking grid upgrades and seabed leasing near potential OSW sites adjacent to emerging data centre clusters, especially in Hokkaido where nuclear restarts remain uncertain. This will support clean power access for strategic organisations like Rapidus, reducing reliance on delayed nuclear restarts.

Best practices from the UK

The Offshore Transmission Operator (OFTO) regime

- **Ownership unbundling:** Separating transmission asset ownership from generation promotes competition and transparency, reducing conflicts of interest and improving efficiency.
- **Regulated asset transfer:** Developers build the connection, but OFGEM sets a fair asset value and auctions ownership to investors, ensuring cost-effective management over asset life.
- **Cost control focus:** The regime's design incentivizes lean investment and operational efficiency, reducing overall system costs.

Clear separation of roles and competitive transfer of assets can unlock private capital and lower consumer costs in grid infrastructure.

Contracts for Difference (CfDs)

- **Revenue certainty:** Providing a fixed "strike price" per MWh for low-carbon projects significantly reduces investor risk and financing costs, driving down project costs.
- **Competitive auctions:** Auctioning CfDs across technology "pots" fosters competition between mature and emerging technologies, accelerating innovation and cost reductions.
- **Adaptive design:** Recent changes (e.g., limiting price protection during negative pricing) balance market incentives with risk management, though they can raise costs.

Well-designed CfDs enable large-scale renewable deployment by balancing investor security with competitive market dynamics, but must evolve to address emerging risks.

7.3.2 Promote the Phase out of Coal-Fired Power Plants to Attract Private Investment for Replacing or Repowering Sites

Context

- Japan has historically relied on coal for stable electricity supply, and today it makes up ~30% of Japan's power mix.[31]
- Japan targets net-zero emissions by 2050, with interim reduction goals of 46% by 2030, 60% by 2035, and 73% by 2040 (from 2013 levels).
- Some coal plants are set for retirement, but many remain due to energy security and economic concerns. Existing policies include partial coal phase-out plans and the GX Emissions Trading Scheme (GX-ETS), which aims to incentivise emissions reductions but currently lacks specific

[31] Japan - Countries & Regions - IEA

provisions to support early retirement or repurposing of coal assets via a just transition.

Opportunity: Accelerating coal phase out through supportive policies and reforms

Accelerating the phase-out of coal-fired power is one of the most impactful actions Japan can take to reduce the carbon intensity of its electricity supply and improve public health outcomes. A clear, ambitious coal phase-out timeline would align with the 2050 net-zero target, offer policy certainty to investors, and help plant owners avoid future losses as carbon prices rise and coal becomes economically unviable. **A strong carbon price or tax, based on the UK's successful 2013 carbon price floor, could further accelerate this shift by making coal generation less competitive.**

Strengthening Japan's GX Emissions Trading Scheme (GX-ETS) to credit early coal plant retirements could also provide a new revenue stream for operators and encourage timely closures. International examples, such as Germany's €1.75 billion compensation for coal exits, the UK's Powering Past Coal Alliance, and U.S. federal support for coal region transitions, show how financial incentives and social support can facilitate a just and orderly transition.

Quick win: Strengthen pollution limits and carbon pricing alongside GX-ETS guidance for early coal retirements

To accelerate Japan's coal phase-out, a priority should be tightening pollution limits similar to the Large Combustion Plant Directive and enhancing carbon tax measures to directly restrict emissions from coal plants. These regulatory approaches create clear, enforceable incentives to reduce coal use without the complexity of setting up carbon credit schemes.

Complementing these measures, issuing interim GX-ETS guidance that recognises early coal plant retirements could help reduce financial uncertainty and encourage private investment by providing clarity on carbon credit eligibility. Paired with pilot financial support programs, this approach can improve the economics of early closures or repowering with renewables, reallocating capital toward decarbonisation goals while minimising investor risk.

Next steps for consideration:

- **Evaluate financial support mechanisms for the early closure of coal fired plants** that can reduce the burden on plant owners to transition and create a more attractive financial environment for private investors to repurpose plants for renewable energy.
- **Evaluate a transparent allocation system and monitoring and verification process** for the distribution of carbon credits within the GX-ETS, ensuring that actual emissions reductions are achieved through early plant closures.
- **Develop a just transition plan** to support workers and communities that are dependent on coal-fired power plants.

Best practice examples for coal phase out

Countries like the UK and EU members have reduced coal use through coordinated regulatory standards, carbon pricing, and electricity market reforms.

Regulatory Standards:

The EU's Large Combustion Plant and Industrial Emissions Directives imposed stricter limits on pollutants (SO_2, NO_x, particulates), driving the retirement or retrofit of inefficient coal plants. Predictable compliance timelines allowed operators to plan ahead.

Carbon Price Floor:

The UK's 2013 Carbon Price Floor set a minimum carbon price, making coal less competitive than gas and renewables. This accelerated coal's decline and boosted investor confidence in low-carbon technologies.

Electricity Market Reform: The UK's reform package supported low-carbon energy while ensuring reliability and affordability:

- **Contracts for Difference (CfDs):** Guaranteed stable revenues for clean energy projects.
- **Capacity Market:** Paid for generation capacity to ensure supply security.
- **Emissions Performance Standards (EPS):** Blocked new coal plants without CCS, halting future coal investment.

7.3.2 Target The Use of Low Carbon Fuels to Decarbonise Hard-to-Abate Sectors Through Targeted Deployment in Industrial Clusters

Context

- Japan's GX strategy highlights hydrogen and CCS as essential for decarbonising hard-to-abate sectors such as steel, cement, and chemicals, which require high-temperature, continuous energy and are difficult to electrify.
- To advance these technologies, the government has released hydrogen roadmaps and launched pilot projects and R&D initiatives. Industrial clusters like Kitakyushu and Keihin are actively exploring hydrogen use and CCUS infrastructure.
- METI has introduced interim guidelines to clarify permitting and safety standards for hydrogen and CCS projects in key industrial areas, aiming to streamline approval processes, ensure safety, and improve coordination with local governments.
- However, progress remains fragmented, infrastructure is still nascent, and comprehensive decarbonisation pathways are yet to be fully developed.

Opportunity: Focusing funding and policy support on industrial clusters where hard-to-abate sectors are concentrated, enabling economies of scale and shared infrastructure use

Japan should focus its efforts and funding on hydrogen and CCUS use in hard-to-abate sectors, such as steelmaking and chemical production, rather than the power sector. Where electrified options are available like Electric Arc Furnaces (EAF), these would be preferrable as they are a more efficient use of energy. This targeted approach aligns with Japan's GX strategy and can help ensure that hydrogen and CCUS are deployed where they deliver the greatest climate and economic impact - supporting energy-intensive industries while maintaining global competitiveness.

To advance low-carbon fuels in hard-to-abate sectors, it is essential to establish clear regulatory frameworks for CCUS that streamline permitting for transport and storage and ensure robust long-term monitoring. In parallel, targeted incentive schemes, such as the UK's CfDs now applied to low-carbon hydrogen,[32] could be developed to support hydrogen and CCUS investments specifically within industrial clusters. Aligning the GX-ETS carbon pricing mechanism to reward early adoption of low-carbon fuels will further encourage industry participation.

Quick win: Accelerate the rollout and nationwide adoption of the interim permitting and safety guidelines for hydrogen and CCUS projects within priority industrial clusters

Since METI has already developed guidelines, swiftly publishing final versions and actively supporting local governments and developers in applying them would:

Enable faster project development and investment flows

Strengthen stakeholder confidence and coordination across regions

This step requires relatively low incremental cost but offers significant impact by unlocking near-term projects.

Next steps for consideration:

Create a collaborative model to foster public-private partnerships, engaging industry stakeholders and the government in developing a shared vision for the integration of hydrogen and CCUS into industrial operations. This model should also provide a framework for guiding R&D investments and innovation, ensuring the solutions deployed are cost-effective and scalable.

[32] Low Carbon Hydrogen - Low Carbon Contracts

Establish cluster-based support hubs, with dedicated local support teams within industrial clusters to assist developers navigating permitting, safety compliance, and stakeholder

Best practice examples for coal phase out

The UK has targeted its hydrogen and CCUS strategies at hard-to-abate industrial sectors - such as chemicals, steel, cement, and refining - where electrification is less viable. This focus ensures public funding supports the most impactful use cases for low-carbon fuels. Key Initiatives:

- **Net Zero Innovation Portfolio (NZIP): The** UK Government's NZIP allocated over £1 billion to support the commercialisation of low-carbon technologies. A significant share was directed to industrial hydrogen production and CCUS applications in heavy industry, ensuring technology readiness where emissions are most difficult to eliminate.
- **Cluster Sequencing Process:** The UK introduced a "cluster" model to develop shared infrastructure for hydrogen and CCUS in key industrial regions, selecting projects based on emissions impact, cost efficiency, and 2030 decarbonisation potential.

This targeted approach has maximised emissions reductions per pound spent, strengthened regional industrial hubs, and encouraged private investment by reducing risk and creating demand certainty.

8. Acknowledgements

About the SEMI Energy Collaborative

The SEMI Energy Collaborative (EC) is a sustainability initiative of SEMI, a trade association representing the global semiconductor value chain and the global electronics manufacturing sector. In collaboration with the Semiconductor Climate Consortium (SCC), the Energy Collaborative aims to accelerate the adoption of low-carbon energy solutions across the semiconductor industry. This position paper was developed in partnership with Carbon Trust, to propose actionable next steps to advance renewable energy procurement policies and market mechanisms in Japan, supporting the nation's clean energy transition.

Read more about the Energy Collaborative: https://www.semi.org/en/industry-group/sustainability/energy_collaborative

About the Carbon Trust

The Carbon Trust is a global climate consultancy with a mission to accelerate the move to a decarbonised future. The Carbon Trust has been climate pioneers for more than 20 years, partnering with leading businesses, governments and financial institutions to drive positive climate action. To date, its 400 experts globally have helped set 200+ science-based targets and guided 3,000+ organisations and cities across five continents on their route to Net Zero.

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