OECD Environmental Performance Reviews: Japan 2025

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Foreword

The principal aim of the OECD Environmental Performance Review (EPR) programme is to help member and selected partner countries improve their individual and collective performance in environmental management by:

- helping countries assess progress in achieving their environmental goals
- promoting continuous policy dialogue and peer learning
- stimulating greater accountability from governments towards each other and public opinion.

This is the fourth EPR of Japan. It examines the country's environmental performance since the previous review in 2010. Progress in achieving domestic objectives and international commitments provides the basis for assessing Japan's environmental performance. Such objectives and commitments may be broad aims, qualitative goals or quantitative targets. A distinction is made between intentions, actions and results. Assessment of environmental performance is also placed within the context of Japan's historical environmental record, present state of the environment, physical endowment in natural resources, economic conditions and demographic trends.

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The OECD Working Party on Environmental Performance discussed the Environmental Performance Review of Japan at its meeting on 12 December 2024. It reviewed and expressed support for the Assessment and Recommendations.

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Reader's guide

Signs

The following signs are used in figures and tables:

.. : not available

– : nil or negligible

. : decimal point

Country aggregates

OECD Europe: This zone includes all European member countries of the OECD, i.e. Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

OECD Asia-Oceania: This zone includes Australia, Japan, Korea and New Zealand.

OECD: This zone includes all member countries of the OECD, i.e. the countries of OECD Europe plus Australia, Canada, Chile, Colombia, Costa Rica, Israel*, Japan, Korea, Mexico, New Zealand and the United States.

Country aggregates may include Secretariat estimates.

Currency

Monetary unit: Japanese Yen (JPY).

In 2024, USD 1 = JPY 150.58
In 2023, USD 1 = JPY 140.51
In 2022, USD 1 = JPY 131.46

Cut-off date

This report is based on information and data available up to December 2024.

Disclaimer

* The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Basic statistics of Japan

2023 or latest available year (OECD values in parentheses)[a]

PEOPLE AND SOCIETY					
Population (million)	124		Population density per km^2	329	(37)
Share of population by type of region:			Population compound annual growth rate, latest 5 years	-0.4	(0.6)
Predominantly urban (%)	58	(49)	Income inequality (Gini coefficient)	0.34	(0.32)
Intermediate (%)	31	(28)	Poverty rate (% of pop. with less than 50% median income)	15	(12)
Rural (%)	11	(23)	Life expectancy	84	(81)
ECONOMY AND EXTERNAL ACCOUNTS					
Total GDP (National currency, trillion)	591.9		Imports of goods and services (% of GDP)	25	(31)
Total GDP (USD, billion, current prices and PPP)			Main exports (% of total merchandise exports)		
GDP compound annual real growth rate, latest 5 years	0.1	(1.6)	Machinery and electronics	32	
GDP per capita (1 000 USD current PPP)	50	(59)	Transportation	24	
Value added shares (%)			Miscellaneous	14	
Agriculture	1	(3)	Main imports (% of total merchandise imports)		
Industry including construction	27	(27)	Fuels	26	
Services	72	(70)	Machinery and electronics	25	
Exports of goods and services (% of GDP)	22	(31)	Chemicals and related products	10	
GENERAL GOVERNMENT					
Percentage of GDP					
Expenditure	44	(43)	Education expenditure	4	(5)
Revenue	34	(34)	Health expenditure	9	(7)
Gross financial debt	243	(109)	Environment protection expenditure	1.1	(0.7)
Fiscal balance	-3	-(3)	Environmental taxes: (% of GDP)	1.2	(1.3)
			(% of total tax revenue)	3.6	(4.0)
LABOUR MARKET, SKILLS AND INNOVATION					
Unemployment rate (% of civilian labour force)	2.6	(4.8)	Patent applications in environment-related technologies (% of all technologies, average of latest 3 years) [b]	12	(11)
Tertiary educational attainment of 25-64 year-olds (%)	56	(40)	Environmental management	3	(3)
Gross expenditure on R&D, % of GDP	3.3	(2.7)	Climate change mitigation technologies	10	(11)
			Climate change adaptation technologies	1	(1)
ENVIRONMENT					
Energy intensity: TES per capita (toe/cap.)	3.0	(3.7)	Passenger cars stock (vehicles/100 inhabitants)	50	(49)
TES per GDP (toe/1 000 USD, 2015 PPP)	0.07	(0.08)	Water stress (abstraction as % of available resources)	19	(9)
Renewables (% of TES)	8	(13)	Water abstraction per capita (m^3/cap./year)	620	(690)
Carbon intensity (energy-related CO_2):			Municipal waste per capita, (kg/capita)	326	(531)
Emissions per capita (t/cap.)	7.4	(7.5)	Material productivity (USD, 2015 PPP/DMC, kg)	3.9	(2.5)
Emissions per GDP (t/1 000 USD, 2015 PPP)	0.17	(0.17)	Land area (1 000 km^2)	364	
GHG intensity: [c]			% of arable land and permanent crops	12	(11)
Emissions per capita (t/cap.)	9.1	(10.7)	% of permanent meadows and pastures	1	(23)
Emissions per GDP (t/1 000 USD, 2015 PPP)	0.22	(0.24)	% of forest area	68	(33)
Mean population exposure to air pollution ($PM_{2.5}$), µg/m^3	13	(12)	% of other land (built-up and other land)	19	(33)

Notes: a) Values earlier than 2018 are not taken into consideration. OECD value: where the OECD aggregate is not provided in the source database, a simple OECD average of the latest available data is calculated where data exist for a significant number of countries. b) Higher-value inventions that have sought protection in at least two jurisdictions. c) Excluding emissions/removals from land use, land-use change and forestry.

Source: Calculations based on data extracted from databases of the OECD, IEA/OECD, EUROSTAT and the World Bank.

Executive summary

Japan has taken steps towards a net-zero, climate-resilient, circular and nature-positive economy

Environmental pressures have lessened but remain significant. Over the last decade, Japan has successfully decoupled major environmental pressures from its moderate economic growth, while its population continued to age and decline. However, challenges remain to further reduce greenhouse gas (GHG) emissions, improve resource circularity and reverse biodiversity loss in line with both national and international commitments, while ensuring resilience to a changing climate.

Japan has built a robust capacity to manage the increasing impacts of climate-related extreme weather events. It has a well-developed national framework for climate change adaptation, prevention of heat-related illness and disaster risk management. The government provides guidance and information to assist local governments, businesses and individuals plan for and invest in adaptation, including through nature-based solutions.

Japan raised its climate commitments but must accelerate GHG emission reductions. The 2030 target (-46% from the 2013 peak level) and 2050 net-zero goal are more ambitious than previous objectives. While GHG emissions fell by 19% from 2013 to 2022, a faster decline is needed to meet the targets. The country's high reliance on fossil fuel and low energy self-sufficiency pose challenges. Implementing binding carbon budgets and establishing an independent advisory body could help align policies with long-term goals.

Resource circularity can support Japan's decarbonisation efforts. The country has taken steps to promote circularity, successfully reducing municipal waste per capita to less than two-thirds of the OECD average and nearly eliminating landfilling in favour of incineration with energy recovery. However, municipal waste recycling remains low at around 20%, and plastic and electronic waste production are high. Japan could set more ambitious targets and expand policies to reduce plastic waste and boost recycling of municipal and electronic waste.

Japan has intensified efforts to ease pressures on biodiversity, but better policy alignment is needed. Forest, freshwater and urban ecosystem degradation have stabilised, but agricultural and marine ecosystems remain under pressure. Over 20% of land and 13% of marine areas are protected. Japan is working to expand areas under conservation to reach the 30% target by 2030. Achieving this will require effective management and private sector incentives, such as payments for ecosystem services. Certification of community and private conservation efforts, subsidies for eco-friendly farming and stricter fisheries regulations are positive steps. However, most agricultural support remains tied to production and input use, and fuels for fishing boats are subsidised, highlighting the need for reforms to reduce environmental risks.

Japan's energy security and successful green transformation call for a quicker clean energy transition

Japan is a major investor in clean energy transition technology, but further investment is needed as the power mix remains carbon intensive. Despite a photovoltaics boom, renewables accounted for 23% of power generation in 2023, or about two-thirds the OECD average. To harness Japan's large renewables potential, the government should continue addressing barriers to renewables expansion

such as lengthy permitting processes, inadequate grids and local opposition. Meanwhile, coal – the main source of the country's GHG emissions – still made up nearly 30% of power generation. Japan should follow through on its plans to phase out inefficient coal power plants and develop a roadmap to phase out unabated coal power on a timeline consistent with the Paris Agreement. The government intends to expand renewables, nuclear power and reduce emissions from fossil fuel-based electricity using emerging, costly technology like hydrogen and carbon capture. Developing alternative decarbonisation scenarios that account for technological uncertainties and the social acceptability of nuclear power would strengthen Japan's energy transition strategy.

Japan's energy intensity has continued to decline, but more could be done to reduce GHG emissions from buildings and transport. Reforms to energy performance rules for new buildings and renovation aid are positive steps, but efficiency standards for existing buildings should also be strengthened. Greater renewable energy integration into buildings is key for reducing emissions from widespread appliances and air conditioning use. The government should set more ambitious electromobility targets, refine vehicle taxes and subsidies and continue to expand the public charging network. This would enable Japan to accelerate the shift to electric vehicles, whose sales remain sluggish.

There is scope to enhance coherence and cost effectiveness of environmental policies

A more comprehensive and cost-effective policy package and better governance are needed to further advance the green transformation. Japan has developed a broad environmental policy mix, relying on regulations, voluntary agreements with industry, and support for research and development. The government has fostered a supportive environment for green finance. However, energy and vehicle taxes, environmental impact assessments and permitting could be strengthened. In a welcome move, in 2023, Japan launched the Green Transformation (GX) Basic Policy, aiming to achieve decarbonisation, energy security and economic competitiveness through green investment, transition finance and carbon pricing. However, cross-policy alignment, institutional co-ordination and public participation could be further enhanced.

The government's policy to raise carbon pricing is welcome but could be improved. Under its Pro-Growth Carbon Pricing, the government plans to introduce a carbon levy and emission trading in the coming years, while providing subsidies to industry for investment in decarbonisation technology. This will help gradually increase carbon prices from their current low levels. However, the design of these carbon pricing measures could be reinforced and their implementation accelerated to ensure they contribute to achieving the 2030 GHG emission reduction target. Legislating the emission cap, the levy rate and their future tightening trajectories would provide certainty for investors.

Reforming fossil fuel support would encourage energy savings and switching to low-carbon energy sources, while alleviating fiscal pressures. Japan should systematically screen budgetary transfers and tax breaks for fossil fuel production and use, with a view to developing a plan to rationalise the support measures that are inefficient and encourage wasteful consumption. Measures that warrant systematic review include sector-specific fuel tax discounts and public support to unabated fossil fuel projects overseas. Japan should discontinue the energy price stabilisation mechanism introduced in 2022 in response to rising energy prices. Public support should focus solely on the most vulnerable households without distorting energy prices. Improving knowledge of energy poverty would enable better targeting of support policies, which could be partly funded by carbon pricing revenue.

Japan has been promoting a place-based approach to maximise local synergies for the green transformation

There is significant spatial variation in environmental performance, challenges and opportunities across Japan, especially between urban and rural regions. While most urban regions reduced their GHG emissions per capita in the last three decades, emissions have increased significantly in some intermediate and rural regions. Large metropolitan areas are leading Japan's decarbonisation efforts, but more could be done to promote compact urban development, while reducing land artificialisation. Built-up areas have been growing faster than the population in all metropolitan areas, while green area coverage has decreased in most of them.

The government has endeavoured to address multiple environmental challenges in an integrated manner and to bring social and economic benefits through environmental action, especially in regions facing depopulation and economic stagnation. Japan's national plans and strategies have increasingly recognised the role of subnational governments in achieving national environmental objectives. About 60% of Japan's local governments have committed to achieving net zero by 2050. Consistent and effective engagement of local governments in the development and implementation of all national-scale environmental plans and strategies would help ensure these reflect local contexts and needs. Improvements to subnational environmental data availability would enable better understanding of local contexts, as well as place-based policy interventions.

The national government has been actively providing financial and technical support for local action through pilot initiatives. The Decarbonisation Leading Areas (DLAs) and Circulating and Ecological Economy (CEE) initiatives aim to leverage synergies to tackle local economic and social challenges (such as ageing populations and labour shortages) in tandem with environmental challenges. With support from the national government, 82 areas have been designated as DLAs to pilot locally tailored decarbonisation solutions and 146 subnational governments have implemented CEE initiatives to promote circularity and local economic resilience. Renewable energy projects such as solar sharing (or agrivoltaics) provide opportunities to reduce GHG emissions, while improving local energy resilience and creating jobs in rural regions. More needs to be done to improve local support for these projects through better engagement, more inclusive consultation and transparent land-use management.

Successful pilot initiatives must be scaled up to expand reach and impact. In addition to continued financial and technical support to local authorities, the government could implement awareness campaigns, develop training programmes and establish a regional support network. Regional Environment Offices could play a more active role to improve co-ordination between national and local governments. A more comprehensive framework to monitor and evaluate the impact of local environmental actions would help the national government make more informed decisions on how to best direct funding and support. Diversifying funding and financing mechanisms at the local level would help leverage private sector investment.

Assessment and recommendations

The Assessment and Recommendations present the main findings of the OECD Environmental Performance Review of Japan. They identify 34 recommendations to help the country make further progress towards its environmental objectives and international commitments.

1. Towards sustainable development

Addressing key environmental challenges

Decoupling of environmental pressures has continued, but further progress is essential

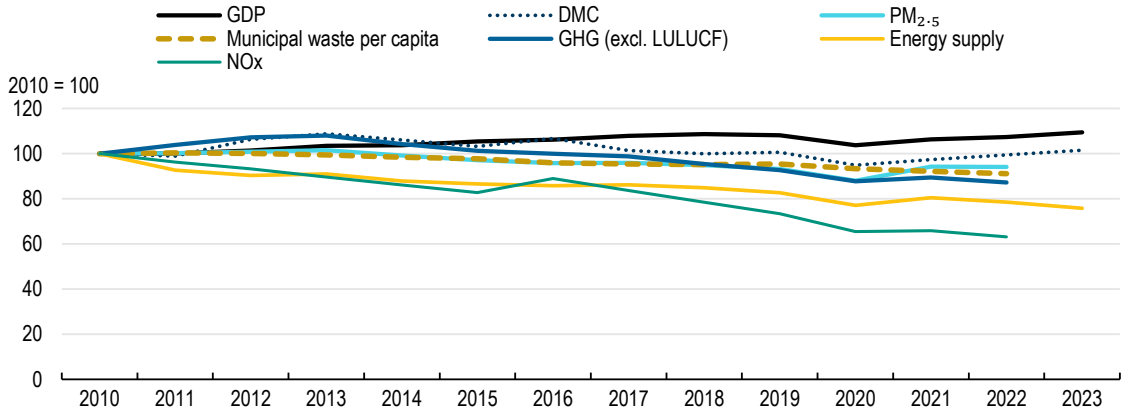
Japan ranks among the largest economies and merchandise exporters globally, while importing much of its natural resources, including fossil fuels. The country is one of the most densely populated in the OECD, combining several bustling metropolitan centres and some rural areas facing depopulation and economic decline. A shrinking and ageing population is a major challenge for Japan's long-term economic sustainability. The economy has grown moderately for several decades and is projected to expand by 1.5% in 2025, primarily driven by domestic demand. Government subsidies, especially for the green and digital agendas, will boost business investment (OECD, 2024[1]).

The 2011 Great East Japan Earthquake and the ensuing accident at the Fukushima Daiichi Nuclear Power Station have had a profound impact on the country's environmental policies and performance in the last decade.[1] The suspended operation of all nuclear reactors for safety checks led to greater reliance on fossil fuels for electricity generation, heightening energy security concerns and driving greenhouse gas (GHG) emissions up to an all-time high in 2013. Since then, dependence on fossil fuels has declined slightly. Emissions started to decouple from economic growth (Figure 1), although the country's energy mix remains carbon intensive.

Japan has also made progress in reducing emissions of some air pollutants and generation of municipal waste (Figure 1). However, most of the country's population remains exposed to harmful levels of particulate pollution, and the circular use of resources could be improved further. Pressures on terrestrial and marine biodiversity persist. Japan is one of the most earthquake-prone countries in the world and highly exposed to natural hazards, including climate-related extreme weather events.

Figure 1. Decoupling of environmental pressures from economic growth has progressed

GDP and selected environment-related indicators, Japan, 2010-23



Note: DMC = domestic material consumption. GDP = gross domestic product in constant 2015 prices. GHGs = greenhouse gases. LULUCF = land use, land-use change and forestry. NOx = nitrogen oxides. $PM_{2.5}$ = fine particulate matter < 2.5 µg (EDGARD database).
Source: EC/JRC/PBL (2024), Emission Database for Global Atmospheric Research (EDGAR); IEA (2024), IEA World Energy Statistics and Balances (database); MOE-GIO (2024), National GHG Inventory Document of Japan 2024; OECD (2024), OECD Economic Outlook (database); OECD (2024), OECD Environment Statistics (database).

StatLink https://stat.link/nyk5vt

Japan has developed a robust capacity to manage the increasing impacts of climate change

The impact of climate change is being felt in Japan, as elsewhere in the world, affecting human health, natural ecosystems and the built environment. More extreme and variable climatic conditions intensify Japan's exposure to weather-related hazards such as tropical cyclones, storm surges and floods. The annual average temperature is 0.98°C higher than in the baseline period 1981-2010 and is set to rise further. Over 60% of the population is exposed to hot summer days with temperatures above 35°C, some of the highest exposure levels in the OECD (OECD, 2024[2]). The health impact has been evident, with growing numbers of heat-related illnesses and fatalities, especially among the elderly. In response, Japan strengthened its prevention framework in 2023 by adopting the Heat Illness Prevention Action Plan. This plan mandates local authorities to issue special heatstroke alerts and enables the opening of designated heat shelters during such alerts. The plan aims to halve the number of annual heat-related fatalities – which exceeded 1 000 per year in the last decade – by 2030.

Japan has strong capacity to cope with extreme weather-related disasters and a well-developed framework for climate change adaptation (IMF, 2022[3]). It has leveraged its longstanding experience in managing earthquake and climate-related disaster risks to assist other countries. Japan employs an advanced, satellite-based early warning system (J-Alert) and prioritises preventive maintenance of infrastructures to enhance their quality and resilience. Japan insures a larger share of damages from weather-related events than many other countries (CRED, 2024[4]). This helps alleviate the financial burden on the public budget for disaster relief and reconstruction. The Climate Change Adaptation Act mandates the adoption of a national adaptation plan, requires developing information systems and promotes subnational adaptation initiatives. A comprehensive assessment of climate change impacts is expected to be conducted about every five years. The 2021 revision of the adaptation plan identifies key performance indicators for adaptation measures and introduces a system for monitoring progress, in line with best international practice (OECD, 2024[5]).

Ongoing efforts to promote local climate adaptation and nature-based solutions are beneficial and should continue

As in all countries, Japan's local authorities play a crucial role in building climate resilience through their responsibility for territorial development. The national adaptation legislation encourages local governments to formulate their plans and set up adaptation centres for collecting and sharing local climate risk data and adaptation information. As of July 2024, all prefectures had formulated their adaptation plans, while 17.6% of municipalities had done so. Many smaller municipalities lack the technical and financial capacity to develop the plans and invest in climate resilience. To address these challenges, the Ministry of the Environment (MOE) provides guidance to municipalities. In addition, the Climate Change Adaptation Information Platform (A-PLAT) serves as a hub to support national and local governments, businesses and individuals. This is a welcome initiative, as sharing information among all policy-making levels is key to scale up preventive adaptation. However, as in many other countries, local authorities may have insufficient incentives to invest in resilience as post-disaster recovery is largely covered by the national government. Delegating specific adaptation responsibilities to local governments, along with enhancing their revenue-raising capacity, could help mobilise local resources (OECD, 2023[6]).

Nature-based solutions (NbS) are gaining traction in Japan. Among key initiatives, Japan is restoring and protecting coastal wetlands and mangrove forests to mitigate storm surges and coastal erosion. It is also expanding urban green spaces to reduce the urban heat island effect and mitigate urban flooding risks. In addition, it is managing forests and researching blue carbon ecosystems to improve absorption of carbon dioxide (CO_2). Ecosystem-based Disaster Risk Reduction (Eco-DRR) has been increasingly incorporated into national policies. The government supports local governments in integrating NbS into their adaptation plans and biodiversity strategies. The "Potential Map of Ecosystem Conservation/Restoration", for

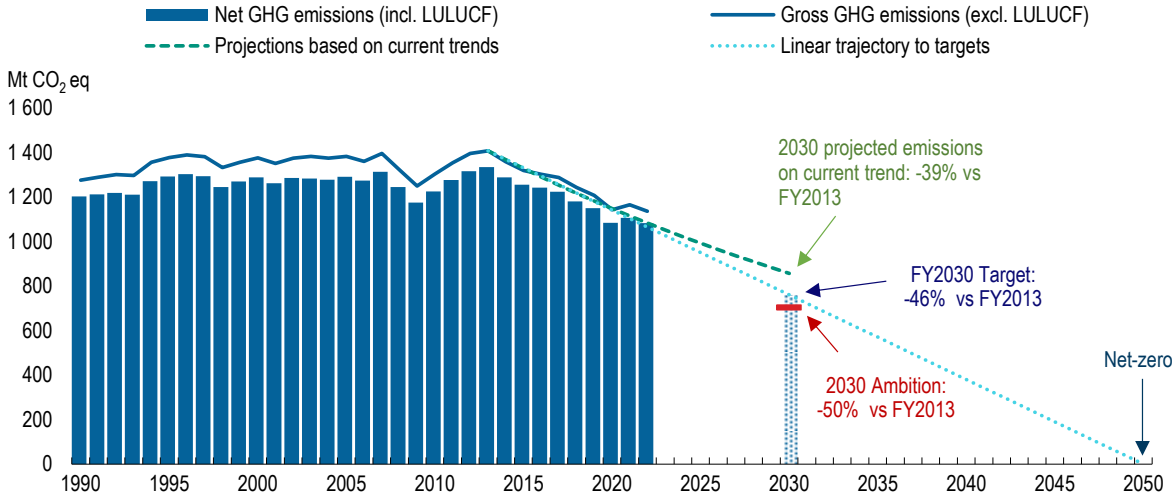
example, helps identify suitable areas for Eco-DRR. Meanwhile, the Green Infrastructure Public-Private Partnership Platform is a vehicle to share information and raise awareness. These efforts are welcome and should be continued to foster wider adoption and integration of NbS.

Japan raised its climate ambition but needs to speed up emission abatement

Japan – the second largest GHG emitter in the OECD – committed to net-zero emissions by 2050 and enshrined this commitment into law. In its Nationally Determined Contribution (NDC), the country pledged to cut GHG emissions by 46% by financial year (FY) 2030 from the FY2013 peak level, with the aspirational goal of halving emissions within the same timeframe (Figure 2).[2] This is a considerable increase in ambition compared to previous targets. Nonetheless, Japan could aim to curb emissions further. The FY2030 target represents a 34% reduction in net GHG emissions from 2019 levels. By comparison, the Intergovernmental Panel on Climate Change (IPCC) has called for a global emission reduction of 43% to align with the Paris Agreement's 1.5°C temperature limit. Japan is expected to lead this global effort, along with other high-income countries (IPCC, 2022[7]). In its path to net zero, Japan can build on its potential for high energy efficiency and renewables, advanced public transit systems, solid industrial base and renowned innovation capacity.

Figure 2. Japan raised its climate targets but needs to accelerate emission reductions to meet them

Historic and projected GHG emissions, and pathway to the FY2030 and 2050 targets



Note: LULUCF: land use, land-use change and forestry. The solid lines and the columns show historical GHG emissions, excluding and including removals from LULUCF, respectively, and including indirect CO_2 emissions. Japan's 2030 NDC is set using a gross-net approach: the FY2030 GHG emissions net of removals from LULUCF need to be 46% below the FY2013 emissions without LULUCF removals. The dotted line shows the linear trajectory between the FY2013 base-year emissions (excluding removals), the FY2030 targeted emissions (with removals) and the 2050 net-zero target. The dashed line shows a linear emission projection to 2030 based on the average annual reduction rate observed between FY2013 (gross emissions) and FY2022 (net emissions).
Source: OECD Secretariat's calculations; Government of Japan (2021), Japan's Nationally Determined Contribution; MOE-GIO (2024), National GHG Inventory Document of Japan; OECD (2024), OECD Environment Statistics (database).

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Japan needs to accelerate its emission abatement efforts to achieve its target by the end of this decade and prepare for a more ambitious goal for 2035. This would help the country contain cumulative emissions and potentially reduce the transition costs in the next decades (UNEP, 2024[8]). The energy industry is the

largest GHG emitter, followed by manufacturing. Since the 2013 peak, emissions have declined by 19%, thanks to energy savings, lower production of energy-intensive industries, the gradual expansion of renewable energy and the restart of some nuclear power plants. Overall, in 2022, net GHG emissions were 11% below their 1990 level. However, if GHG emissions continue to decline at the same average annual rate as in FY2013/22, they would be 39% below the base-year level in FY2030, exceeding the NDC target (Figure 2).

The government foresees to achieve the 2030 target by implementing the existing policy measures and investments outlined in the Plan for Global Warming Countermeasures. The plan focuses on increasing energy efficiency in all sectors through technology improvements, fostering a shift in consumption patterns, and scaling up regional and local decarbonisation initiatives (Chapter 2). In addition, the 2023 Basic Policy for the Realization of the Green Transformation (GX) (hereafter GX Basic Policy) provides financial support for technology development and foresees the introduction of carbon pricing later in the decade (see below). However, there are uncertainties regarding the ability of Japan to meet its NDCs with the current policy suite (UNEP, 2024[8]).

The Plan for Global Warming Countermeasures is comprehensive and identifies the expected emission reductions from existing policy measures. However, it lacks a projected emission trajectory to the 2030 target, making it more challenging to track progress and adjust policies. The plan neither identifies the additional policy efforts that may be needed to reach the aspirational goal of halving emissions by 2030, nor outlines projections or policies for the next decades. A climate mitigation planning framework based on binding periodic carbon budgets (setting limits on national and/or sectoral emissions) and an independent advisory body would help Japan ensure that its current and planned measures are aligned with the long-term target. Several OECD countries have adopted such an approach, including France, Germany and the United Kingdom.

Accelerating the clean energy transition will be key to decarbonise the economy and enhance energy security

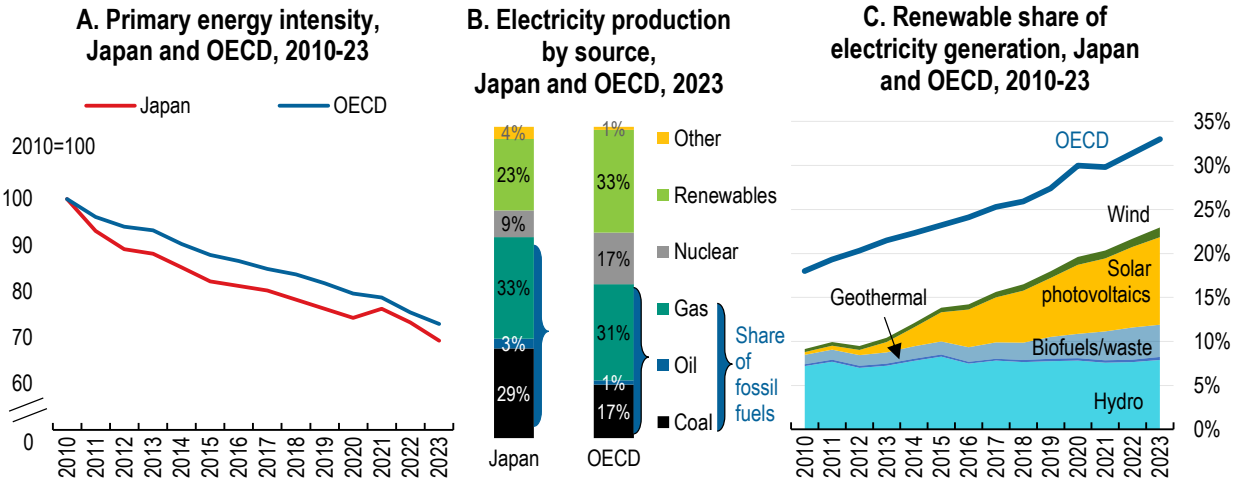
Progress has been made in reducing energy use and shifting to low-carbon energy sources in the last decade. Energy intensity has declined by 31% since 2010, in line with OECD trends, and remains below the OECD average (Figure 3, panel A). Longstanding policy measures such as the Top Runner Programme for vehicles and appliances, country-wide energy-saving initiatives, voluntary agreements with industry and considerable financial support have contributed to this progress. After a decade of stagnation, the share of renewables in power generation more than doubled between 2010 and 2023, driven by a boom in solar photovoltaics (PV) (Figure 3, panel C). However, the role of renewables remains below the OECD average. Meanwhile, fossil fuels – including coal – still accounted for nearly two-thirds of Japan's power generation in 2023, compared to about half on average in the OECD (Figure 3, panel B).

The government acknowledges that Japan's high reliance on fossil fuels, low self-sufficiency and geography make the clean energy transition a must on both decarbonisation and energy security grounds. The Sixth Strategic Energy Plan (SEP, approved in 2021) aims to reduce energy demand and more than double the share of power from nuclear and renewable sources from the 2019 level. However, fossil fuels are projected to account for 41% of electricity generation in FY2030, a larger share than that of most OECD countries in 2023. The government's strategy envisions carbon capture utilisation and storage (CCUS), as well as hydrogen and ammonia, to reduce emissions from existing and new fossil fuel-based power generation by 2030 and beyond.

Japan's strategy to decarbonise the energy sector faces several uncertainties. Concerns include the speed of reactivation of mothballed nuclear power facilities, technology development, grid constraints and social acceptance of energy infrastructure. The restart of nuclear power plants depends on stringent safety assurances and thorough consultations with local communities. Compared to mature renewables technology, low-emission hydrogen (and its derived products) and CCUS technologies remain at early

stages of deployment and are more expensive (IEA, 2023[9]; BNEF, 2023[10]). To accelerate deployment, Japan enacted legislation to regulate and promote the commercial use of these technologies and provides funds for infrastructure and supply chains development. Increasing the use of low-emission hydrogen and CCUS will depend on global market development and ongoing research and innovation efforts (OECD, 2024[11]). If these technologies cannot be deployed at a large scale and nuclear plants do not restart as planned, the anticipated high reliance on coal and gas will weaken Japan's ability to reach net zero. In light of these uncertainties and implementation challenges, the SEP recognises the need to develop potential pathways for decarbonising the energy sector to 2050. This is essential for several reasons. First, it would help ensure the targeted 2030 energy mix lays a cost-effective foundation for a decarbonised energy system by mid-century. Second, it would help ensure that policy actions are sufficient to achieve the targeted mix.

Figure 3. Energy intensity has continued to decline, but the power mix remains carbon intensive



Note: Panel A: Primary energy intensity = total energy supply/GDP at 2015 purchasing power parities. Panel B: Percentages may not add to 100% due to rounding. Renewables include hydro, wind, solar, geothermal, biofuels and renewable waste. Other includes non-renewable municipal and industrial waste and other sources not elsewhere included.
Source: IEA (2024), IEA World Energy Balances (database).

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A clear pathway towards phasing out unabated coal power is imperative to get on track to net zero

Coal is expected to maintain a key role in Japan's energy mix, due to the government's energy security concerns. While declining, coal's share in the power mix would remain at 19% in 2030, higher than the 2023 OECD average (Figure 3, panel B). Coal accounted for 39% of the country's GHG emissions from energy production and use in 2023 (IEA, 2024[12]). The SEP outlines a progressive phase-out of inefficient coal power plants, which represent about half of coal installed capacity. It plans to gradually co-fire ammonia with coal in the remaining and new coal power fleets. Co-firing ammonia is effective in reducing CO_2 emissions from coal burning. However, today nearly all hydrogen and ammonia worldwide are produced from unabated fossil fuels. If the hydrogen and ammonia used, whether sourced domestically or imported, are not decarbonised, retrofitting fossil fuel power plants or building new hydrogen- or ammonia-ready coal and gas facilities could lead to carbon lock-in, while displacing GHG emissions to countries producing hydrogen and ammonia using carbon-intensive processes.

In 2023, Japan announced it would end new construction of unabated coal-fired power plants. It would be prudent to implement this commitment by introducing a regulatory requirement for future plants to be built "capture-ready", in line with an International Energy Agency recommendation to the country (IEA, 2021[13]). In 2024, alongside the other G7 countries, Japan pledged to phase out unabated coal power generation during the first half of the 2030s, or in a timeline consistent with the Paris Agreement goal and in line with countries' net-zero pathways. Taking energy security concerns into account, formalising this pledge by formulating a coal phase-out timeline, as done by most OECD countries with coal power capacity, would provide a clear direction for the sector and smooth the transition.

Air emissions declined, but concentrations of fine particulate matter and photochemical oxidants are a concern for human health

As in most advanced economies, emissions of major air pollutants in Japan have declined over the last decade. The emission intensities of sulphur and nitrogen oxides (SO_x and NO_x) decreased further and are among the lowest in the OECD (OECD, 2024[14]). Technological improvements in electricity generation, industrial processes and vehicles have reduced emissions of air pollutants, while also helping to curb GHG emissions. This exemplifies the significant synergies between addressing climate change and improving air quality and public health. Dioxin emissions, which mostly originate from waste incineration, declined due to the related facility upgrade (MOE, 2024[15]).

Emissions and concentrations of fine particulate matter ($PM_{2.5}$) decreased over the last decade (MOE, 2024[16]). Japan complies with its $PM_{2.5}$ environmental quality standard (EQS) of 15μg/m^3. However, as in nearly all OECD countries, 99% of the population is exposed to levels of $PM_{2.5}$ above the World Health Organization (WHO) guideline (5μg/m^3) (OECD, 2024[14]). The OECD estimated that PM-related mortality and welfare impacts are higher in Japan than on average in the OECD (OECD, 2024[14]). Japan should consider updating its EQS by considering the latest scientific knowledge and the WHO guideline, while continuing to strengthen policies to curb $PM_{2.5}$.

While the concentrations of major air pollutants in ambient air have remained within the EQSs, high concentrations of ground-level ozone and other compounds responsible for photochemical smog remain a concern. Measures such as emission standards for stationary sources and more stringent regulation for mobile sources in specific regions have helped reduce emissions of NO_x and non-methane volatile organic compounds, which are precursors of ground-level ozone and other photochemical oxidants (Ox). This has lowered Ox concentration but not enough to meet the related EQS in most locations (MOE, 2024[16]). Updating comprehensive emission inventories and improving atmospheric model simulation would provide better evidence for informed policy decisions to address both $PM_{2.5}$ and Ox.

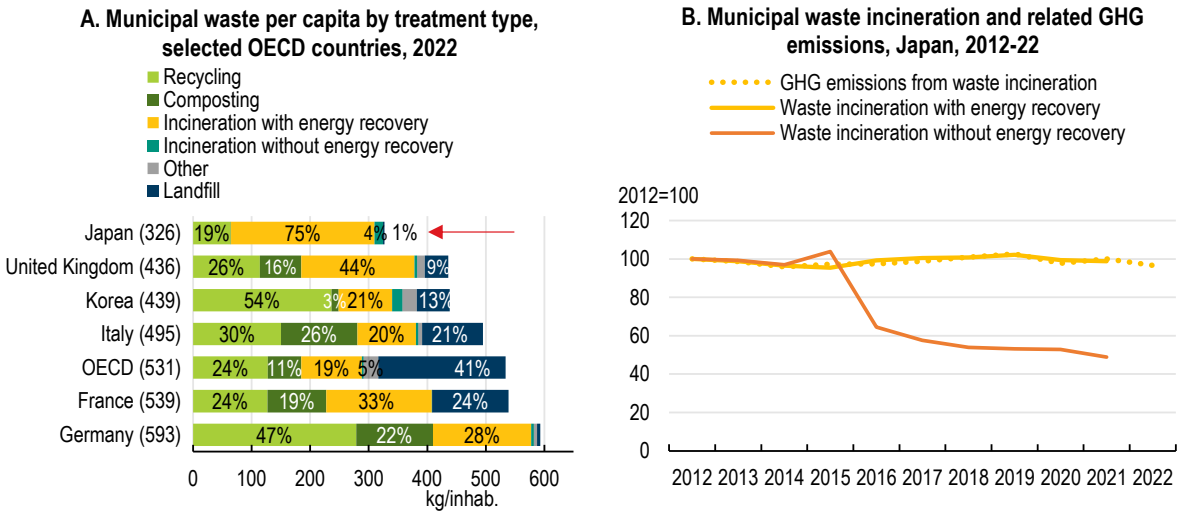
Promotion of circularity has significant synergies with a net-zero transition

Promoting resource circularity can help reduce GHG emissions, especially in the industry, freight transport and waste sectors. Japan incinerates almost 80% of its municipal waste, mostly with energy recovery, the highest rate in the OECD (Figure 4, panel A). Incineration plants can provide electricity to local communities, but their power generation efficiency is relatively low. GHG emissions from incineration have hovered around the same level in the last decade, remaining strongly coupled to the amount of incinerated waste (Figure 4, panel B). The country's heavy reliance on waste incineration can be an obstacle to improving recycling.

Japan's policy mix has been effective in controlling generation of household waste. Municipal waste generation per capita is less than two-thirds of the OECD average (Figure 4, panel A) and has continued to decrease in the last decade, albeit moderately. However, the recycling rate of municipal waste should be improved as it is lower than that of Japan's economic peers (Figure 4, panel A). Japan has taken steps to promote circularity, including by setting targets in the Fundamental Plans for Establishing a Sound Material-Cycle Society. The most recent plan, adopted in 2024, sets targets to 2030. It expands the set of

indicators to better monitor synergies between improving circularity and reducing GHG emissions, a positive development. The country is on track to meet the 2030 target for the resource cyclical use rate, while the waste cyclical use rate has been hovering around the target level in the last decade. This suggests a review of these targets could be explored. The government is promoting unit-based fees for municipal waste services. Experience from other countries shows that unit-based charging schemes can help reduce waste generation and encourage recycling (Brown, 2024[17]). Charging households and businesses for waste management has progressed, but cost recovery for municipal waste services is still low (12% nationwide in FY2022).

Figure 4. Most municipal waste is incinerated with energy recovery, contributing to GHG emissions



Note: Panel A: Japan and Italy 2021 data. Total municipal waste generation per capita in brackets. Panel B: Index based on amounts of municipal solid waste incinerated with and without energy recovery, and GHG emissions generated from the incineration of municipal and industrial solid waste.

Source: MOE-GIO (2024), National GHG Inventory Document of Japan 2024; OECD (2024), OECD Environment Statistics (database).

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Further promoting prevention and recycling of plastic waste can contribute to meeting climate mitigation goals, as it helps curb GHG emissions from incineration and from Japan's large plastics industry. The country's plastic waste generation per capita is higher than the OECD average (OECD, 2024[14]). Most plastic waste is used as fuel in incineration plants with energy recovery, and only 25% as mechanical and feedstock recycling (PWMI, 2023[18]). Japan set targets and introduced several measures, including the 2022 Plastic Resource Circulation Act, that are expected to reduce plastic waste generation and increase reuse and recycling. The fee on single-use plastic bags, introduced in 2020, has contributed effectively to reducing use and triggered behavioural changes in consumers. Certain regions implement deposit-refund schemes, which encourage the collection of non-contaminated recyclable plastic waste. However, Japan could broaden the set of policy measures to further curb the use of single-use plastics and enhance recycling.

More efforts are needed to reduce food loss and waste, and promote recycling and composting.[3] Food waste decreased by over 25% in the last decade and is on track to meet the FY2030 domestic target. In FY2022, Japan had already achieved its target of halving business-related food waste by FY2030 from the FY2000 level, suggesting the target could be raised. However, direct waste of non-used foods from homes remained almost constant over 2012-22 (MOE, 2024[19]). Food waste from franchise convenience stores is substantial, partly due to a business model that encourages franchises to over-order (Kimura, 2022[20]),

as well as consumer expectations for food freshness. Food waste and scraps account for a quarter of household waste; they are mostly incinerated, where their high moisture content lowers incineration efficiency. The composting rate of municipality waste is significantly lower than in other OECD countries (Figure 4, panel A).

Enhancing circularity of critical minerals is crucial to secure energy supply in a decarbonised energy system, in Japan as in other countries (IEA, 2023[21]). Japan has potential to leverage un-managed electrical and electronic waste (e-waste). It has among the highest levels of e-waste generation per capita in the OECD but one of the lowest e-waste collected and recycled volumes per capita (OECD, 2024[22]). The government aims to increase the amount of electronic scrap recycled and processed, including rare metals, by 50% between 2020 and 2030. It has supported the development of related recycling facilities and implemented measures to prevent abandonment or illegal dumping of solar power generation equipment. To prepare for an expected peak in PV panel disposal beginning in the late 2030s, more could be done to promote circularity, including by setting targets for PV panel recycling as in the European Union. Japan has commendably worked with international partners to enhance critical mineral security, including by establishing partnerships between Japan and the Association of Southeast Asian Nations.

Japan has stepped up efforts to alleviate strong pressures on biodiversity

Japan has made some progress in slowing biodiversity loss in the last two decades. While forest, freshwater and urban ecosystem degradation have stabilised, the quality and extent of agricultural and coastal and marine ecosystems have continued to decline (Table 1). Conservation projects have helped restore the populations of some threatened species, but many remain threatened (IUCN, 2024[23]). The rapid post-war economic development and the ensuing habitat loss continue to drive ecosystem degradation today. Direct drivers of biodiversity loss in recent years include small-scale conversion of natural land to built-up areas, farmland abandonment, invasive alien species and climate change (Working Group for Comprehensive Assessment of Biodiversity and Ecosystem Services, 2021[24]).

Table 1. Biodiversity loss continues in Japan

Indicators of the current degree of biodiversity loss and trend

	Extent and quality of the ecosystem		Population and distribution of species		Connectivity	
	Degree of loss	Trend	Degree of loss	Trend	Degree of loss	Trend
Forest ecosystems	(strong) ●	(constant) →	●	(worsening) ↘	●	→
Agricultural ecosystems	●	↘	●	↘	●	↘
Urban ecosystems	(moderate) ●	→	●	→		
Freshwater ecosystems	(very strong) ●	→	●	↘	(a) ●	→
Marine and coastal ecosystems	●	↘	(b) ●	↘		

Note: (a) Connectivity of rivers and lakes. (b) Species in shallow marine and coastal waters.
Source: Adapted from (Working Group for Comprehensive Assessment of Biodiversity and Ecosystem Services, 2021[24]).

Japan met the 2020 Aichi targets for protected areas but needs to expand conservation areas to reach the 2030 target under the Kunming-Montreal Global Biodiversity Framework (GBF). In 2024, 20.6% of land and 13.3% of sea areas were designated as protected areas. Protected areas have been moderately effective in preventing pressures on biodiversity, depending on strictness and location of the area (Shiono, Kubota and Kusumoto, 2021[25]). To achieve the 30by30 target of conserving at least 30% of both terrestrial

and marine areas by 2030, the government plans to expand officially protected areas and adopt Other Effective area-based Conservation Measures (OECMs). These OECMs will focus on areas of high biodiversity value such as *satochi-satoyama* rural landscapes, forests, and urban and coastal areas. The MOE established a scheme to certify areas hosting community or private biodiversity conservation initiatives. These Nationally Certified Sustainably Managed Natural Sites may qualify for registration as OECMs if outside officially protected areas. As of December 2024, Japan had registered 159 sites in the international OECM database (UNEP-WCMC and IUCN, 2024[26]).

Japan has increasingly engaged the business community in biodiversity conservation and in mainstreaming biodiversity into economic activities. It developed the National Biodiversity Strategy and Action Plan (NBSAP) 2023-2030 in response to the GBF goals and targets. The NBSAP emphasises NbS, the 30by30 target and nature-positive economies that harness synergies between biodiversity conservation and economic opportunities, including at local level. The local biodiversity strategies and action plans (LBSAPs) should consider these elements. All prefectures and about 10% of municipalities have formulated their LBSAPs. The 2024 inter-ministerial Transition Strategies toward Nature-Positive Economy encourage companies to reduce environmental impacts and contribute to nature conservation throughout their value chain. As of December 2024, Japan had the world's highest number of institutions adopting recommendations of the Taskforce on Nature-related Financial Disclosures (TNFD). Keidanren (Japan Business Federation) also promotes biodiversity considerations within industry through its Nature Conservation Council.

Expanding the areas under conservation effectively will require sound governance and management to address complex land ownership patterns, overlapping laws and limited administrative resources. It will also call for appropriate incentives for engaging the private sector (Tanaka and Takashina, 2023[27]). With this aim, since September 2024, Japan has been piloting a scheme that issues certificates to individuals or entities supporting OECMs. These certificates can be leveraged for TNFD purposes and enhancing investor relations. Likewise, programmes of payments for ecosystem services (PES) can provide financial resources to support OECM implementation (Sharma et al., 2023[28]). A few PES programmes are implemented at subnational level.

Agricultural and fishing policies should be better aligned to support biodiversity objectives effectively

Agricultural ecosystems are vital to Japan's biodiversity, and the government has focused on supporting sustainable farming. Over the last two decades, it has actively promoted revitalisation of the traditional and culturally significant *satochi-satoyama* rural landscape, which is threatened by farmers' ageing, farmland abandonment and conversion to other uses. More recently, the MIDORI Strategy for Sustainable Food Systems sets targets on agriculture's environmental performance (e.g. GHG emissions, organic farming, fertilisers). It also introduces farm certification and product labelling to encourage eco-friendly farming practices and consumption choices. However, market-price support and payments based on agricultural output and inputs, including fuels, still accounted for about 80% of farmer support in 2021-23 (OECD, 2024[29]). These subsidies potentially distort markets and contribute to high domestic food prices. OECD work has shown that these measures are also potentially harmful to the environment, though the actual environmental impacts of these policies depend on several local context-specific factors. Reforming these subsidies can encourage innovation and improve the environmental sustainability of agriculture, as well as its resilience to climate change (OECD, 2024[29]).

With limited land available for farming, Japan's agriculture is intensive, with high use of chemical fertilisers and pesticides, and negligible organic farming (OECD, 2023[30]). Rice paddies occupy more than half of all agricultural land. The country's high nitrogen surplus has contributed to water and soil pollution, as well as eutrophication of lakes and enclosed coastal waters, although eutrophication has been declining over the past two decades (Working Group for Comprehensive Assessment of Biodiversity and Ecosystem

Services, 2021[24]). While 88% of water bodies meet organic pollution standards, progress has stalled in the last decade. Compliance of lake water with nitrogen standards has improved, but the rate of achievement of chemical oxygen demand standards has decreased. Regulatory measures and public investment in wastewater treatment aim to reduce water pollution. The government subsidises advanced decentralised wastewater treatment systems (*johkasou*) in rural areas.

The government has strengthened regulations for sustainable fisheries management, but further action is needed. Fishing is important in Japan, with seafood central to its diet. Japan is one of only three countries engaging in commercial whaling. Despite declining fishing capacity and catch volume, half of the assessed commercial fish stocks remain in unfavourable biological conditions. Japan provides large support to fisheries, primarily for general services (OECD, 2022[31]). In a welcome move, Japan accepted the World Trade Organization's Agreement on Fisheries Subsidies in 2023. However, it continues to exempt fuel for fishing boats from excise duties and subsidises it when fuel prices rise above a certain threshold, as has occurred since 2022. In general, support for fuel presents a high risk of encouraging unsustainable fishing in the absence of effective fisheries management. It also tends to disproportionally benefit large companies over small-scale coastal fishers (OECD, 2022[31]).

Improving environmental governance

Japan has a comprehensive strategic framework for the green transformation but needs to enhance policy coherence and institutional co-ordination

Japan has consistently advocated, both domestically and internationally, for a "synergistic approach" to address the triple planetary crisis of climate change, biodiversity loss and pollution effectively (Chapter 2). In addition, the MOE has long promoted the vision that environmental initiatives can revitalise regions facing depopulation and economic stagnation. In line with this vision, the Sixth Basic Environment Plan (BEP), approved in 2024, focuses on improving citizens' well-being and maximising synergies, including through regional development. Numerous other plans address each environmental policy area, as well as sectors related to the environment, such as energy, transport and agriculture. The GX Basic Policy aims to foster decarbonisation, energy security and economic competitiveness through a mix of green investment, transition finance, international collaboration and carbon pricing. While commendable, the GX could be more effective with a synergistic vision of the country's transformation towards net zero, and circular and nature-positive economic and social systems.

Much has been done to improve institutional co-ordination and coherence between environmental, economic and social policies. Several inter-ministerial bodies co-ordinate policies such as climate mitigation and GX. However, a "silos" administrative practice (*tatewari gyōsei*) tends to persist, where different government ministries and agencies operate with a high degree of independence and limited co-ordination (Aoki, 2023[32]). Many countries face similar institutional challenges, which can hinder comprehensive policy making and lead to inefficiency in tackling multifaceted environmental and socio-economic problems. Some countries have established government secretariats directly attached to the Prime Minister to co-ordinate development of national strategies for climate, energy, biodiversity and the circular economy.

Adopting a green budgeting approach could also help Japan strengthen policy synergies and enhance the transparency of budget allocations. While Japan tags the environment-related budget allocations, it has not fully integrated climate and environmental considerations into its budget and fiscal frameworks (OECD, 2024[33]). The government does not systematically evaluate the environmental impacts of budgetary and fiscal policies, including taxes and subsidies, or assess their alignment with environmental goals.

Citizens' environmental awareness is high, but stakeholder engagement should be improved

Citizens in Japan demonstrate a strong interest in environmental issues such as climate change and plastic waste, according to public opinion surveys. More than 90% of respondents expressed willingness to take action in these fields (Cabinet Office, 2023[34]; 2019[35]), thanks in part to environmental education and awareness-raising initiatives. However, recognition of biodiversity issues remains lower, although showing some signs of improvement.

Public participation in policy formulation is secured by established mechanisms, such as the public comment process in developing the BEP. However, there is room to improve such mechanisms for communication, consultation and stakeholder engagement in decision making. Overall, stakeholder engagement in Japan is relatively low; many people perceive their opinions during public consultations are often overlooked (OECD, 2023[36]). Japan has been working to improve the balance in gender and age representation to address the disparity in opportunities for women and youth to participate in and influence government decisions (OECD, 2024[37]). Efforts to improve these engagements are essential for fostering a more inclusive and participatory approach to environmental policy making in Japan. This is particularly important for decisions about reactivating nuclear power plants and the siting of renewable energy infrastructure, which have been facing opposition from local communities, as well as of emerging technology installation, such as CCUS and hydrogen transport infrastructure.

Enhancing the cost effectiveness of the environmental policy mix

A comprehensive policy package is needed to advance towards the green transformation in an integrated and cost-effective manner. The policy mix should include public investments, better regulations, innovation, support and incentives for businesses and households, and consistent price signals. To enable a smooth transition and seize its economic opportunities, Japan will need structural reforms that facilitate reallocation of capital and labour resources and help it adjust more quickly to economic shifts (Kurachi et al., 2022[38]; OECD, 2024[11])

The effectiveness of environmental impact assessments and permitting could be enhanced

Environmental impact assessment (EIA) is routinely implemented in Japan for a wide variety of projects, including infrastructure, power plants, and industrial, commercial and residential developments. Wind power plants accounted for more than 80% of the EIAs in process as of March 2024, reflecting developers' interest in renewables but also the complexity and length of the procedure. However, the EIA scope could be broadened to cover some activities with potentially high environmental impacts that are excluded, such as mining or aquaculture (OECD, 2024[39]). Japan also needs a more adaptive EIA framework that can address the challenges posed by emerging technologies, especially those needed for the clean energy transition. Local citizens and governments can provide their views at several stages of the EIA process. However, more inclusive and effective public engagement methods can be pursued (Kitamura, 2023[40]). Japan would benefit from introducing environmental assessments at the level of plans, programmes or policies (strategic environmental assessment, or SEA) as recommended by the OECD (OECD, 2024[39]), while ensuring effective public participation during the SEA process.

Japan's environmental permitting system for economic activities is medium-specific, with separate permits for air emissions, water discharges and waste disposal. EU countries and some others issue integrated environmental permits that cover all releases and processes, in line with the OECD Recommendations on Integrated Pollution Prevention and Control (IPPC). In Japan, licensing conditions for pollution sources on air emissions, as well as water discharges and waste disposal, are set based on EQSs and technological feasibility. These conditions consider best available techniques (BATs) for certain substances like mercury.

BATs are defined as the most environmentally effective and economically viable proven techniques within each sector. To promote BATs further, Japan could implement a stepwise approach that identifies BATs by sector and establishes national BAT-based standards systematically, in line with the OECD IPPC Recommendation. Using these standards to set permitting conditions would increase the effectiveness of the permitting system to continuously minimise pollution, with increasingly stringent conditions as technology develops.

A strong culture of compliance limits the need of enforcement actions

A strong culture of adherence to rules leads to a low rate of non-compliance, ranging from almost full respect of air emission standards to 6% non-compliance with water effluent standards. The country leverages a toolbox for compliance promotion, including training or guidance provided during inspections. In addition, numerous governmental and business organisations help disseminate information. In case of non-compliance, and before issuing a sanction, inspectors provide administrative guidance with recommendations to improve pollution control measures and support the facility to return to compliance. This is an effective compliance promotion practice. Some 10-20% of inspections lead to issuing administrative guidance, while administrative orders (i.e. sanctions) are rarely seen. The intervention of the authority is already regarded as a sanction due to a potentially high reputational damage.

Regulations, voluntary agreements and financial incentives shape the environmental policy landscape

Regulations, voluntary agreements, research and development (R&D) support and generous subsidies play a key role in Japan's environmental policy. The 2023 GX Basic Policy considerably boosts support for business investment in the clean energy transition to 2030 and beyond. The longstanding Voluntary Action Plan (VAP) of Keidanren (Japan Business Federation) has encouraged industrial companies to improve their environmental performance, particularly energy efficiency, GHG emission abatement and waste management. Reporting requirements, benchmarking and targets encourage energy savings in manufacturing industry – the country's largest energy user – and services. Many listed companies publish reports on corporate social responsibility, environment and sustainability. Japan hosts the world's largest number of companies and institutions supporting the recommendations on climate-related and nature-related financial disclosure.

It is not clear whether progress through the VAP and reporting requirements goes beyond business-as-usual. Environment-related investments, such as those to save energy or recycle materials, are in the companies' own interest and give them a competitive edge. The VAP has mainly promoted incremental improvements, as companies are incentivised to avoid exceeding their voluntary commitments to prevent more ambitious future targets (OECD, 2010[41]; IEA, 2021[13]). The government regularly reviews progress and is consulted when industries set their targets. However, companies have an information advantage that can prevent setting sufficiently ambitious targets that go beyond implementation of BATs.

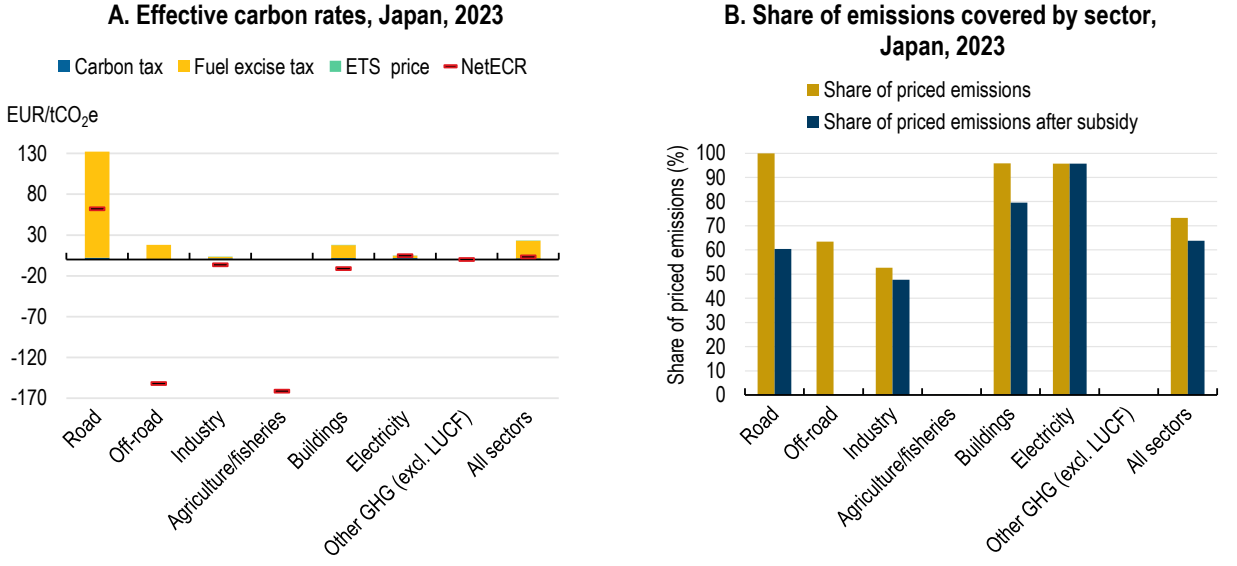
There is considerable opportunity to provide more consistent price signals

Expanding the use of environmental taxation and reforming environmentally harmful subsidies would provide more consistent price signals, while contributing to generate revenues. Japan's public debt amounts to about 240% of GDP, the highest in the OECD. Fiscal consolidation is crucial for the country to rebuild buffers amid rising pensions and health care costs, as well as high investment needs for the green and digital transformation (OECD, 2024[11]). Tax rates on energy and vehicles are broadly applied but at relatively low rates. As elsewhere, taxes on pollution and resource use are negligible. As a result, environmental taxes account for a lower share of GDP (1.2%) and total tax revenue (3.6%) than in most other OECD countries (OECD, 2024[42]).

Carbon pricing has been limited so far

Pricing instruments have generally played a lower role in Japan's environmental and climate policy mix compared to many other OECD countries (D'Arcangelo, Kruse and Pisu, 2023[43]). GHG emissions are mainly priced through taxes on energy products, as well as a carbon tax and two subnational emission trading systems or ETSs (Tokyo Metropolitan City and Saitama Prefecture). The headline carbon tax rate and the emission coverage of the ETSs are the lowest among the OECD countries that implement these instruments. The carbon tax and subnational ETSs have had limited impact on reducing GHG emissions in Japan (Wakabayashi and Kimura, 2018[44]; Gokhale, 2021[45]). Fossil fuel use in several sectors is partially or totally exempt from the carbon tax and other energy taxes (see below), which further reduces effective carbon prices. Overall, in 2023, fuel and carbon taxes and the ETSs together covered nearly three-quarters of Japan's GHG emissions, with wide disparities across sectors (Figure 5, panel B) and fuels. The average effective carbon rate (excluding pre-tax subsidies) was EUR 23 per tonne of CO_2, among the lowest rates in the OECD. It is also well below EUR 120, the price needed by 2030 to be consistent with net-zero goals (OECD, 2024[46]). In 2022, a fuel price support was introduced in response to soaring energy prices. Factoring in this support, the average effective carbon price drops to EUR 3/tCO_2, with only 64% of emissions priced across the economy (Figure 5).

Figure 5. Effective carbon rates are low



Note: The sum of carbon taxes, ETS permit prices and fuel excise taxes is the aggregate Effective Carbon Rate (ECR) paid on emissions. The Net ECR is the difference between the ECR and subsidies that decrease pre-tax prices of domestic fossil fuels. Negative Net ECRs indicate that subsidies exceed the sum of fuel taxes, carbon taxes and ETS permit prices.
Source: OECD (2024), Companion dataset to the OECD Series on Carbon Pricing and Energy Taxation.

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The Pro-Growth Carbon Pricing is a positive step but has room for improvement

Against this backdrop, the Pro-Growth Carbon Pricing, part of the GX Basic Policy, represents a welcome breakthrough in Japan's environmental policy. This provides immediate subsidies to industry for investment in decarbonisation technology followed by introducing a country-wide ETS for large emitters and a carbon levy on fossil fuels (GX-surcharge) later in the decade. The future carbon pricing level and coverage are expected to be defined in the first half of 2025. The GX-surcharge is scheduled for FY2028.

The ETS has been voluntary since FY2023, covering more than half of Japan's GHG emissions. It will transition to a mandatory system in FY2026 with participants receiving free CO_2 emission allowance allocations. Auctioning of allowances to power companies is expected to be phased in from FY2033. The government aims to raise finance through its GX Economy Transition Bonds to provide up-front support of JPY 20 trillion (3.4% of 2023 GDP) over ten years and leverage private investment of more than JPY 150 trillion (USD 962 billion). Revenues from future carbon pricing will be used to repay the bonds.

Accelerating implementation of carbon pricing could enhance the effectiveness and economic efficiency of Japan's climate policy mix (D'Arcangelo et al., 2022[47]). The GX Economy Transition Bonds are set to provide a substantial low-carbon investment push. However, the long phase-in of the mandatory ETS and carbon levy may limit their contribution to achieving the 2030 emission reduction target (OECD, 2024[11]). Gradually replacing the allocation of free allowances with auctioning can help mitigate potential market distortions. Evidence suggests that free allowance allocations can reduce the effectiveness of an ETS (Dechezleprêtre, Nachtigall and Venmans, 2023[48]). They also represent a subsidy to ETS participants that receive them (IEA, 2020[49]), which include fossil fuel-based power facilities. In addition, the free allowance allocation, along with the late introduction of the carbon levy, will hinder revenue generation (OECD, 2024[11]). For the ETS and carbon levy to work effectively, it is essential to enshrine in legislation an automatic tightening of the emissions cap and increases in the levy rate to create certainty for investors. Carbon pricing can adversely affect vulnerable households in Japan, which calls for recycling part of the revenue to finance social benefits.

The GX Basic Policy has facilitated greater acceptance of carbon pricing from the regulated business community. Meanwhile, subsidies for decarbonisation technologies that are not yet cost competitive (such as low-emission hydrogen and CCUS) aim to lower their costs and pave the way for large-scale deployment. However, like green industrial policies worldwide based on government financial support, the GX entails risks such as market distortion, picking winners, political capture and windfall gains for companies that would invest even without financial assistance (Millot and Rawdanowicz, 2024[50]; OECD, 2024[51]).

Support to fossil fuel production and use remain substantial

The government has provided sizeable support to shield households and businesses from the sharp increase in global energy prices that began in 2021. However, part of this support is untargeted and in conflict with climate goals. In January 2022, the government introduced a subsidy to wholesalers for preventing excessive price increases of petroleum products, including road transport fuels. This scheme has been repeatedly extended and was still in place in December 2024, with plans to gradually reduce the subsidy rate. In addition, discounts on electricity and city gas rates, first put in place in 2023, were reinstated from January to March 2025. These types of untargeted energy price discounts weaken the incentive for consumers to save energy, are regressive and a fiscal burden. In 2022, the energy price subsidy cost over JPY 3.5 trillion or 84% of the energy tax revenue that year. The fuel price stabilisation mechanism should be phased out as a matter of priority, as it dramatically reduces the already low effective carbon rates (Figure 5, panel A). Any further public support, if needed, should solely target the most vulnerable households, and avoid interfering with energy prices (Hemmerlé et al., 2023[52]). Improving knowledge of energy poverty would enable more effective targeting of support policies. Official data on the population at risk of energy poverty are lacking in Japan. However, some analysis indicates it is a significant issue for the elderly, single-parent households and students, as well as in car-dependent rural areas (Okushima and Simcock, 2024[53]).

Several other exemptions and discounts apply to energy taxes, often provided as tax refunds. These include exemptions for fuels used in agriculture, fishery, shipping and certain energy-intensive industrial sectors (IEA, 2021[13]). Comprehensive data on the fiscal revenue losses due to these fuel tax concessions are not available. These concessions weaken the incentives for energy savings or fuel switching. As such, they will likely undermine the ability of the GX subsidies and carbon pricing to deliver effective price signals.

Japan has long provided direct public support for oil, gas and coal exploration and development projects overseas to increase energy security. Along with other G7 countries and recognising the importance of national security and geostrategic interests, Japan committed to ending new direct public support for the international unabated fossil fuel energy sector by the end of 2022, except in limited circumstances consistent with the goals of the Paris Agreement, as defined by countries. According to Japan's definition of "limited circumstances", an unabated fossil fuel project can be financed if it aligns with the host country's decarbonisation pathway or Japan's national security, energy security or geopolitical interests (METI, 2023[54]). It would be prudent to periodically review the implementation of these conditions to ensure that financed projects fully align with global climate goals. Given the lifetime of energy infrastructure, today's financing and investment decisions in developing countries have the potential of either accelerating their shift to clean energy sources or locking in emissions for decades (IEA, 2021[55]).

Investing in green growth

Japan is among the major investors in the clean energy transition

Japan has increasingly invested in the green transformation in the last decade, with most investment targeting the clean energy transition. The government has created a supportive environment for green finance by establishing platforms and formulating guidelines.[4] The market for green financial products has grown considerably to more than JPY 5 trillion (about USD 38 billion) in 2023. Public investment for environmental protection grew by 20%, driven by local governments' investment in waste incineration and recycling facilities.[5] The country's (public and private) average annual investment in the clean energy transition grew by 40% between 2016-20 and 2021-23. Energy efficiency in end-use has traditionally been the primary focus of clean energy investment in Japan. Since 2021, it has attracted over 60% of clean energy investment, a higher share than in many other regions of the world (IEA, 2024[56]). In 2023, the country invested about USD 15 in clean energy for each dollar invested in fossil fuels, over eight times the global average. Japan's orderly transition from fossil fuels will require significant investments in low-carbon energy. IEA (2024[56]) estimates that Japan's clean energy investment should increase by 17% between 2024 and 2035 for the country to align with its own climate goals.

Clean energy investment could boost technological innovation and business investment, with a positive effect on Japan's productivity and economic growth (Kurachi et al., 2022[38]). The country is known for its large R&D spending and high number of patents. Large manufacturing businesses account for most R&D spending. Clean energy R&D including energy efficiency, renewables and hydrogen averaged nearly half of public energy R&D outlays in 2019-23. As a result, Japan has acquired a relative specialisation in technologies that contribute to climate change mitigation, such as batteries, electric vehicles (EVs) and hydrogen. In 2021, the share of green patents in Japan's total patents was higher than the OECD average.

Addressing barriers to renewables deployment is a priority

More investment in renewable electricity and storage capacity will be needed to compensate for the expected decline in fossil fuel capacity, produce low-emission hydrogen and further the electrification of the economy. Large investment led renewable electricity capacity to more than double between 2010 and 2023. An exponential growth in solar PV, driven by generous feed-in tariffs, was the primary factor behind this development. Japan now ranks among the global leaders in installed PV capacity. The Sixth SEP aims to maximise the use of renewable electricity and to reach 36-38% of renewables in power generation by 2030, from 23% in 2023, mostly through solar and wind. The IEA estimates that achieving this 2030 target will require increasing renewable power capacity by 17-25% from the 2022 level. IEA (2024[57]) estimates that Japan will exceed its 2030 capacity target under current policy and market conditions. Some modelling studies suggest that renewables could account for 70-80% of Japan's total power generation by 2035 – more than double the 2030 government target – at competitive market prices (REI, 2023[58]; Shiraishi et al., 2023[59]), and could help reduce GHG abatement costs in the power sector (Kuwabara et al., 2021[60]).

To fully tap its vast renewable electricity potential, Japan must overcome key challenges that keep installation costs high (IRENA, 2023[61]). These include limited land availability, deep offshore waters, grid constraints, complex permitting procedures and social resistance. The fragmentation of the electricity network into regional grids limits the dispatch of renewable power, whose best potential lies in areas far from demand centres. Japan has planned considerable investment in grid and storage infrastructure, but much higher grid investment will be needed to stay on the path to net zero (BNEF, 2023[10]). The government has taken steps to address administrative hurdles, including simplifying and accelerating the EIA procedure for wind power plants. Japan has also allowed local governments to designate renewable promotion areas with faster EIA and permitting processes. In addition, these areas aim to better address community concerns about safety, disaster prevention and landscape impact by involving residents in decisions. Dual-use land systems, such as combining PV with farming (solar sharing or agrivoltaics), can also help foster public acceptance by preserving traditional land use and offering economic benefits to local communities.

Energy efficiency is a cornerstone of Japan's decarbonisation strategy

Japan rightly prioritises further improving energy efficiency – especially in buildings – to meet its climate and energy security goals. While space heating energy use is relatively low, space cooling intensity is among the highest in the OECD (IEA, 2024[62]). This reflects the nearly ubiquitous presence of air conditioning systems, albeit highly efficient ones. Improving energy performance in homes can also reduce energy bills, enhance health and quality of life, and protect against increasingly frequent extreme heat. The government provides financial support for energy efficiency and renewable energy integration into buildings. Targeting aid for renovations to vulnerable and credit-constrained households could prevent the benefits from accruing only to wealthier homeowners (Castaño-Rosa and Okushima, 2021[63]; Hemmerlé et al., 2023[52]).

The recent reform of energy performance regulations for buildings is welcome, as most buildings do not meet current standards (MOE, 2024[15]). Efficiency standards will become mandatory for all new buildings as from 2025, four years after the European Union implemented its nearly zero-energy building mandate for new buildings. The reform also aims for zero-energy buildings and houses for new constructions by 2030 and on average for the building stock by 2050, in line with best international practice.[6] Nonetheless, Japan should strengthen efficiency requirements for existing buildings to encourage retrofitting of the worst-performing ones. Greater renewable energy integration into buildings will be key for reducing the carbon intensity of energy use in homes and commercial buildings and fully reap the benefits of electrification. Despite lower energy intensity of space heating and cooling, their carbon intensity has increased with the rising carbon intensity of Japan's power generation. The MOE's initiative to source all its energy needs from renewables by 2030 is an exemplary action.

The flagship Top Runner Programme, which sets energy performance targets, has helped improve the energy performance of appliances, office equipment and vehicles for over two decades. However, its targets may lack ambition. Targets apply to the average energy performance of a manufacturer's products, not to individual products as with minimum energy performance standards. Rising number and usage of electric appliances have partly offset the technical energy efficiency gains (Inoue and Matsumoto, 2019[64]). Appliance use is the largest energy consumer in Japanese homes. Greater focus on encouraging behavioural changes is needed. Campaigns like the "Cool Choice" and "Decokatsu" are positive steps that could be expanded.

Japan boasts excellent transport infrastructure and a fuel-efficient car fleet but needs to speed up the transition to electromobility

Japan's GHG emissions from transport have steadily declined over the past two decades, partly due to enhanced fuel efficiency of passenger cars. Emissions decreased by 10% between 2010 and 2019, prior

to the abrupt drop in 2020 during the COVID-19 pandemic. However, the Top Runner fuel economy targets for trucks and cars set for 2025 and 2030, respectively, are less stringent than those in the European Union (IEA, 2021[13]). Japan's excellent rail system and coastal shipping play a significant role in passenger and freight transport, respectively. Yet, road transport is the dominant mode, accounting for some 90% of GHG emissions from transportation. Transport modes differ significantly between metropolitan and rural areas, with train usage much higher in cities than in rural regions where private cars dominate.

Japan is home to one of the world's largest automotive industries and has been a frontrunner in the development of hybrid, electric and fuel cell vehicles. While hybrid cars already account for most new domestic car sales, EVs still account for only 3.6% of new car sales and less than 1% of the car stock, far below other G7 countries (IEA, 2024[65]). The government targets 100% sales of "next-generation vehicles" (including hybrid, plug-in hybrid, electric and fuel cell) by 2035. Modelling suggests that, if power generation quickly shifts to low-carbon sources, a 90% share of battery electric in new vehicle sales by 2030 would help meet the NDC in a more cost-effective manner (Kuwabara et al., 2021[60]). In addition to fostering electromobility, decarbonising the transport sector calls for reducing private car use and boosting alternative modes of transport through demand-side initiatives, spatial planning and support for shared mobility, especially in rural areas.

Better vehicle taxes and subsidies are needed to accelerate the transition to electromobility, reduce GHG emissions from transport and contain fiscal costs. The government has long provided support to lower-emission vehicles through tax incentives and purchase subsidies. EVs and hydrogen fuel cell vehicles benefit from purchase subsidies and are fully exempt from vehicle taxes.[7] Hybrid and internal combustion engine vehicles (ICEVs) with fuel efficiency above certain thresholds, as well as cars running on natural gas, also benefit from vehicle tax exemptions. Such subsidies could delay the transition to truly zero-emission vehicles.

Subsidies may be necessary to bridge the cost gap between EVs and traditional cars, but Japan should carefully manage their cost effectiveness and fiscal implications. The budget allocations to cover the fiscal costs of the EV purchase subsidies tripled in FY2021/23. In addition, EV purchase subsidies are generally regressive. As the country's EV market matures, subsidies should prioritise low-income buyers and be accompanied and progressively replaced by higher taxation of ICEVs. With the gradual shift to electromobility, Japan will need to further boost its comprehensive road use toll system to internalise costs of car use and substitute transport fuel tax revenues (OECD, 2024[46]).

Expanding Japan's EV charging network in co-ordination with renewables and power grid development is essential to support the transition to electromobility. The public charging network has grown slowly, hindering EV deployment. The government aims to install 300 000 charging plugs by 2030, a ten-fold increase from 2023. In 2024, it revised the EV subsidy criteria to adjust subsidies by manufacturers based on factors like EV infrastructure provision, maintenance services and used battery collection systems. This is a positive initiative, as it can trigger private investment in charging networks and services that enable a wider EV adoption.

Recommendations on sustainable development

Towards a net-zero, climate-resilient, circular and nature-positive economy

- Accelerate GHG emission abatement actions and prepare for setting a more ambitious target to 2035, and possibly to 2030. Implement a climate mitigation planning framework based on binding time-bound carbon budgets that impose limits on national and/or sectoral emissions. Establish an independent advisory body to provide transparent, expert guidance to the government and monitor progress.
- Follow through with the announced phase-out of inefficient coal plants. Develop a timeline to phase out unabated coal power generation during the first half of the 2030s, or in a timeline consistent with reaching the Paris Agreement goal and in line with Japan's net-zero pathway, while taking energy security concerns into account.
- Develop alternative energy mix scenarios to 2050 that are compatible with achieving net zero, include intermediate milestones and that reflect technology, market and social uncertainties. Assess whether the planned expansion of renewable power generation capacity is sufficient to meet the expected growing domestic demand of low-emission hydrogen.
- Continue to provide support to local governments in formulating their adaptation plans and biodiversity strategies, and in integrating nature-based solutions into local strategies for biodiversity, climate mitigation and adaptation.
- Consider setting stricter environmental quality standards for $PM_{2.5}$ in light of WHO guidelines; continue to strengthen policies to curb concentrations of $PM_{2.5}$ and photochemical oxidants in ambient air, while addressing the heat island effect.
- Implement effective measures to reduce plastic waste at every stage of its lifecycle (e.g. restrictions on single-use plastic products, introducing modulated extended producer responsibility fees and scaling up regional deposit-refund schemes). Introduce regulations and targets for solar PV panel recycling. Reduce food waste from convenience stores by addressing their business practices; promote composting of organic waste. Promote recycling of critical minerals to secure energy supply in a decarbonised energy system. Expand use of waste charges to encourage waste prevention and sorting, and enhance cost recovery.
- Further enhance management effectiveness of protected areas. Promote private sector sustainable management initiatives that contribute to biodiversity conservation in *satoyama* landscapes. Expand the use of payments for ecosystem services, including in combination with area-based conservation measures.
- Reform support to agricultural producers that is tied to production and input use, including fuels; replace those subsidies with payments targeted to producers in need and to encourage green farming practices and technology. Continue to encourage farmers to reduce the use of chemical fertilisers and pesticides.
- Carefully review fishery support linked to input use, primarily fuel use; repurpose the saved financial resources for targeted direct income support to fishers in need and for improving the social, economic and environmental sustainability of fishing.

Improving environmental governance

- Strengthen institutional arrangements to pursue policy coherence towards sustainable development. Adopt green budgeting to evaluate environmental impacts of budgetary and fiscal policies and assess their coherence towards environmental goals.

- Improve mechanisms for stakeholder engagement in environment-related decision making and ensure a more gender- and age-balanced membership of working groups and committees.

Enhancing the cost effectiveness of the policy mix

- Expand the EIA scope to cover potentially environmentally damaging projects beyond the infrastructure and area development projects; ensure the EIA Act is systematically updated to more readily address the specific environmental impacts of emerging technologies; ensure more meaningful public engagement in the EIA process.
- Establish a system for the environmental assessment of plans, programmes or policies with a potentially significant environmental impact, which would provide for consideration of alternatives and broad public participation.
- Consider transitioning to an integrated environmental permitting that covers all releases to air, water and land, and all processes of a facility, while accounting for best available techniques, local environmental conditions and health-based standards.
- Systematically assess the cost effectiveness of Keidanren Voluntary Action Plan and of the energy efficiency target and benchmarking for large companies. Enhance transparency of target setting and progress tracking, and increase deterrence for non-compliance.
- Ensure additionality of the financial support provided under the GX Basic Policy; implement a competitive and transparent selection process for businesses receiving support; establish regular review and feedback mechanisms, including independent scrutiny of supported investments.
- Consider accelerating implementation of the GX-surcharge and the mandatory emissions trading system (ETS). Assess the first ETS phase annually to adjust the system at an early stage, if needed, and clarify the design of the next phases. Enshrine in legislation the ETS cap, the GX-surcharge rate and their future tightening trajectories. Bring forward the auctioning of CO_2 allowances and consider partly earmarking revenues to support vulnerable households.
- Remove the fuel price stabilisation mechanism. If needed, provide targeted support to vulnerable households as means-tested lump-sum transfers untied from energy use. Expand the information base about energy poverty to improve targeting of support mechanisms.
- Screen budgetary transfers and tax concessions for fossil fuel production and use to identify those that are inefficient and encourage wasteful consumption; develop a plan to rationalise these support measures, in line with the Sustainable Development Goals (Target 12c) and in accordance with national circumstances.
- Periodically evaluate the consistency of eligibility conditions for public financing of overseas unabated fossil fuel projects with the goals of the Paris Agreement, in line with the 2022 G7 Leaders' Communiqué, and adjust these conditions as necessary.

Investing in green growth

- Further streamline the environmental assessment and permitting procedures for renewable energy infrastructure without undermining their ability to identify and mitigate potential environmental impacts. Engage local communities in identifying renewable promotion areas and specific siting decisions. Ensure adequate co-ordination and benefit sharing between renewable energy developers and local actors.
- Continue to invest in transmission and distribution infrastructure, based on cost-benefit analysis, and enhance the electricity grid to support higher renewable electricity supply. Enable more grid investment from the private sector.

- Tighten the efficiency requirements for existing buildings, including by mandating performance standards and certifications for major renovations and for existing buildings and homes when sold or rented. Introduce requirements for integrating renewables into new and retrofitted buildings. Provide targeted financial support to low-income households to help improve energy efficiency in their homes and address energy poverty risks.
- Assess the Top Runner Programme targets in terms of their level of ambition, ability to induce breakthrough innovations and cost effectiveness. Complement the programme with minimum energy performance standards by product. Continue to develop demand-side initiatives to encourage consumers to adopt energy-saving behaviours and practices.
- Establish more ambitious electromobility targets and consider setting a phase-out target for all fossil-fuelled vehicles. Tighten vehicles' fuel efficiency targets. Limit the eligibility to total exemptions from vehicle taxes to battery electric, plug-in and fuel cell vehicles. Gradually refocus EV purchase subsidies to support low-income households. Continue to invest in expanding public infrastructure for electric vehicles, in co-ordination with power grid developments.

2. Leveraging synergies and place-based approaches for a green transformation

The need for a place-based approach to environmental action

Japan is taking an integrated approach to environmental action to create synergies and co-benefits

In line with the commitments of the G7 Hiroshima Communiqué, Japan aims to pursue synergies between the environmental goals of climate mitigation, biodiversity conservation and circular economy enhancement. This means considering the interconnections among these environmental challenges to maximise complementarities and minimise trade-offs between policies, thereby enhancing the overall impact of policy interventions. Japan is implementing solutions that aim to resolve environmental challenges and address pressing social and economic issues, such as rapidly declining and ageing populations within weak local economies. This integrated approach is essential for achieving the Sustainable Development Goals.

Marked differences in environmental performance and challenges across the country call for more tailored policy approaches

Japan is perceived as a homogeneous country in terms of a range of social and economic criteria, but it exhibits significant differences in environmental performance (e.g. greenhouse gas emissions, green spaces, waste recycling) across its territories. Such differences can be partly explained by broad challenges and opportunities that distinguish urban areas from rural areas. Even among urban areas, environmental challenges such as the risk of flooding may vary according to population density, infrastructure levels or geography. For example, in Osaka (Kansai) metropolitan area, the second largest urban agglomeration in Japan, 28.6% of the population is at risk of river flooding compared to the OECD average of 12.9%. This underscores the importance of tailoring environmental policies and strategies to the unique characteristics of urban and rural areas.

Understanding and addressing these disparities requires a more robust, consistent and comprehensive framework for measuring and monitoring subnational environmental performance. First, Japan should produce and collect additional data and statistics at functional geographical spaces (e.g. metropolitan areas, water basins), allowing for better comparisons across places. Second, it could produce and collect

more granular data and statistics in targeted environmental policy areas (e.g. GHG emissions by sector, energy consumption, biodiversity). This would allow Japan to track progress better, identify regional vulnerabilities and tailor environmental actions to the unique needs of each area, including for vulnerable populations. Japan has made good progress in the areas of water-related risk assessment. As of 2024, 98% of municipalities had prepared and disclosed flood hazard maps, which can be an effective tool to prepare for floods and minimise damage (Huang, 2024[66]). Such locally grounded geospatial data can also be developed for the other environmental policy areas. Given that many smaller municipalities may lack the capacity to develop robust monitoring and assessment systems, the national government can play a key role in supporting them through pilot projects. It can also provide methodologies and tools to measure impacts of subnational environmental policies for others to replicate them.

Integrating local environmental action into national plans and strategies

Local governments are increasingly recognised in national plans and strategies, but implementation challenges remain

The major national environmental plans and strategies illustrate how the national government increasingly recognises the role of subnational governments in achieving national environmental goals and targets. For instance, the Plan for Global Warming Countermeasures requires local governments (alone or jointly) to adopt action plans to reduce greenhouse gas (GHG) emissions arising from their own activities and projects. More than half of subnational governments have committed to achieving net-zero carbon emissions by 2050, either voluntarily or with national support. This demonstrates the success of national plans and strategies in engaging subnational governments (MOE, 2024[67]). The National Biodiversity Strategy and Action Plan (NBSAP) engages local governments effectively in planning and includes local action in implementation. The NBSAP promotes the development of local biodiversity strategies and action plans (LBSAPs) that reflect regional characteristics and are consistent with broader targets. The government further supports local government action by providing guidelines such as the “Potential Map of Ecosystem Conservation/Restoration” for implementing nature-based solutions for disaster risk management at the local level.

On the other hand, other national strategies such as the newly developed GX Basic Policy are focused on supply-side solutions. As such, they lack sufficient emphasis on local economic and social impacts and demand-side measures, inadvertently overlooking the potential to foster synergies. While the outcomes of these strategies need to be carefully monitored, the lack of subnational engagement may limit the effectiveness of these national measures. This is due both to policy misalignment or simply missed opportunities to mobilise the capacity of subnational governments. The GX 2040 vision, under development, provides an opportunity for Japan to integrate place-based approaches that tailor the GX strategies to regional characteristics.

Japan’s national environmental initiatives could place greater emphasis on generating synergies across multiple policy goals

In addition, Japan’s national initiatives could place greater emphasis on generating co-benefits within the environmental domain, as well as across the social and economic domains. Some national plans and strategies discuss synergies within and across domains, to a certain extent. For instance, the Climate Change Adaptation Plan mentions the importance of integrating biodiversity conservation into adaptation strategies to enhance ecosystems' resilience. To foster such synergetic actions, these connections could be more systematically highlighted in national strategies and the role of local governments could be enhanced.

Japan’s Regional Environment Offices (REOs) could play a more central role in engaging subnational governments and aligning environmental policies across different levels of government. They are MOE’s

decentralised branches that co-ordinate and implement national environmental policies at the local level to ensure alignment between national goals and regional needs. By doing so, REOs can help tailor technical and financial support to meet the needs of cities and regions, particularly small local governments with limited capacity. Strengthening the role of these offices would ensure that national environmental plans and strategies are implemented more effectively, with local governments having the resources and guidance needed.

Enabling and scaling up local environmental action

Pilot initiatives to strengthen synergies at the local level are promising and should be scaled up

Japan has made progress in providing local governments with the necessary resources and frameworks to implement integrated approaches that leverage synergies. The country's strategies focus on regional revitalisation, tackling local economic challenges (such as ageing populations and labour shortages) in tandem with environmental challenges, through sustainable energy and other environmental initiatives. As a flagship initiative, Decarbonization Leading Areas (DLAs) aim to advance locally tailored decarbonisation solutions across 82 diverse regions. There are plans to extend DLAs to 100 regions, tailoring solutions to their specific environmental challenges. Similar to the EU's 100 Climate-Neutral and Smart Cities programme, DLAs aim to demonstrate how Japan can achieve net-zero emissions by 2050 through local pilot projects. Some DLAs like Yokohama and Kitakyushu have already been demonstrating the effectiveness of these place-based actions through marked emission reductions. The Circular and Ecological Economy (CEE) framework, another flagship initiative, integrates social, environmental and economic considerations across urban, peri-urban and rural areas to address sustainability challenges. According to a survey, 146 subnational governments have implemented their own initiatives in line with the CEE. The uniqueness of these pilot initiatives lies within their wide sectoral coverage and tailored support. This allows cities and regions to address various economic and social challenges, such as depopulation, ageing, labour force shortages, and abandoned farmland, together with environmental challenges.

Japan should extend the reach of the DLA and CEE initiative through awareness raising, training and a regional support network. This would ensure municipalities with low financial and technical capacity and a high sustainability and decarbonisation potential to be targeted for implementing the initiatives. First, informational campaigns could be carried out to ensure that all municipalities know they can take part in these initiatives. Second, the national government could carry out training in collaboration with representatives from successful DLAs and CEE initiatives to inform municipalities about potential projects and getting involved. Third, a regional support network could be developed to allow for knowledge sharing between DLAs or CEE initiatives, national government officials and other municipalities. This could be used to share effective strategies, challenges and resources. To this end, it is essential for the national government to ensure sufficient human and financial resources, so the benefits can reach the areas most in need. Regular monitoring and evaluation of the DLAs and CEE initiatives is also crucial to maximise effectiveness.

Japan needs to diversify sources of funding and financing for environmental action at the subnational level

Many local governments face significant financial and budgetary constraints to scale up environmental action. While the national government has provided substantial financial support, the distribution of resources has been uneven, positioning regions with limited fiscal capacity at a disadvantage. This challenge is in part because of their limited financial tools, specifically their reliance on subsidies. To address this, Japan would benefit from diversifying its funding and financing tools, which cities and regions

can use according to their local contexts. Japan could also promote tools such as biodiversity offsetting, land value capture, payments for ecosystem services and environmental bonds. This would enable cities and regions to leverage private investment in their environmental initiatives. Such an approach will first require enhancing fiscal capacities of cities and regions by generating a broader range of local own revenue streams (e.g. taxes, fees, charges). Moreover, these instruments must mitigate potential negative impacts on vulnerable and marginalised communities (OECD, 2023[68]).

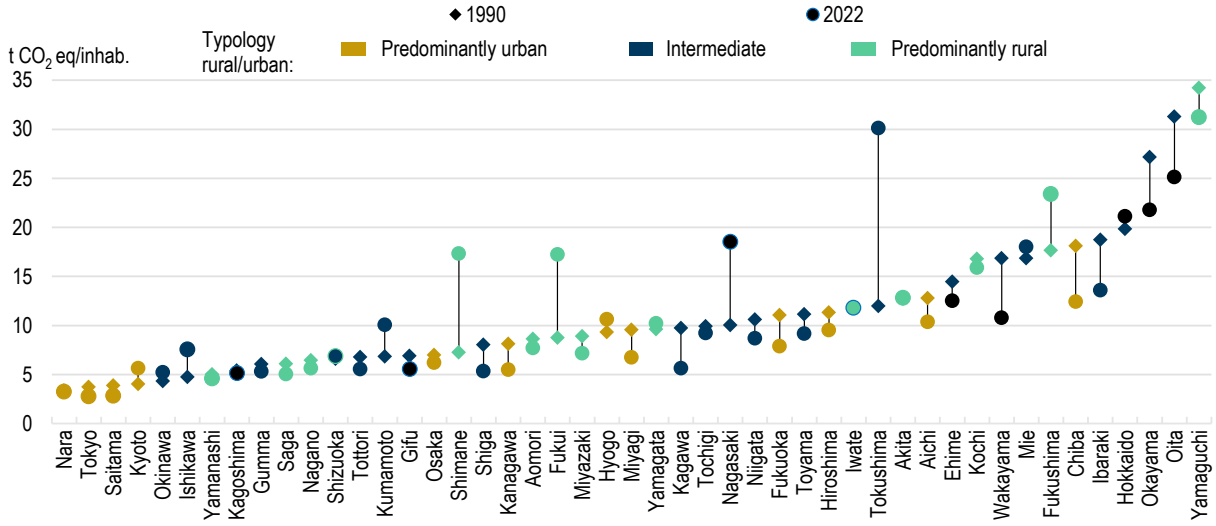
Leveraging synergies through urban and rural development

Large metropolises are leading Japan's decarbonisation efforts, but more could be done in the areas of building decarbonisation and compact urban development

In 2022, urban prefectures in Japan exhibited, on average, relatively low levels of emissions per capita, in comparison to intermediate and rural prefectures (Figure 6). They have led Japan's GHG emission reduction between 1990 and 2022, as their total emissions dropped by 16% during the period, compared with intermediary (7.2%) and rural (1.3%) prefectures (Figure 6). GHG emissions from buildings remains a challenge. Urban regions account for most total emissions from buildings in Japan, although emissions from buildings are higher in rural regions on a per capita basis (OECD, 2023[69]).

Figure 6. Urban prefectures in Japan have made steady progress in reducing GHG emissions

GHG emissions per capita in 1990 and 2022 by type of TL3 regions (prefectures) in Japan



Note: The analysis in this figure is based on the OECD regional typology as outlined in OECD (2024), *OECD Regions and Cities at a Glance 2024*.
Source: OECD (2024), OECD Database on Regions, cities and local areas; Crippa et al. (2023), EDGAR v8.0 Greenhouse Gas Emissions, European Commission, Joint Research Centre (dataset).

StatLink https://stat.link/ehlwa8

Innovative solutions are needed to increase the supply of renewable energy in urban areas. Storage batteries and new technology such as Perovskite solar cells could be introduced. Electricity could also be transmitted from rural and other areas where renewable energy generation exceeds their regional energy demand. In addition, Japan could redouble its efforts to minimise land artificialisation and promote mixed-

use, high-density and nature-positive urban development. Such instruments can generate synergies between climate action, biodiversity and material circularity objectives.

While larger, resource-rich cities excel in aligning their development policies with climate objectives, smaller and less well-resourced cities need help implementing similar measures. These disparities result in unequal progress towards urban sustainability across Japan. Developing tailored policy measures suitable for small and medium-sized cities in Japan is needed to ensure they can keep pace with larger metropolitan areas. A dedicated decarbonisation strategy for small and medium-sized cities, for example, could identify and tackle their sustainability challenges with tailored solutions.

Rural areas have opportunities to address their economic, social and environmental challenges together, including through renewable energy projects

Japan's rural areas face challenges related both to the environment, and demographic shifts such as an exodus to urban centres and an ageing population. Expanding renewables could help address these challenges and improve overall welfare by creating job opportunities in rural areas, where renewable energy potential is high (IRENA, 2022[70]). There are promising examples of rural areas leveraging local resources for sustainable energy production. Maniwa city, for example, is generating biogas from organic waste, human waste, septic tank sludge and livestock manure, while Sosa city is pursuing agrivoltaic projects. These projects illustrate the potential for rural decarbonisation when tailored to local contexts. However, scaling up these initiatives remains a challenge. The broader integration of climate and biodiversity goals, along with circular economy principles, is still underdeveloped in many rural areas. In particular, local citizens have resisted rural renewable solar energy farms. This has resulted in reactionary restrictive ordinances limiting the expansion of rural renewable energy projects in certain municipalities.

The national government can look to and share international best practices of solar energy generation and agrivoltaics to gain valuable insights and foster greater acceptance of renewable energy projects. For instance, countries such as France, Germany and Korea have successfully integrated solar sharing into their agricultural and renewable energy sectors. In addition, the national government can minimise trade-offs in rural land use by promoting urban-rural collaboration within Functional Urban Areas.[8]

Recommendations to leverage synergies and place-based approaches

- Promote a place-based approach in all environmental plans and strategies, prioritising actions that minimise trade-offs and enhance synergies for climate, biodiversity and material circularity at the local level. Improve subnational environmental data availability to better understand local impacts, particularly for vulnerable populations.
- Ensure the vision for the Green Transformation to 2040 (GX2040 Vision) recognises the varying potentials and critical roles of subnational governments in designing and implementing the strategy. This should include fostering tailored actions that reflect local capabilities and developing comprehensive measures addressing both the supply and demand sides.
- Scale up locally tailored environmental actions like the "Decarbonization Leading Areas" and "Circular and Ecological Economy" initiatives, to expand their reach and impact. Facilitate knowledge sharing beyond pilot cities and regions, and create additional pilot programmes, such as supporting local GX projects.

- Expand the responsibilities of REOs to align environmental policies across levels of government and provide more tailored technical and financial support to cities and regions.
- Diversify funding and financing mechanisms for environmental action at the subnational level by promoting financial tools (e.g. biodiversity offsetting, land value capture and environmental bonds) to leverage private investment and strengthen subnational own revenues (e.g. taxes, fees and charges).
- Accelerate compact urban development and building decarbonisation in urban areas to continue leading Japan's decarbonisation efforts.
- Support small- and medium-sized cities through a dedicated decarbonisation strategy. Provide targeted technical and financial assistance tailored to their specific environmental and infrastructure needs, with a view to helping these cities implement renewable energy projects, improve waste management systems and enhance public transportation.
- Promote urban-rural partnerships and leverage Functional Urban Areas to facilitate collaborative projects, such as joint renewable energy initiatives, shared public transportation systems and co-ordinated land-use planning, with a view to enhancing complementarities between urban and rural areas.
- Increase engagement and ensure inclusive consultations with civil society and local communities in energy policy making to build support for infrastructure projects critical to meeting energy and climate goals. Manage trade-offs and potential citizen resistance to renewable energy installation through transparent land-use regulations and strategic impact assessments, including enhanced use of renewable energy priority areas.

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Notes

[1] On 11 March 2011, a magnitude 9.0 earthquake occurred off the coast of Japan. It generated a tsunami that caused massive damage across northeastern Japan, including to the Fukushima Daiichi Nuclear Power Station run by the Tokyo Electric Power Company (TEPCO).

[2] The NDC is set using a gross-net approach, meaning that emissions and removals from the LULUCF sector are not included in the FY2013 base year (gross). However, they are considered for the target year (net). It includes removal from the LULUCF sector of up to 47.7 $MtCO_2e$/year. Japan indicated that it would use the Joint Credit Mechanism to achieve its NDC.

[3] In the definition by World Food Program, food loss happens when food unavoidably becomes unfit for human consumption. On the other hand, food waste happens when people discard food that is still fit for human consumption (corresponding to *Shokuhin rosu* in Japanese).

[4] Green finance includes green bonds; green loans; sustainability bonds; sustainability linked bonds; sustainability linked loans; transition-labelled bonds and loans.

[5] Environmental protection investment includes investment on pollution abatement (air, water, soil and noise), waste and wastewater management, protection of biodiversity, and related research and development, education and training activities.

[6] Zero-energy buildings and houses are buildings or houses with zero net primary energy consumption annually.

[7] EVs include battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).

[8] A Functional Urban Area is composed of a “city” and its surrounding, less densely populated areas that are part of the city’s labour market (“commuting zone”).

Annex 1. Actions taken to implement selected recommendations from the 2010 OECD Environmental Performance Review of Japan

Recommendations	Actions taken
Addressing key environmental challenges	
Examine the cost effectiveness of the climate policy mix, particularly of negotiated agreements, looking across a range of alternative measures.	Japan has not assessed the cost effectiveness of the climate policy mix. The Global Warming Prevention Headquarters assessed the voluntary action plan of the Japan Business Federation (Keidanren) as "sufficiently highly effective".
Strengthen efforts to reduce nitrogen oxides (NOx) and non-methane volatile organic compound (NMVOC) emissions in order to effectively tackle photochemical smog in urban areas; establish a monitoring system for small particulates.	Emission standards for fixed sources and more stringent regulations for mobile sources in specific regions have helped reduce emissions and concentrations of NOx and NMVOC. The number of days of photochemical oxidant alerts decreased from 123 in 2011 to 41 in 2022. The monitoring system for fine particulate matter expanded from 309 measuring stations in FY2011 to 1 116 in FY2022.
Strengthen the extended producer responsibility system in order to reduce waste generation and illegal dumping of waste, for instance by promoting environment-friendly design and eco-labelling, further internalising, recovery costs into product prices (e.g. by a recovery fee included in the purchase price), and abolishing charges to consumers for disposal of electric and electronic products.	The 2022 Plastic Resource Circulation Act strengthened extended producer responsibilities. It requires development of guidelines for manufacturers to design products to be recyclable or reusable and the establishment of a mechanism to certify that products meet the guidelines. Under the Act on Promoting Green Procurement, the government prioritises certified products in its procurement as an incentive to manufacturers.
Implement measures that promote synergies between recycling, landfill diversion and reduction of greenhouse gas (GHG) emissions (e.g. develop incineration capacity with energy recovery, improve separate collection of bio-waste).	The Fundamental Plan for Establishing a Sound Material-Cycle Society, adopted approximately every five years, aims to divert waste from landfills and increase resource productivity and waste circularity. The 2022 Plastic Resource Circulation Act addresses the lifecycle of plastics, including by strengthening extended producer responsibility (see above). In July 2020, Japan introduced a fee on single-use plastic bags. As of 2021, almost 80% of municipal waste was incinerated (mostly with energy recovery), while landfilling was residual. GHG emissions from the waste sector (excluding incineration) constantly declined in the last decade. A fifth of municipal waste and 54% of industrial waste are recycled.
Increase recycling and materials and energy recovery to substitute primary resources for production and fossil fuels for energy supply.	
Promote waste prevention and greater cost recovery in municipal waste services by expanding the use of waste charging schemes.	Guidance on fee-based municipal waste disposal was revised and published in 2022. In FY2022, 67% of municipalities had implemented unit-based charges for household waste, up from 61% in FY2010, and 87% for commercial waste. In FY2022, cost recovery was about 12% nationwide.
Speed up the expansion of water supply and sanitation infrastructure in medium and small cities carefully assessing costs and benefits of existing collective and individual systems.	Access to water supply and sanitation increased. In 2023, wastewater treatment systems covered 93% of the population. About 81% of the population was connected to public wastewater treatment plants, 9% to decentralised systems (*johkasou*) and the remaining to collective rural systems. Nearly 99% of the population has access to safe water.
Expand the territory allocated to nature protection, in particular in national forests and marine areas, and provide additional finance for this purpose.	The extension of terrestrial protected areas increased from 20.3% of total area in 2014 to 20.6% in 2024. The marine area under protection grew from 8.3% of Japan's territorial waters and exclusive economic zone in 2014 to 13.3% in 2024.
Redesign agricultural support measures so as to reduce the negative impacts on biodiversity, and provide incentives to protect it.	The MIDORI Strategy for Sustainable Food Systems provides financial assistance for organic farming, adoption of climate-smart technologies, and less use of synthetic fertilisers and pesticides. The share of potentially most distorting support to agriculture (i.e. market price support; support based on output; and variable input use without input constraint) declined. In 2021-23, it was 26% of gross farm receipts and 78% of producer support estimate.
Establish payments for ecological services as a means to protect biodiversity, including in satoyama areas.	In 2020, the direct payment system for farmers operating in hilly and mountainous areas was revised to prevent the abandonment of farmland with unfavourable agricultural production conditions, thereby contributing to maintaining the provision of ecosystem services.

Recommendations	Actions taken
	No other new payments for ecosystem service programmes have been reported since 2010.
Develop a comprehensive climate change adaptation strategy; mainstream adaptation into land-use and sectoral plans; as part of broader international efforts, provide additional finance to further integrate climate change mitigation and adaptation into development co-operation.	Japan adopted the Climate Change Adaptation Act in 2018. The 2021 revision of the adaptation plan includes actions to mainstream adaptation into relevant policies. According to the OECD database of aid activities (Creditor Reporting System), in 2021-22, USD 9.4 billion or 68% of Japan's total bilateral allocable aid focused on climate change mitigation and adaptation. When considering contributions through multilateral, regional and bilateral channels, Japan's public and private support for climate mitigation and adaptation in developing countries totalled USD 26.9 billion in 2021–22 (of which USD 22.4 billion of public finance).
Improving environmental governance for policy coherence	
Strengthen inter-institutional co-operation, to ensure more effective and coherent integration of sectoral and environmental policies at all levels of government.	Japan established several inter-ministerial bodies to improve policy co-ordination. These include the Sustainable Development Goals (SDGs) Promotion Headquarters, the Global Warming Prevention Headquarters and the GX Implementation Council, all chaired by the Prime Minister.
Improve the evaluation of environmental policy by strengthening ex ante and ex post economic analysis and enhancing the independence of advisory bodies.	The Central Environment Council (CEC), an advisory body to the Ministry of the Environment (MOE), evaluates progress on various environmental policies annually. The CEC monitors implementation of the Basic Environment Plans based on a set of indicators. The indicators are systematically reviewed to ensure they reflect the objectives of the plans. Several other plans, such as the Fundamental Plan for Establishing a Sound Material-Cycle Society, set indicators to monitor implementation and evaluate policy effectiveness.
Accelerate the programme for testing and assessing the potential health and environmental effects of existing chemicals, particularly through the greater involvement of the private sector, with a view to establishing a comprehensive chemicals management system, including the management of potential risks to children's health.	In 2012, the country compiled the national plan for the implementation of the Strategic Approach to International Chemicals Management. For existing chemicals, the government identifies Priority Assessment Chemical Substances (PACSs) through screening assessments. As of April 2024, 225 substances were designated as PACS, and the results of the detailed risk assessments were discussed for 46 substances by April 2024.
Broaden the range of mechanisms for public participation in environmental decision-making; increase public support for grassroots NGOs and more public participation in environmental impact assessment (EIA) procedures.	The Basic Act on Water Cycle (2014) includes provisions to ensure the opinions of residents are considered in the management of the water basin. The 2011 amendment to the EIA Act introduced a requirement for project proponents to hold meetings with relevant stakeholders to discuss the scoping document, which clarifies the EIA methodology. In addition, the amendment introduced a procedure, the Primary Environmental Impact Consideration, to compare alternative projects or project features, such as location and scale, at the planning stage. This procedure requires project proponents to seek inputs from citizens.
Towards a more comprehensive and cost-effective environmental policy mix	
Review transport-related taxation and pricing, with a view to directly linking taxes on the purchase and ownership of vehicles to their fuel efficiency, and to better targeting pollution related to vehicle use through fuel taxes and road pricing.	In 2019, Japan introduced the environmental performance-based tax, which is paid upon purchase based on the car's fuel efficiency and exhaust emissions. The other vehicle taxes include the tonnage tax – based on weight and paid upon mandatory vehicle inspections – and the annual automobile tax, based on engine size. Electric (battery electric and plug-in hybrid electric), hydrogen fuel-cell cars and natural gas-powered cars are exempt from the tonnage tax and the environmental performance-based tax and benefit from a 75% discount on the automobile tax. Partial or total discounts apply to the tonnage and environmental performance-based taxes paid for internal combustion engine vehicles (excluding natural gas-powered ones) depending on fuel efficiency and exhaust emission levels. The discount eligibility criteria have been tightened over the years.
Mainstream environmental considerations in the 2011 tax reform, with a view to broadening the use of environmentally related taxes and reducing incentives and subsidies that have perverse environmental effects, or that contravene the polluter-pays-principle.	The use of environment-related taxes has increased with the introduction of a carbon tax in 2012 and some taxes at subnational level (on waste disposal and for forest development). Japan has not assessed the environmental impact of tax incentives and subsidies.
Put a consistent price on carbon through emissions trading in combination with climate-related taxes; transform the trial emissions trading system (ETS) into a mandatory cap-and-trade scheme that is compatible as far as possible with trading schemes in other countries; gradually introduce auctioning of permits.	Japan introduced the Tax for Climate Change Mitigation in 2012. The tax rate is JPY 289/tCO_2 (USD 1.9) and applies to CO_2 emissions from the combustion of fossil fuels across all sectors, with exemptions. The Tokyo and Saitama ETSs were launched in 2010 and 2011, respectively. In 2023, Japan launched the Pro-Growth Carbon Pricing, including an additional carbon levy and a national ETS. The new carbon levy (the GX surcharge) will be introduced in FY2028. The ETS has been operating on a voluntary basis since FY2023 among participants in the

Recommendations	Actions taken
	GX Leagues. It will become mandatory in FY2026 and allowances will be auctioned to the power sector in FY2033.
Investing in green growth	
Speed up the implementation of green public procurement in local governments, while ensuring its environmental effectiveness, economic efficiency and compliance with competition rules.	The MOE developed guidelines to promote and raise awareness of green purchasing among local governments. Since 2014, the MOE has provided technical assistance to local authorities. The Green Purchasing Network has published an annual ranking of local governments' green purchasing practices since 2016.
Further expand public direct investment in basic R&D in environment- and climate-related technologies; analyse the effectiveness and dynamic efficiency of current performance targets (e.g. the Top Runner Programme) in inducing eco-innovation.	Environment averaged 2.6% of government R&D budgets in 2019-23, with energy at 8.5%. Energy efficiency, renewables and hydrogen averaged 48% of public energy R&D outlays in 2019-23. The 2019 Strategy for the Promotion of Environmental Research and Environmental Technology Development sets out the priorities for R&D in technology related to climate change, resource recycling and biodiversity, among others. The MOE's Environmental Research Promotion Fund had an average annual budget of JPY 5.3 billion in FY2021-23. The Green Innovation Fund (managed by the Ministry of Economy, Trade and Industry) supports business innovation in climate mitigation technology and development of related supply chains. The government has not evaluated the effectiveness of the Top Runner Programme in inducing eco-innovation.
Establish a consistent and long-term framework to develop renewable energy sources and reduce reliance on fossil fuels, avoiding technology-specific targets.	The Sixth Strategic Energy Plan (2021) aims to maximise the use of renewable energy sources and to reach 36-38% of renewables in power generation by 2030, mainly by expanding solar and wind capacity. In 2022, the government replaced the feed-in tariff scheme for power from renewable sources (introduced in 2012) with a feed-in premium incentive.
Further expand integrated public transport systems in smaller cities and rural areas, and improve traffic demand management to tackle congestion in large metropolitan areas and on motorways.	In 2022, Japan launched the Decarbonisation Leading Areas (DLAs) initiative to support neighbourhood-scale pilot projects. Several of the 82 selected projects include measures to advance public transport systems. Some smaller urban areas have advanced sustainable transport initiatives, including light rail transit, electric buses and electric mobility systems. More than 200 municipalities offer demand-responsive transport schemes or integrate bus routes with school buses and shared taxis.

Source: OECD Secretariat's elaboration based on country submission; OECD (2010), *OECD Environmental Performance Reviews: Japan 2010*, OECD Environmental Performance Reviews, OECD Publishing, Paris, https://doi.org/10.1787/9789264087873-en.

Chapter 1. Towards sustainable development

This chapter examines Japan's progress towards achieving a net-zero, climate-resilient, circular and nature-positive economy. It assesses the country's performance in meeting key targets in these areas, benchmarking it against international standards. The chapter analyses the environmental effectiveness and economic efficiency of the environmental policy mix, including regulatory and voluntary approaches, fiscal and economic incentives, and investment in environment-related infrastructure and the clean energy transition. Additionally, it explores the interaction between environmental policies and other policy domains, highlighting opportunities and barriers to enhancing policy coherence for sustainable development.

1.1. Introduction

Japan is one of the world's largest economies, supported by a strong industrial sector and advanced technology. Its manufacturing industry plays a larger role in the economy than in most OECD countries, making up for about one-fifth of Japan's gross domestic product (GDP) (World Bank, 2024[1]). Although it is a leading merchandise exporter, the country imports much of its natural resources, including fossil fuels. Japan's focus on industry competitiveness and technology development influences its environmental policy.

The country's population density is among the highest in the OECD but shows considerable regional disparities. While rural areas are facing depopulation, ageing and economic decline, population and economic activities are heavily concentrated in dense metropolitan areas and along coastal plains. This is due to Japan's geography, including being an archipelago and its mountainous and forested terrain (OECD, 2024[2]). Revitalising rural economies is a key policy priority. The government sees the green transformation as an economic and social opportunity for struggling regions (Chapter 2).

The Japanese economy has grown moderately for several decades. GDP grew by an average of 0.6% per year over 2010-22 compared to the OECD average of 1.9%. At about USD 50 000 (in current purchasing power parities), Japan's GDP per capita is the lowest among G7 countries. The economy is projected to grow by 1.5% in 2025, thanks in part to robust public investment and government subsidies for the green and digital agendas (OECD, 2024[3]; OECD, 2024[4]). At about 240% of GDP, Japan's public debt is the highest in the OECD, while population ageing and decline add pressure on public finances. Fiscal consolidation is crucial for Japan to address rising pensions and health care costs, support the green and digital transformation, and ensure long-term economic stability and resilience (IMF, 2024[5]; OECD, 2024[4]). This calls for improving the efficiency of public spending and increasing fiscal revenues (OECD, 2024[6]). Removing and repurposing environmentally harmful fiscal measures and expanding the use of environment-related taxes can help in this respect (Sections 1.4.3 and 1.4.4).

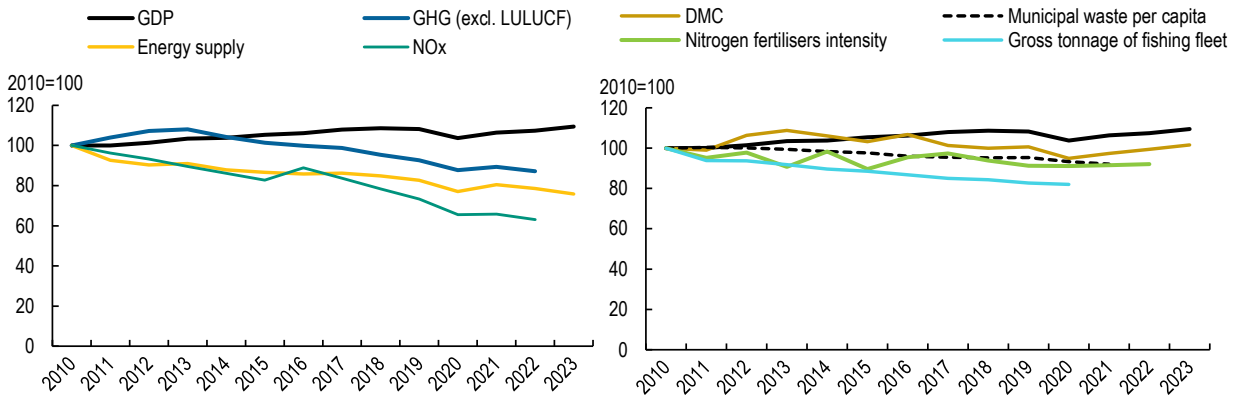
Japan has made considerable progress in decoupling environmental pressures from its economic performance (Figure 1.1). Energy supply declined and greenhouse gas (GHG) emissions started to decouple from GDP growth in 2013 (Figure 1.1). However, Japan's energy mix remains heavily reliant on fossil fuels. The 2011 Great East Japan Earthquake and the ensuing accident at the Fukushima Daiichi Nuclear Power Station (hereafter "2011 earthquake and nuclear accident"),[1] have exacerbated energy security concerns and affected Japan's climate and energy policy (Sections 1.2.1 and 1.2.2). Japan has also made progress in reducing emissions of air pollutants, generation of municipal waste per capita, use of chemical fertilisers and fishing effort (Figure 1.1). However, most of the country's population is exposed to harmful levels of particulate pollution (Section 1.2.3), and the circular use of resources could be improved further (Section 1.2.4). More than half of assessed fish stocks fall below biological sustainability standards. Japan is home to diverse endemic species, but pressures on terrestrial and marine biodiversity persist (Section 1.2.5). Japan is one of the most earthquake-prone countries in the world and is exposed to climate-related extreme weather events (Section 1.2.6).

Japan has consistently advocated, both domestically and internationally, for a "synergistic approach" to address the triple planetary crisis of climate change, biodiversity loss and pollution effectively, while improving economic prospects and well-being (Section 1.3.1). The government has also emphasised the socio-economic benefits of the green transformation for local communities (Chapter 2). As this chapter discusses, to fully harness policy synergies, Japan needs to further strengthen its governance and foster inter-institutional collaboration (Section 1.3.1). A comprehensive policy package is needed to advance towards the green transformation in an integrated and cost-effective manner. The policy mix should include public investments, better regulations, innovation, support and incentives for businesses and households, and consistent price signals (Section 1.4). Japan can leverage its high energy efficiency, vast renewables potential, extensive railway network, solid industrial base and renowned innovation capacity. To enable a

smooth transition and seize its economic opportunities, Japan will need to facilitate reallocation of resources and alleviate the potential negative impact of the transition on vulnerable households.

Figure 1.1. Decoupling of environmental pressures from economic growth has progressed

GDP and selected environment-related indicators, Japan, 2010-23



Note: GDP = gross domestic product. GHGs = greenhouse gases. LULUCF = land use, land-use change and forestry. DMC = domestic material consumption. NOx = nitrogen oxides.
Source: FAO (2024), *FAOSTAT & FISHSTAT* (databases); IEA (2024), *IEA World Energy Statistics and Balances* (database); MOE-GIO (2024), National GHG Inventory Document of Japan 2024; OECD (2024), *OECD Economic Outlook* (database); OECD (2024), *OECD Environment Statistics* (database).

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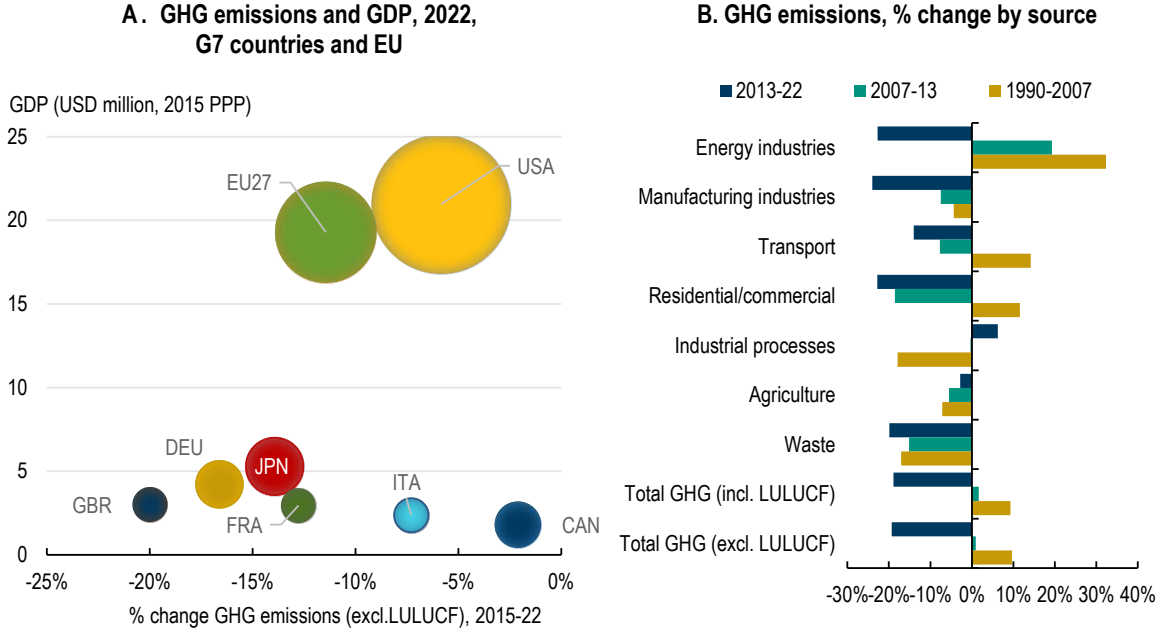
1.2. Addressing key environmental challenges

1.2.1. Progress towards net zero

While declining, Japan's GHG emissions are linked to a carbon-intensive energy mix

Japan is the second largest GHG emitter in the OECD and G7, after the United States (Figure 1.2, panel A). The year 2013 marked a turning point in the country's GHG emission trend. Before 2013, emissions had generally increased, with the only notable drop occurring during the 2008-09 financial crisis. GHG emissions rose again after the 2011 earthquake and nuclear accident. The subsequent temporary closure of all nuclear reactors for safety checks led to increased reliance on natural gas, oil and coal for electricity generation, driving GHG emissions to an all-time high in 2013. Since then, emissions have been declining in most sectors (Figure 1.2, panel B), thanks to energy savings, reduced output of energy-intensive industries such as steel and cement, the gradual expansion of renewable energy and the restart of some nuclear power plants (Section 1.2.2). The land use, land-use change and forestry (LULUCF) sector has been a small net carbon sink, absorbing about 5% of Japan's gross emissions in the last decade. Overall, in 2022, net GHG emissions were 11% below their 1990 level and 19% below their 2013 level (Figure 1.2).

Figure 1.2. Japan, the G7's second largest GHG emitter, reduced its emissions in the last decade



Note: Panel A: GHG emissions excluding emissions and removals from land use, land-use change and forestry (LULUCF). The size of the bubbles indicates absolute emissions. Panel B: Residential and commercial sectors include GHG emissions from energy used in the institutional sector and in agriculture, forestry and fishing.
Source: MOE-GIO (2024), National GHG Inventory Document of Japan 2024; OECD (2024), *OECD Environment Statistics* (database); UNFCCC (2024), National Inventory Reports.

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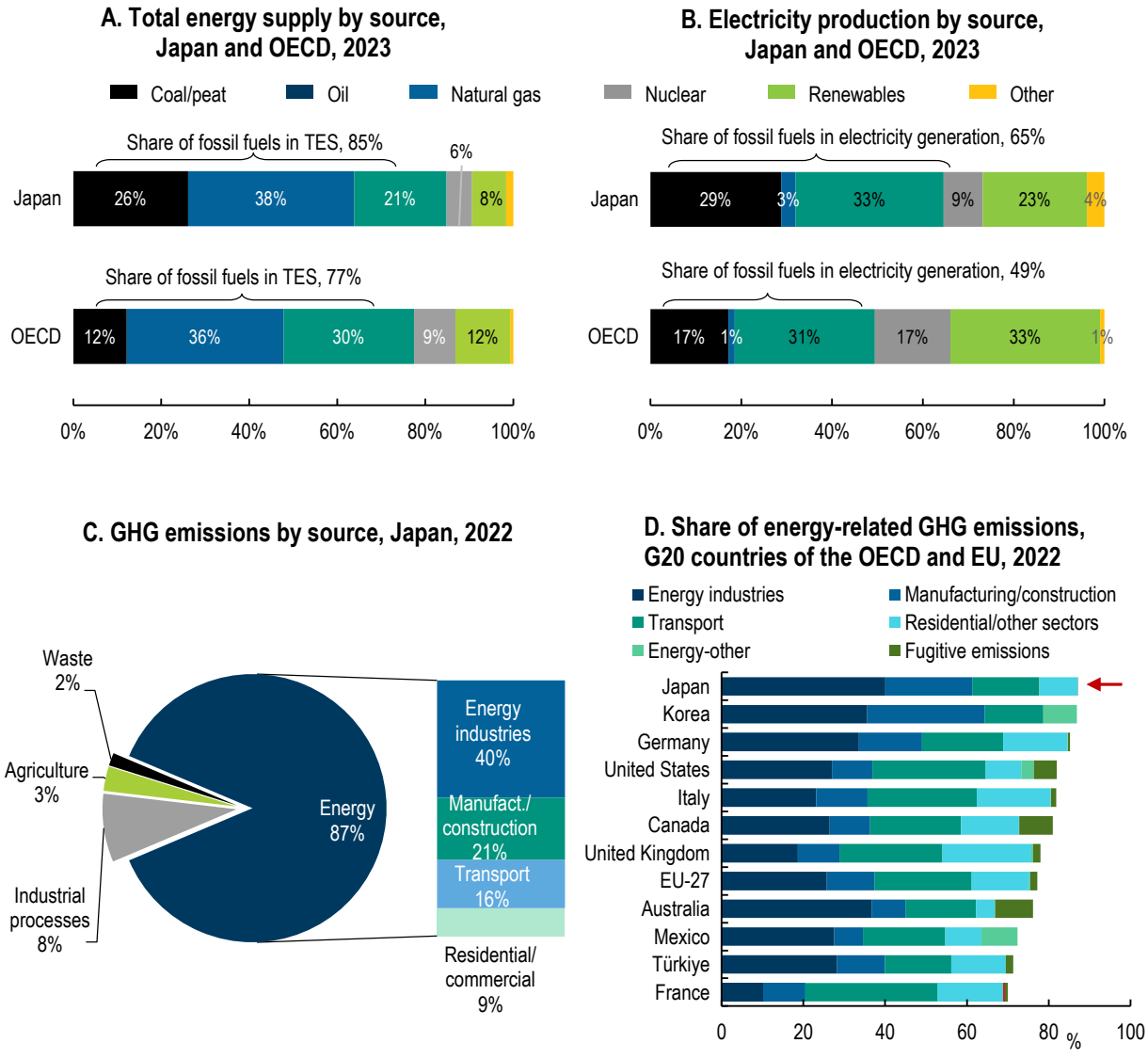
Japan's high reliance on fossil fuels is the main driver of GHG emissions. Use of fossil fuels (especially oil) has declined since the 2013 peak. However, their share in total energy supply and electricity generation remains above the corresponding OECD averages (Figure 1.3, panels A and B) and the levels prior to the 2011 nuclear accident (Section 1.2.2). As a result, 87% of Japan's GHG emissions were linked to energy production and use in 2022 – the highest share in the OECD – and energy industries are the largest single source of emissions (Figure 1.3, panels C and D).[2] Manufacturing, the second largest source of emissions, generates a larger share of emissions than in most OECD countries, reflecting the role of energy-intensive industries in the economy. Transport accounts for a relatively lower share than the OECD average, underscoring the efficiency of rail and public transport networks, and vehicle fleet (Figure 1.3, panels C and D) (Section 1.5.3).

Japan needs to step up abatement efforts to meet its higher climate mitigation targets

Japan has revised its medium- and long-term emission reduction targets to be more stringent. The country exceeded its 2020 emission reduction target (Figure 1.4). It committed to net-zero emissions by 2050 and enshrined this commitment into its Act on Promotion of Global Warming Countermeasures (first enacted in 1998). In its 2021 Nationally Determined Contribution (NDC), Japan pledged to cut GHG emissions by 46% by FY2030 from the FY2013 peak level (Figure 1.4). It also set an aspirational goal of halving GHG emissions in the same timeframe (Box 1.1). This is a considerable increase in ambition compared to Japan's previous targets.[3]

Figure 1.3. Japan's carbon-intensive energy mix is the main driver of GHG emissions



Note: Panels A and B: Percentages may not total 100% due to rounding. The breakdown of total energy supply excludes heat and electricity trade. Renewables include hydro, wind, solar, geothermal, biofuels and renewable waste; energy-other includes non-renewable municipal waste and industrial waste. Panel D: Countries are ranked according to the share of low-carbon sources; data refer to 2022 or latest available year.
Source: IEA (2024), *IEA World Energy Balances* (database); OECD (2024), *OECD Environment Statistics* (database).

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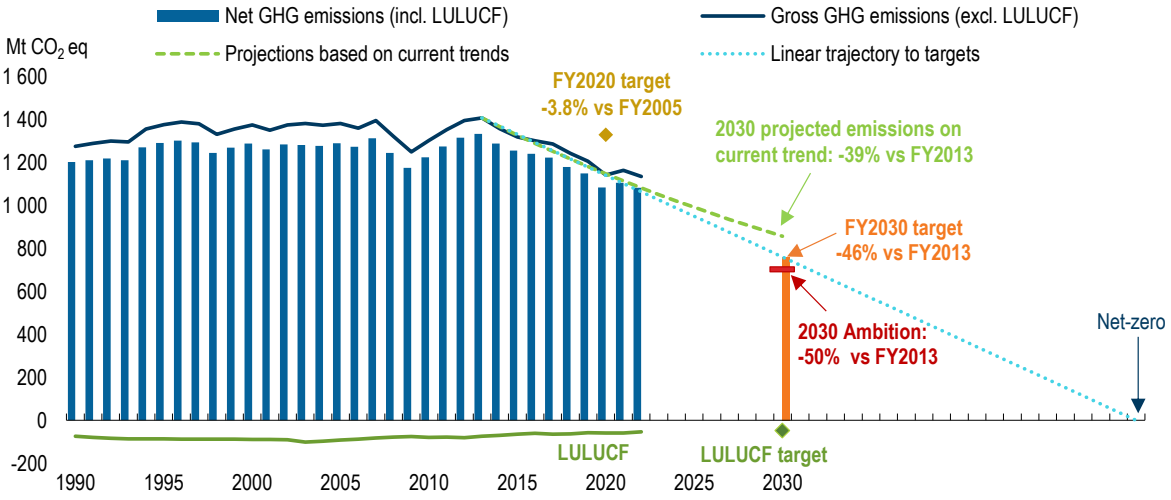
Nonetheless, Japan could aim to curb emissions further by 2030 to be consistent with the Paris Agreement. The country's FY2030 target represents a 34% reduction in net GHG emissions from 2019 levels. By comparison, the Intergovernmental Panel on Climate Change has called for a 43% global reduction in emissions to align with the Paris Agreement's 1.5°C temperature limit (IPCC, 2022[7]). Japan shares with other major advanced economies the responsibility of leading this global effort.

Figure 1.4. Japan raised its climate targets but needs to accelerate emission reductions to meet them

Historic and projected GHG emissions, and pathway to the FY2030 target and net zero by 2050



Note: LULUCF = land use, land-use change and forestry. The solid lines and the columns show historical GHG emissions, excluding and including removals from LULUCF, respectively, and including indirect carbon dioxide emissions. Japan's 2030 NDC uses a gross-net approach: the FY2030 GHG emissions net of removals from LULUCF need to be 46% below the FY2013 emissions without LULUCF removals. The dotted line shows the linear trajectory between the FY2013 base-year emissions (excluding removals), the FY2030 targeted emissions (with removals) and the 2050 net-zero target. The dashed line shows a linear emission projection to 2030 based on the average annual reduction rate observed between FY2013 (gross emissions) and FY2022 (net emissions).
Source: OECD Secretariat's calculations; Government of Japan (2021), Japan's Nationally Determined Contribution; MOE-GIO (2024), National GHG Inventory Document of Japan.

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Box 1.1. Japan's Nationally Determined Contribution

Japan's Nationally Determined Contribution (NDC), submitted in 2021, covers all gases and emission sources. It includes removals of up to 47.7 Mt CO_2eq/year of emissions from land use, land-use change and forestry (LULUCF). Japan's NDC is set using a gross-net approach. This means that emissions and removals from the LULUCF sector are not included in the FY2013 base year (gross) but are considered for the FY2030 target year (net). If removals from LULUCF were included in the base year as well, the target would equate to cutting net greenhouse gas (GHG) emissions by 43% in 2030 compared to 2013 levels, by 41% below 2005 levels and by 36% below 1990 levels. For comparison, the United States pledged to cut net GHG emissions by 50-52% from 2005 levels and the European Union committed to bring net GHG emissions at least 55% below 1990 levels.

Japan indicated it would use the Joint Crediting Mechanism (JCM) to achieve its NDC. It aims to contribute to global emission reductions and removals for about 100 Mt CO_2eq by FY2030 through public-private projects in developing countries. In FY2023, the number of JCM partner countries grew to 29, with over 250 projects registered or under implementation (MOE, 2024[8]).

Source: Government of Japan (2021), Japan's Nationally Determined Contribution, www.env.go.jp/content/900442543.pdf; UNFCCC (2022), Nationally Determined Contributions Registry, https://unfccc.int/NDCREG.

Japan's vision to net zero aims to create a carbon-neutral and climate-resilient socio-economic system that addresses climate change, fosters efficient and circular resource use, and protects natural ecosystems for societal well-being and economic growth. This vision counts on disruptive technological development as a key driver of emission reductions, especially from energy production and industrial activities (Government of Japan, 2022[9]). Promoting resource circularity, especially for plastics, is expected to further contribute to achieving the NDC (Section 1.2.4). In addition, the government plans to scale up regional and local decarbonisation initiatives (Chapter 2).

Japan foresees to achieve its FY2030 target by implementing the existing policy measures and investments outlined in the Plan for Global Warming Countermeasures, which was last updated in 2021 to align it with the revised NDC. The plan focuses on increasing energy efficiency in all sectors and expanding the use of renewable energy, as well as on fostering a shift in consumption patterns to help reduce emissions from households, services and transport (Sections 1.2.2 and 1.5.3). In addition, the 2023 Basic Policy for the Realization of the Green Transformation (GX) (hereafter GX Basic Policy) provides JPY 20 trillion (about USD 130 billion) of financial support for technology development over ten years, financed through the GX Economy Transition Bonds. The policy also foresees introducing a mandatory emission trading system (ETS) in FY2026 and a carbon levy in FY2028 – the so-called Pro-Growth Carbon Pricing (Sections 1.4.3).

The Plan for Global Warming Countermeasures is comprehensive and identifies the expected emission reductions from existing policy measures. However, the plan lacks a projected emission trajectory to the 2030 target, making it more challenging to track progress and adjust policies as needed. The plan does not identify the additional policy efforts needed to reach the aspirational goal of halving emissions by 2030. Nor does it provide projections or policies for the next decades. A climate mitigation planning framework based on binding periodic carbon budgets (i.e. limits on national and/or sectoral emissions) would help Japan ensure that its current and planned measures are aligned with its long-term target. Some OECD countries have adopted the carbon budget approach, including France, Germany and the United Kingdom (OECD, 2023[10]; OECD, 2022[11]; OECD, 2016[12]).

Japan has implemented a broad set of GHG abatement measures. Their potential effectiveness in driving emission reductions has increased in the last decade. The country's climate policy approach has traditionally relied on research and development (R&D) support, subsidies (e.g. energy efficiency, renewables and electric vehicles) and non-market-based instruments such as regulations, performance targets and voluntary agreements with industry. Pricing instruments such as energy and vehicle taxes have generally played a lower role in Japan's policy mix compared to the average in the OECD. Their ability to drive behavioural changes has been limited – a feature common to other major OECD non-European economies such as Canada and Korea (D'Arcangelo, Kruse and Pisu, 2023[13]). Given this context, the introduction of the Pro-Growth Carbon Pricing is a welcome development, as the effective carbon rate is currently low compared to most OECD countries. However, the contribution of the planned carbon levy and ETS to meeting the 2030 target remains difficult to assess, as their level and coverage are expected to be defined in the first half of 2025 (Section 1.4.3).

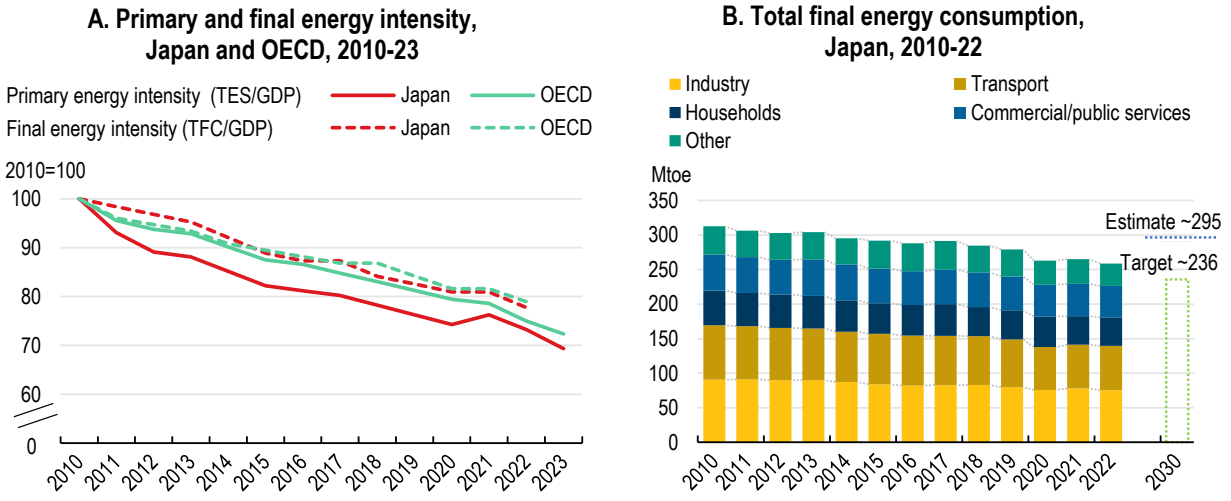
Japan needs to accelerate its emission abatement efforts to achieve the target at the end of this decade and prepare for setting a more ambitious target for 2035. This would help the country contain cumulative emissions and potentially reduce the transition costs in the next decades (UNEP, 2024[14]). If domestic GHG emissions continue to decline at the same annual average rate of 2.9% as in FY2013/22, in FY2030 net emissions would be 39% below gross emissions in FY2013 and exceed the NDC level (Figure 1.4). UNEP (2024[14]) estimates that Japan is unlikely to meet the NDC with existing policies.

1.2.2. Accelerating the clean energy transition

Japan has made gradual progress towards a clean energy transition

Japan has made progress in reducing energy use in the last decade. Primary and final energy intensities have declined by 31% and 22%, respectively, since 2010, in line with OECD trends. They remain below the corresponding OECD averages (Figure 1.5, panel A). Energy consumption has declined in all sectors (Figure 1.5, panel B). Longstanding policy measures such as the Top Runner Programme, industrial voluntary agreements and financial support have contributed to this progress (IEA, 2021[15]) (Section 1.5.3).

Figure 1.5. Energy use has continued to decline



Note: Panel A: GDP at 2015 purchasing power parities; TES: total energy supply; TFC: total final consumption. Panel B: Other includes energy consumption by the agriculture, forestry and fishing sectors, consumption not elsewhere specified and non-energy use. The conversion factor of toe 0.842 per kilo litre of oil equivalent (kLoe) is used to convert Japan's estimated final energy consumption in 2030 (350 million kLoe) and the 2030 target of about 280 million kLoe.
Source: IEA (2024), *IEA World Energy Balances* (database); METI (2024), Japan's Energy.

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Some progress has also been made in shifting to low-carbon energy sources. As of January 2024, Japan had reactivated one-third of the country's operational reactors, which have been off line since the 2011 Fukushima accident. This brought the share of nuclear in power generation from zero in 2013 to 9% in 2023 (Figure 1.3, panel B). At the same time, the decontamination of the areas affected by the nuclear accident has advanced (Box 1.2). Renewable energy supply grew by 60% between 2010 and 2023 (Figure 1.6, panel A), following a decade of nearly stable production. Increased solar photovoltaics (PV) capacity and generation, encouraged by generous subsidies, has been the main driver of this growth (Section 1.5.2). This has helped contain the role of fossil fuels in the energy mix and curb GHG emissions (Section 1.2.1). In particular, the use of coal has declined since 2017. However, coal still accounted for 26% of Japan's total energy supply in 2023, double the average share in the OECD. Meanwhile, the role of renewables in the energy mix was still below the OECD average (Figure 1.3, panel A).

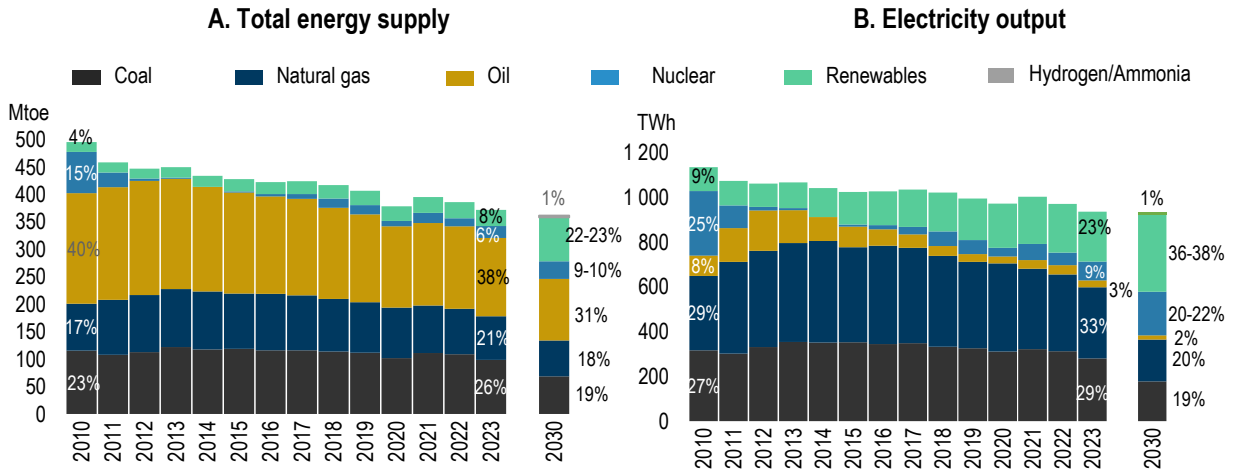
Box 1.2. Progress in the decontamination of the areas affected by the 2011 nuclear accident

Work has been progressing to decommission the TEPCO's Fukushima Daiichi Nuclear Power Station and to decontaminate nearby areas affected by the radioactive release. No radioactive caesium has been detected in rivers, coastal waters or groundwater in the Fukushima Prefecture and surrounding areas in recent years. Moreover, it has only been detected in 2 of 164 lake spots. Decontamination of several areas has been nearly completed, and evacuation orders were lifted for several villages. The government stores contaminated soil in a temporary facility in the Fukushima Prefecture until its planned disposal outside the prefecture by 2045. To meet this deadline, the Ministry of the Environment (MOE) is leading work to recycle soil (e.g. in road construction) and reduce amounts for disposal.

In 2023, Japan began discharging treated water from the plant into the sea. The discharged water is treated using the Advanced Liquid Processing System to remove most radioactive nuclides, except for tritium. This process is expected to continue over several decades to manage the large volume of stored water and facilitate the decommissioning of the plant. To ensure safety, the MOE has been monitoring tritium and other nuclides in seawater and aquatic organisms since 2022. The Japanese government and the International Atomic Energy Agency have stated that the discharge process is safe.

Source: METI (2024[17]); MOE (2024[8]).

Figure 1.6. Japan's clean energy transition has started but should accelerate



Note: Breakdown data exclude non-renewable waste and other sources not otherwise included (about 2% and 4%, respectively, for energy supply and electricity generation in 2023). Panel A: The conversion factor of toe 0.842 per kilo litre of oil equivalent (kLoe) is used to convert Japan's 2030 target for total energy supply of about 480 million kLoe.
Source: IEA (2024), *IEA World Energy Balances* (database); METI (2024), Japan's Energy.

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The government recognises that Japan's high reliance on fossil fuels for energy production, low self-sufficiency and its island geography make the clean energy transition a must on both decarbonisation and energy security grounds. Japan imports about 90% of its needed fossil fuels. The government's Sixth Strategic Energy Plan (SEP, adopted in 2021) aims to lower the share of fossil fuels in total energy supply

from 85% in 2023 to 68% in 2030 (Figure 1.6, panel A). This would allow Japan to reduce energy-related CO_2 emissions by 45% by 2030 compared to 2013, accounting for nearly 95% of all emission reductions needed to achieve the NDC target (Section 1.2.1). It would also help improve energy security and reduce the total energy bill of the country.[4]

Lowering energy demand and shifting to low-carbon power generation sources are the main levers of Japan's plan to reduce GHG emissions from the energy sector to 2030. The Sixth SEP assumes decreased energy demand with a lower population, moderate economic growth and substantial energy efficiency improvements (Section 1.5.3). It plans to more than double the share of power from nuclear and renewable sources from the 2019 shares (Figure 1.6, panel B). However, the SEP also foresees to boost investment in natural gas generation. Fossil fuels are projected to account for 41% of electricity generation in FY2030, with coal comprising a little less than half of this (Figure 1.6, panel B). The expected contribution of fossil fuels to power generation in 2030 is larger than that of most OECD countries in 2023 (Figure 1.3, panel B). It also exceeds the global average of 30% for unabated fossil fuels in electricity generation projected as necessary by 2030 by the International Energy Agency (IEA) to achieve net zero (IEA, 2024[16]).[5]

Japan has sufficient renewable economic and technical potential to reach and exceed the SEP target of 36-38% renewables in power generation by 2030 (IEA, 2021[15]) (Figure 1.6, panel B). The SEP indicates this share may rise to 50-60% in 2050. Some scenario analyses suggest renewables may grow further (Box 1.3). Renewables are mature technologies that can decarbonise power generation in a cost-effective manner. The government has taken steps to address barriers to renewables deployment. Some barriers are common to other countries, notably inadequate grids, lengthy permitting procedures and social resistance (IEA, 2024[18]) (Section 1.5.2).

The government expects that restarting 30 reactors will bring nuclear to cover about 20% of electricity generation by the end of the decade – more than double the 2023 share (Figure 1.6, panel B). It also plans to build new advanced and small modular reactors. The reactivation of nuclear power plants depends on meeting stringent safety assurances, requiring an extended technical and safety review process.[6] Social acceptance of nuclear power has increased nationally in recent years, after a dramatic drop following the 2011 accident and heightened concerns about disaster risks (The Asahi Shimbun, 2024[24]).[7] However, opposition to nuclear power remains strong at the local level, where the reactors are situated, and regaining local community acceptance requires lengthy consultations with uncertain outcomes.

The SEP foresees developing hydrogen, ammonia and carbon capture, utilisation and storage (CCUS) technology to reduce emissions from existing and new thermal power plants, paving the way to full-scale applications in the next decades. Ammonia and hydrogen are expected to be co-fired with coal and gas to produce 1% of electricity in FY2030 (Figure 1.6, panel B). The SEP also indicates low-emission hydrogen and ammonia may contribute to 10% of power generation by 2050 – a share ten times higher than the global figure projected by the IEA's net-zero emission scenario (IEA, 2023[25]). However, there are considerable uncertainties about the scope for scaling up these technologies in a cost-effective manner. Despite Japan's remarkable R&D investment, hydrogen and CCUS technologies remain at early stages of deployment in the country, as in the rest of the world (Section 1.5.2). They are expensive and may face public resistance (IEA, 2024[16]). Increasing their use will depend on global market development and on whether R&D efforts can successfully reduce production, transport and storage costs (OECD, 2024[6]). If hydrogen and ammonia – whether domestic or imported – are not decarbonised, investing in retrofitting existing or building new thermal combustion power plants could lead to higher GHG emissions over the lifespan of these plants, as well as carbon lock-in (IEA, 2023[26]). Japan should consider prioritising the use of low-emission hydrogen and ammonia and CCUS in sectors where other emission abatement options are limited and where these technologies would be the most cost-effective option, such as for hard-to-abate industrial processes (e.g. chemicals, iron and steel) (BNEF, 2023[20]; IEA, 2023[25]).

Box 1.3. Alternative energy scenarios in line with Japan's net-zero goal

The cost-optimal clean energy transition scenario developed by McKinsey & Company projects 60% of electricity from renewables in 2050 in Japan (Kuwabara et al., 2021[19]). The remainder would be covered primarily by natural gas with carbon capture, utilisation and storage (CCUS), and to a lesser extent by hydrogen and ammonia, and nuclear. Coal power generation would be phased out by 2030. This pathway would require investment of USD 330 billion per year to 2050 (7.8% of Japan's 2023 GDP) to change the power generation mix, reinforce the electricity grid, accelerate deployment of electric vehicles and improve the energy efficiency of buildings. Achieving the 2030 target could lead to cost savings of USD 34/tCO_2eq over the decade because the required technologies are mature, while abating a tonne of CO_2eq emissions would cost the Japanese economy USD 36/tCO_2eq on average by 2050.

Under the BloombergNEF's net-zero scenario, renewables and nuclear generate 72% of Japan's electricity in 2030 and 93% in 2040, with wind and solar jointly accounting for 79% of total power generation in 2050. All fossil fuel-based vehicles, including hybrids, would be phased out. Hydrogen-based fuels would be primarily used in shipping and aviation, and to a limited extent in power generation, due to the high cost of domestic production and transport of low-emission hydrogen. CCUS would account for half of emission abatement in industry by 2050. This scenario would require investment of USD 239 billion per year on average over 2022-50 (BNEF, 2023[20]).

According to the Berkeley Lab's Clean Energy Scenario (Shiraishi et al., 2023[21]), renewable electricity (mostly photovoltaics and wind) would generate up to 70% of electricity by 2035. Nuclear power and natural gas-fired power would account for 20% and 10% of electricity generated, respectively. All coal plants would be closed by 2035, and no powered plants running on fossil fuels would be built. The wholesale electricity costs and spending on imported coal and natural gas would decrease between 2022 and 2035.

The Renewable Energy Institute, a Japan-based think tank, estimates that renewables could supply 80% of electricity by 2035, with the remaining supplied by natural gas-fired plants. Alternatively, nuclear power could cover up to 11% of electricity needs in 2035. Coal power would be phased out by 2030. This electricity mix would enable cutting greenhouse gas (GHG) emissions from power generation by 73%. At the same time, it would lower the annual cost of imported fossil fuels for thermal power by 78% by 2035 (REI, 2023[22]).

Japan's Institute for Global Environmental Strategies suggests that renewables (mainly rooftop solar power and offshore wind power) could meet 90% of electricity demand by 2050. This scenario could be possible if Japan also promotes energy savings, expands electricity storage capacity, enhances grid flexibility and fast-tracks electrification. Along with phasing out coal power generation by 2035, this scenario would bring the GHG emission trajectory in line with the Paris Agreement goal. At the same time, it would increase energy self-sufficiency to 40% by 2040 and nearly 90% by 2050. Investment needs in renewables and hydrogen would average JPY 3.9-4.6 trillion/year in 2021-50, below the current annual fossil fuel imports (JPY 20-30 trillion/year) (Kuriyama et al., 2023[23]).

Overall, Japan's strategy to decarbonise the energy sector faces potentially high costs and several uncertainties, including about reactivation of mothballed nuclear power facilities, technology development, grid constraints and social acceptance of energy infrastructure. If low-emission hydrogen and CCUS technologies cannot be deployed at a large scale and nuclear plants do not restart as planned, the anticipated high reliance on coal and gas will weaken Japan's ability to reach net zero.

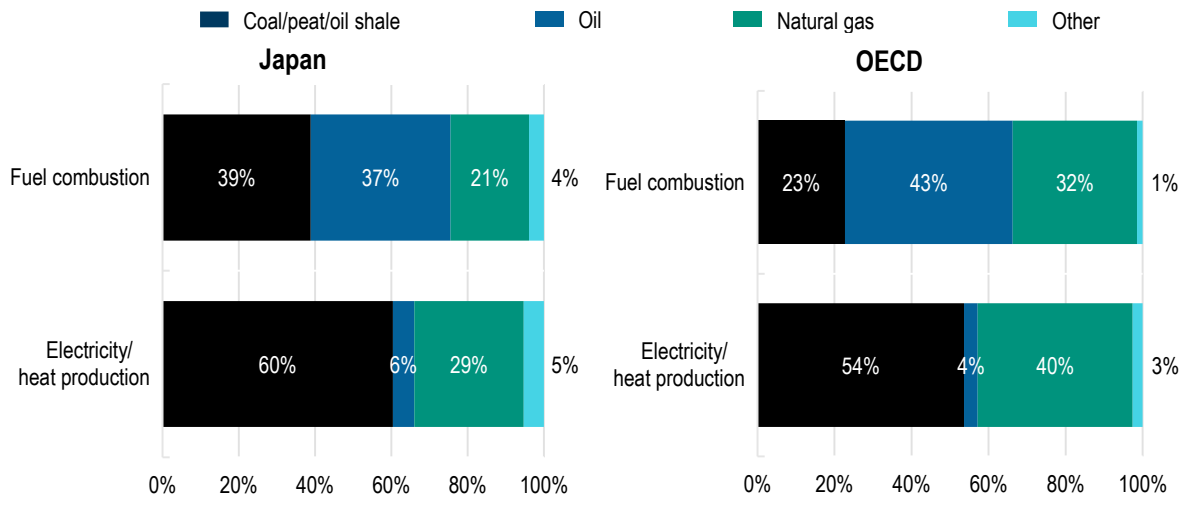
In light of these uncertainties and implementation challenges, the SEP recognises the need to develop alternative pathways for decarbonising the energy sector to 2050. This is essential to ensure that the 2030

energy mix targets are compatible with the energy mix needed in 2050 to achieve the net-zero goal, and that policy actions are adequate to achieve the targeted mix. Some organisations have formulated unofficial, independent energy scenarios for Japan (Box 1.3). Japan should also further engage civil society in energy policy making to build broader social support for the infrastructure developments essential to achieving the country's energy and climate policy objectives (Section 1.3.2).

Phasing out unabated coal power is imperative to get on track to net zero

Coal is expected to maintain a key role in Japan's energy supply beyond 2030 due to the government's energy security concerns. Coal is a major fuel for both electricity generation and industrial activities in Japan. While declining, coal's share in the power mix will remain high, at 19% in 2030 (Figure 1.6, panel B). This is higher than the OECD average in 2023 (Figure 1.3, panel B). The country has the fourth-largest operating coal fleet in the world behind the People's Republic of China, India and the United States (IEA, 2022[27]; Global Energy Monitor et al., 2024[28]) and has historically financed coal projects overseas (Section 1.4.4). Its coal power capacity has increased since the 2015 Paris Agreement (Agency for Natural Resources and Energy, 2024[29]).[8] While Japan's coal fleet is among the most efficient in the world, even a highly efficient coal plant emits more CO_2 than any alternative power source (IEA, 2024[30]). As a result, coal remains the dominant source of Japan's GHG emissions from energy production and use (Figure 1.7).

Figure 1.7. Coal use is the main source of Japan's GHG emissions



Source: IEA (2024), *CO_2 Emissions from Fuel Combustion and Greenhouse Gas Emissions from Fuel Combustion* (databases).

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Japan has taken some steps towards reducing its reliance on coal. The Sixth SEP outlines a progressive phase-out of inefficient coal power plants,[9] which made up about half of total coal capacity in 2023. Available information indicates that as of July 2024, 8.5% of operating capacity was planned to be retired in 2024-31 (Global Energy Monitor, 2024[31]). The pace of closing inefficient coal plants should be accelerated. At the 2023 Conference of the Parties for the United Nations Framework Convention on Climate Change, Japan announced it would end new construction of unabated coal-fired power plants. To put this announcement into action, Japan could introduce a regulatory requirement for all future plants to be built CCUS-ready, in line with an IEA recommendation to the country (IEA, 2021[15]).[10] In 2024, along with other G7 countries, Japan pledged to phase out unabated coal power generation by 2035, or in a timeline consistent with the Paris Agreement and in line with countries' net-zero pathways. Taking energy

security concerns into account, formalising this pledge by committing to a coal phase-out timeline, as done by most OECD countries with coal power capacity, would provide a clear direction of travel for the sector and smooth the transition. It would also encourage the development of renewables and other low-carbon generation capacity.

The government plans to co-fire ammonia in existing and new coal power plants to reduce emissions.[11] Co-firing ammonia with coal lowers CO_2 emissions from burning the fuels. However, Japan is a net ammonia importer and virtually all hydrogen and ammonia worldwide are currently produced from unabated fossil fuels. Thus, in the short term, co-firing would likely lead to higher life cycle CO_2 emissions than coal-only combustion and displace GHG emissions to the countries producing ammonia using carbon-intensive processes. In addition, ammonia combustion emits nitrogen oxides (NO_x) and fine particulate matter ($PM_{2.5}$), as well as nitrous oxide (a powerful GHG). This can worsen air quality in Japan and increase GHG emissions (Myllyvirta and Kelly, 2023[32]). Japan has tested co-firing coal and ammonia at a 20% blend rate with reduced NO_x emissions (METI, 2024[33]). While further technology development is under way to reduce the emissions impact at higher blend rates, results remain uncertain.

1.2.3. Tackling air pollution

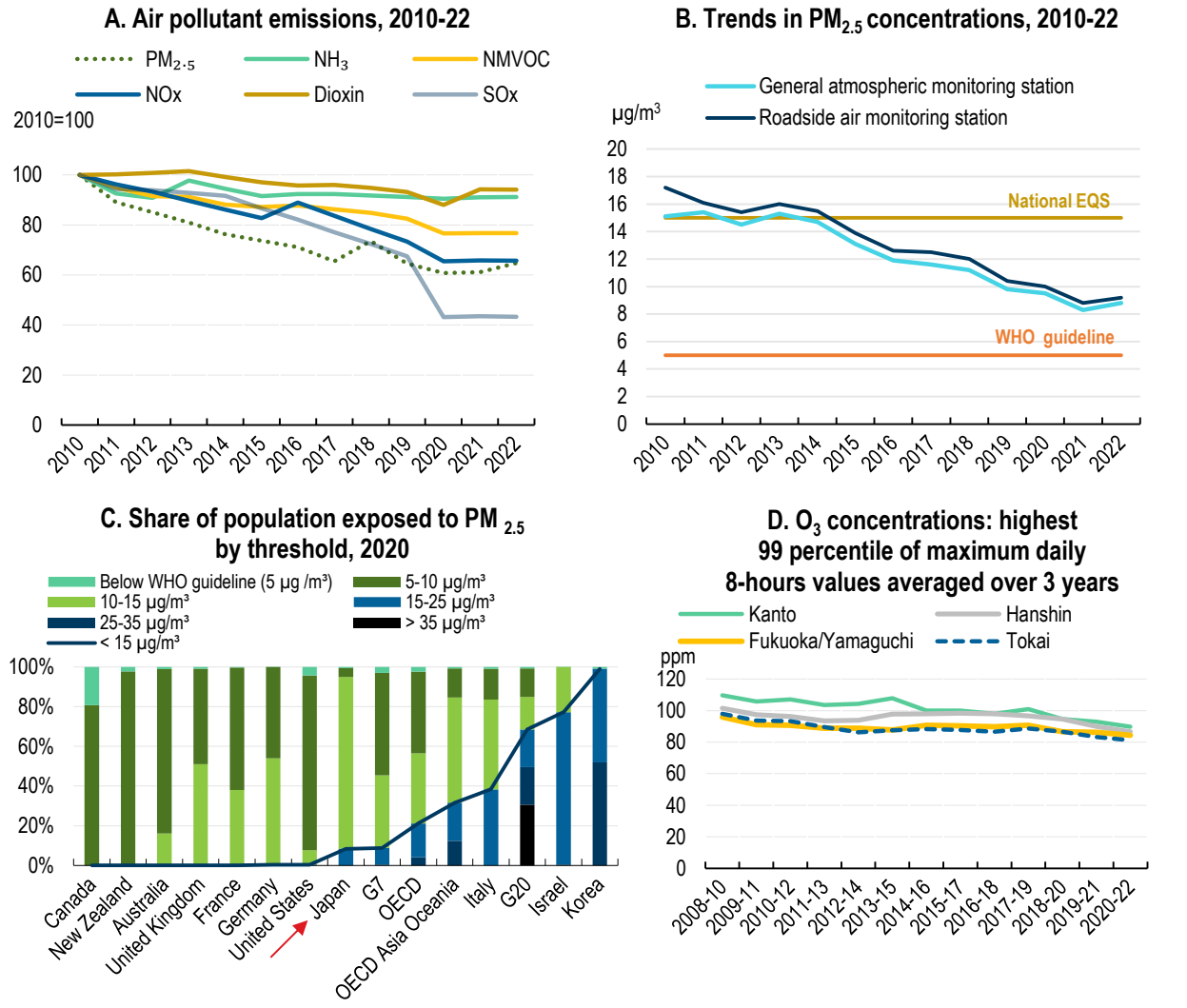
Air emissions declined, but air quality could improve further

Japan's climate mitigation and air pollution control policies have reinforced each other, exemplifying the potential for synergies. Regulations, industrial voluntary agreements and international market demands have driven technological improvements in electricity generation, manufacturing and vehicles. This has brought down emissions of both major air pollutants and GHGs in the last decade (Figure 1.8, panel A). Intensities of sulphur oxides and NOx decreased further and are among the lowest in the OECD (OECD, 2024[2]). The COVID-19 pandemic brought emissions down even more in 2020-21. Dioxin emissions, which mostly originate from widespread waste incineration, declined due to the incineration facility upgrade (MOE, 2024[8]).

Environmental quality standards (EQSs; Section 1.4.1) are set for several air pollutants: sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide, $PM_{2.5}$, suspended particular matters, photochemical oxidants (Ox), hazardous air pollutants (such as benzene and trichloroethylene) and chlorinated dioxins. In 2022, compliance was nearly 100% for major air pollutants except Ox, such as ground-level ozone. Measures such as emission standards for fixed sources and more stringent regulation for mobile sources in specific regions have helped reduce emissions of NOx and non-methane volatile organic compounds (NMVOCs) (Figure 1.8, panel A), which are precursors of ground-level ozone and other Ox (Botta and Yamasaki, 2020[34]). This has lowered the Ox concentration (Figure 1.8, panel D) and the number of acute episodes of high Ox levels[12] but not enough for them to meet the related EQS in most locations (MOE, 2024[35]). Efforts to reduce emissions of NOx and NMVOCs should continue complemented by other measures to tackle ozone formation such as addressing the heat island effect (i.e. higher temperature due to human activities and heat-absorbing built environment). These include nature-based solutions (NbS) like urban green spaces (Section 1.2.6).

$PM_{2.5}$ emissions and concentration decreased over the last decade (Figure 1.8, panels A and B). In 2022, Japan met the domestic $PM_{2.5}$ EQS (15μg/m^3) with almost 100% compliance rate. Indeed, the share of population exposed to $PM_{2.5}$ over 15μg/m^3 is lower in Japan compared to the OECD, G7 and OECD Asia-Oceania average. However, as in nearly all OECD countries, 99% of the population is exposed to levels of $PM_{2.5}$ above the World Health Organization (WHO) guideline (5μg/m^3) (Figure 1.8, panel C), which is stricter than the domestic EQS. PM-related mortality and its welfare impacts are higher in Japan than the average of OECD countries (OECD, 2024[2]).

Figure 1.8. Air emissions declined, while concentrations of $PM_{2.5}$ and photochemical oxidants remain a concern



Note: NH_3 = ammonia. NMVOC = Non-methane volatile organic compound. NOx = nitrogen oxides. $PM_{2.5}$ = fine particulates. SOx = sulphur oxides. O_3 = ozone. EQS = Environmental quality standard. Panel A: 2022 data include estimates. Panel C: Population exposure to $PM_{2.5}$ refers to annual mean concentration weighted by the population residing in the relevant area as reported in the *Global Burden of Disease* database. These data combine satellite-based estimates, ground-based measurements and chemical transport models, and differ from data reported in national sources.

Source: EC/JRC/PBL (2024), *Emission Database for Global Atmospheric Research* (EDGAR); MOE (2024), Air Quality Monitoring Portal; MOE (2024), White Paper on Environment, Circular Economy and Biodiversity; MOE-GIO (2024), National GHG Inventory Document of Japan 2024; OECD (2024), *OECD Environment Statistics* (database).

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Japan should consider updating its EQSs to take in the latest scientific findings and the WHO guideline to safeguard the health of its ageing and vulnerable population. Moreover, Japan should consider policies to further reduce $PM_{2.5}$ concentration by addressing both primary $PM_{2.5}$ emissions and secondary formation from precursor emissions. It should also better report official $PM_{2.5}$ emissions data, as currently available official data stop at 2018. Updating comprehensive emission inventories and improving atmospheric model simulation would provide better evidence for informed policy decisions to address both $PM_{2.5}$ and Ox. This

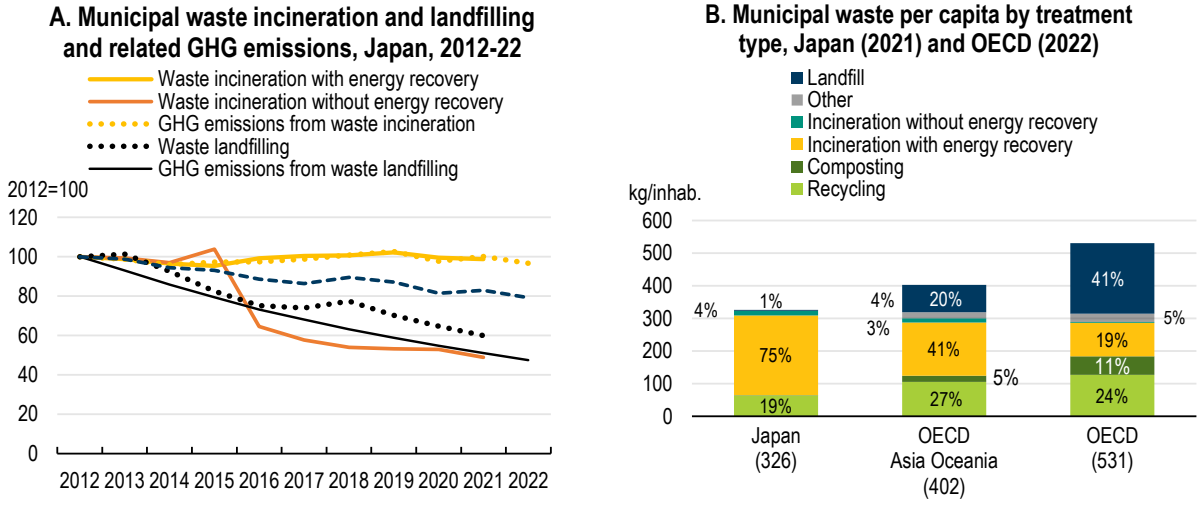
effort is a key component of Japan's "Photochemical Oxidant Countermeasures Working Plan", launched in 2022.

1.2.4. Progress towards a circular economy

Promoting circular use of resources can contribute to the net-zero transition

Promoting circularity provides an opportunity to reduce GHG emissions. The government estimated that 36% of Japan's GHG emissions (before electricity and heat allocation) come from sectors such as industry, freight transport and waste, where resource circulation can contribute (MOE, 2023[36]). Waste management (including landfilling and incineration) accounted for about 3% of GHG emissions in 2022. GHG emissions from landfilling have declined steadily in the last decade with the progressive shift from landfilling to incineration of municipal waste (Figure 1.9, panel A). GHG emissions from waste incineration with energy recovery (which are accounted for under energy-related emissions) hovered around the same level over 2012-22, remaining strongly coupled to the amount of incinerated waste. Total waste generation in Japan has remained stable. Industrial waste accounted for about 90% of total generation, while household waste and other municipal waste made up the remainder (Figure 1.10, panel A).

Figure 1.9. Municipal waste treatment relies on incineration with energy recovery



Note: Panel A: index based on amounts of municipal solid waste i) incinerated with; and ii) without energy recovery; and iii) landfilled, and associated GHG emissions, and total emissions from the waste sector. Panel B: total municipal waste generation per capita in brackets.
Source: MOE-GIO (2024), National GHG Inventory Document of Japan 2024; OECD (2023), *OECD Environment Statistics* (database).

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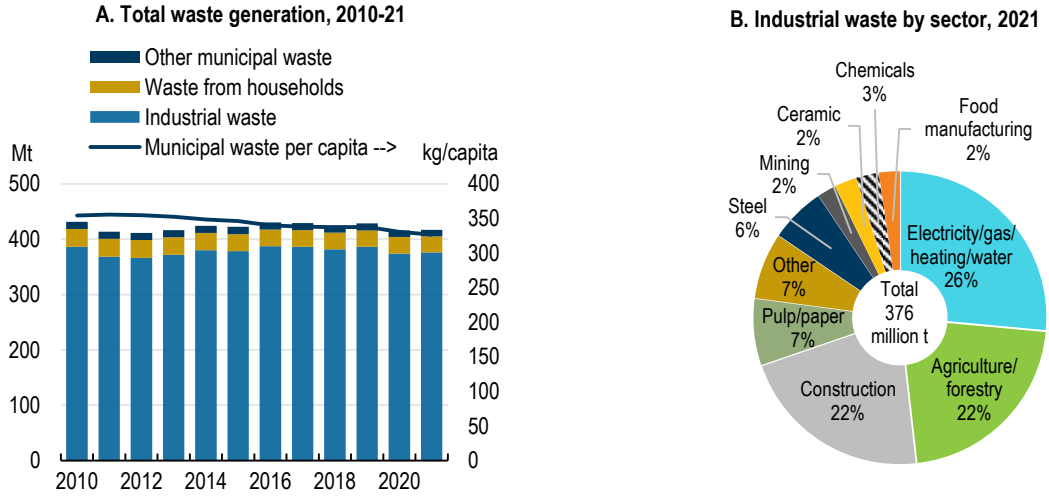
Japan has a longstanding and effective policy of promoting municipal waste prevention and sorting at source. This dates back to the 1970s and builds upon the country's *mottainai* culture (a simple lifestyle avoiding waste). As a result, municipal waste generation per capita is less than two-thirds of the OECD average (Figure 1.9, panel B). It has continued to decrease in the last decade, albeit moderately. As in other OECD countries, local governments are responsible for managing waste in their jurisdictions. They are required to develop local solid waste management plans and promote waste reduction, reuse and recycling, based on national guidelines.

Figure 1.10. Industrial waste dominates total waste, while per capita municipal waste decreased



Source: MOE (2024), Report on industry waste generation and treatment survey; OECD (2024), *OECD Environment Statistics* (database).

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Recycling of municipality waste should improve further. At about 20%, the rate of municipal waste recycled is lower than the averages of the OECD and Asia-Pacific OECD countries (Figure 1.9, panel B). In contrast, a higher share of industry waste is recycled (54%) in Japan. As a result, about 44% of the country's total waste is recycled (MOE, 2024[8]). The country slightly missed the 2020 targets of recycling rate (cyclical use rate) but shows a positive trend towards achieving 2025 and 2030 goals (Figure 1.11, panel C).

An increasing share of municipalities implement pay-as-you-throw waste charging systems. The government has provided guidance to municipalities on implementing unit-based (or pay-as-you-throw) waste charging systems to reduce municipal waste generation. In FY2022, 67% of municipalities had implemented unit-based charges for household waste, up from 61% in 2010, and 87% for commercial waste. Experience from other countries shows that pay-as-you-throw charging schemes and collection services can help reduce waste generation and encourage recycling (Brown, 2024[37]). Despite progress in charging for waste management services, cost recovery is still low: about 12% nationwide in FY2022.

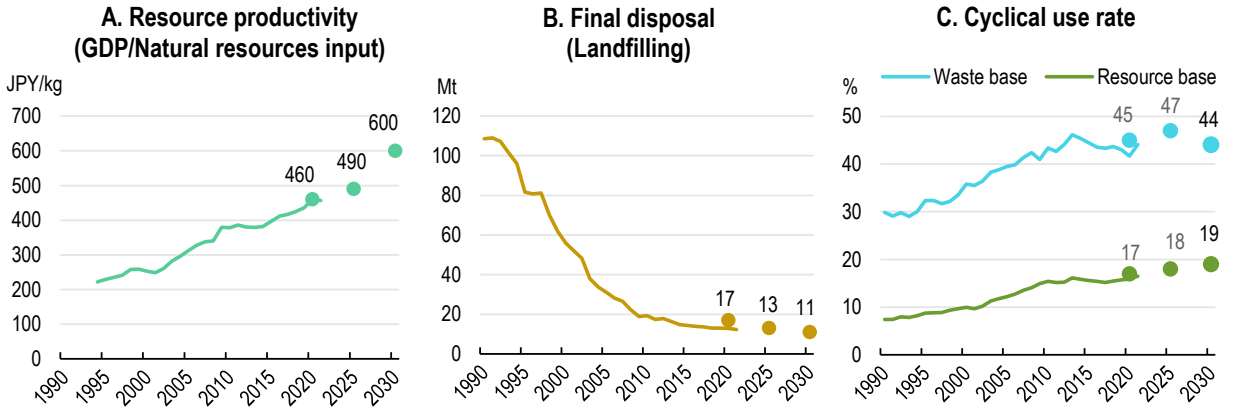
With limited land for landfilling, Japan has gradually turned to incineration for waste disposal. Today, landfilling is residual, while almost 80% of municipal waste is incinerated – the highest rate in the OECD (Figure 1.9, panel B). Nearly three-quarters of Japan's incineration facilities enable energy recovery (MOE, 2024[8]). In 2022, power generation from incineration plants was enough to meet the demand of 2.6 million households in Japan. This type of power generation can contribute to provide energy to local community, in line with the concept of Circulating and Ecological Economy (Chapter 2). Although average power generation efficiency of Japan's incineration plants has increased, the efficiency is still relatively low compared to other types of fuels (PWMI, 2023[38]). The country's heavy reliance on waste incineration can be an obstacle to improving circularity.

The country has taken some steps to promote circularity. The MOE provides guidance to business on principles of the circular economy. It formulated the Circular Economy Roadmap in 2022, which set the direction towards circular economy with the aim to achieve net-zero GHG emissions by 2050. The Roadmap aims for a market size of JPY 80 trillion (about USD 530 billion) or more for businesses related to circular economy by 2030 (from JPY 63 trillion in 2022). The GX Basic Policy (Section 1.3.1) foresees investments of JPY 2 trillion (about USD 13 billion) on circular economy over ten years. This would cover areas such as installing facilities to manufacture products that use less carbon and fewer materials, as well

as recycling facilities for plastics and metals. The government and Keidanren (Japan Business Federation) launched the Japan Partnership for Circular Economy in 2021 to enhance public-private collaboration.

Figure 1.11. Japan is on track to meet its circularity and waste disposal targets

Circularity trends (lines) and targets (dots) to 2020, 2025 and 2030



Note: Break in cyclical use rate data in 2016. Cyclical use rates are calculated by dividing the recycled amounts by i) recycled amounts plus the inputs of natural resources (resource base); or ii) the amounts of generated waste (waste base). The dots indicate the targets to 2020, 2025 and 2030 as established by the 3rd, 4th and 5th Fundamental Plan for Establishing a Sound Material-Cycle Society, respectively.
Source: MOE (2013), The 3rd Fundamental Plan for Establishing a Sound Material-Cycle Society; MOE (2018), The 4th Fundamental Plan for Establishing a Sound Material-Cycle Society; MOE (2024), The 5th Fundamental Plan for Establishing a Sound Material-Cycle Society.

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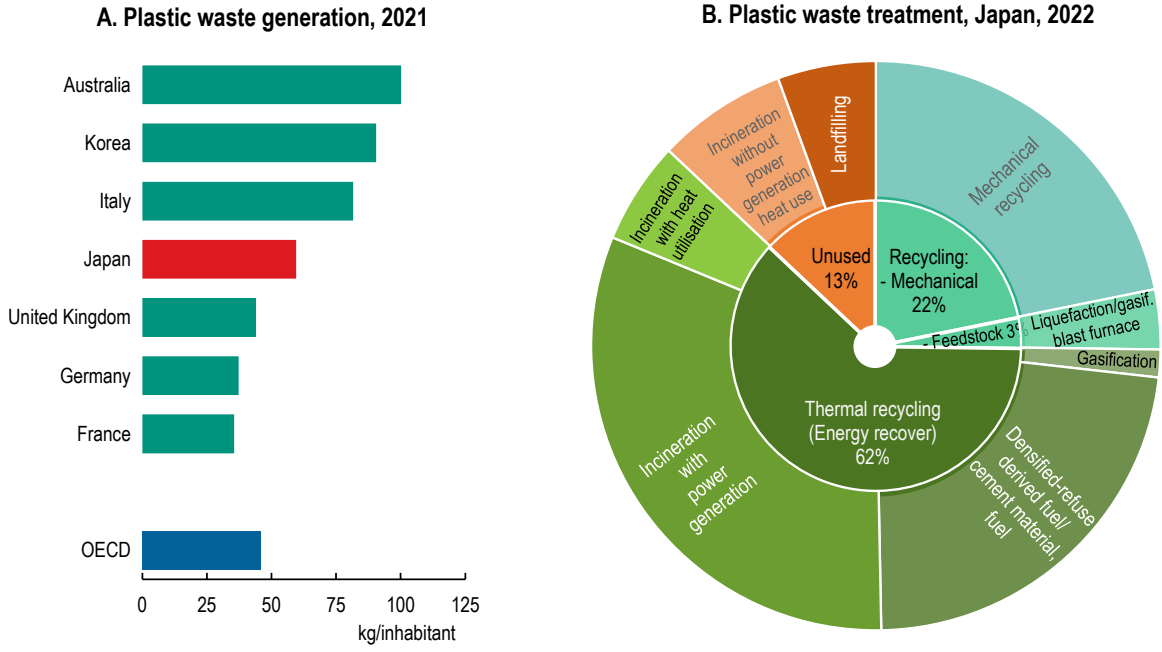
The legislation requires formulation and review of a Fundamental Plan for Establishing a Sound Material-Cycle Society approximately every five years. The Fifth Fundamental Plan, adopted in 2024, set several targets on waste management and circular economy to be achieved by 2030, including those set by the 2022 Roadmap. In a positive development, it also expanded the indicator set to be measured to include public awareness and contribution to net-zero objectives. The country is on track to meet the 2030 target for the resource cyclical use rate, while the waste cyclical use rate has been hovering around the target level in the last decade, which suggests reviewing these targets could be explored (Figure 1.11, panel C). In the European Union, municipal waste has a recycling target of 55% by 2025 and 60% by 2030 (European Environmental Agency, 2020[39]). These targets are more ambitious than those in Japan.

3Rs on plastics should be promoted further to curb their GHG emissions

Further promoting prevention and recycling of plastic waste, especially packaging, can help achieve climate mitigation goals in Japan. Prevention and recycling help curb GHG emissions from incineration and the carbon-intensive plastics production process. Japan has a large plastics industry, producing about 3% of global plastic materials and products (OECD, 2022[40]). Japan's plastic waste per capita is higher than the OECD average (Figure 1.12, panel A). Most plastic waste is used as fuel in incineration because of its high calorific value; only 25% is used as mechanical and feedstock recycling (Figure 1.12, panel B). While incineration with energy recovery is considered "used", it generates significant amounts of GHGs.

Figure 1.12. Plastic waste per capita exceeds the OECD average, with most used as fuel



Note: Panel A: Waste generation data are 2021 or latest available year; OECD average including 30 countries for which data are available.
Source: OECD (2024), Environment at a Glance Indicators; Plastic Waste Management Institute (2024), An Introduction to Plastic Recycling.

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Japan has introduced targets and policy measures to promote reducing, reusing and recycling (3Rs) of plastic waste (Box 1.4), including design guidelines for plastic products and certifications for recyclable or reusable products. The fee on single-use plastic bags, introduced in 2020, triggered a considerable response from consumers: by the following year, use of plastic bags had been halved from 2019 levels (MOE, 2022[41]). Measures in the 2022 Plastic Resource Circulation Act (Box 1.4) go in the right direction but Japan could strengthen these measures. For instance, an outright ban on single-use plastics and plastic bags as in the European Union can accelerate progress in reducing use. Producers of containers and packaging are required to pay recycling fees to recyclers based on the concept of extended producer responsibility. Japan could take this further by differentiating these fees based on product design, as seen in Korea. Implementing similar modulated extended producer responsibility fees could contribute to further increase the lifespan, recyclability and recycled content of plastic products. In Japan, certain regions implement deposit-refund schemes. Scaling up such programmes to national level can promote the collection of non-contaminated recyclable plastic waste.

Reducing plastics waste would also help address marine litter. The government hosted and endorsed the G20 Osaka Blue Ocean Vision in 2019 that aimed to reduce additional pollution by marine plastic litter to zero by 2050. This called for a comprehensive life cycle approach through improved waste management and innovative solutions.

Composting and better food logistics can reduce food loss and waste

Reducing food loss and waste[13] also contributes to reducing GHG emissions. In 2021, food loss and waste was estimated to account for nearly 6% of total waste generation and 25% of home municipal waste (MOE, 2024[8]). While 87% of food loss and waste from businesses is recycled (converted into animal feed and fertilisers), only 35% from restaurants and 8% from households is recycled. The composting rate of

municipal waste is significantly lower than that of other OECD countries (Figure 1.9, panel B). Japan should expand composting to manage organic waste and to harness synergies with net-zero and nature-positive objectives. Using organic compost fosters plant growth, sustains diverse animal populations and reduces reliance on synthetic fertilisers, which emit GHGs and pollute soil and water (Section 1.2.5).

Box 1.4. Strategy and legislation for plastic resource circulation

Japan's Resource Circulation Strategy for Plastics (2019) sets national targets for the 3Rs of plastics, while promoting investment in technology innovation for alternatives, such as bioplastics.

- Reduce: 25% total reduction of single-use plastics by 2030. To meet this target, a fee on single-use plastic bags was introduced in July 2020.
- Reuse, recycle: all plastic packaging must be either reusable or recyclable by 2025; 60% of plastic containers and packaging must be reused or recycled by 2030 (which is higher than the EU target of 55%); all plastic waste must be reused or recycled by 2035.
- Recycled materials, alternatives: double the use of recycled content in products by 2030; introduce approximately 2 Mt of bio-based plastics by 2030.

The 2022 Plastic Resource Circulation Act addresses the whole life cycle of plastics by promoting "3R+Renewable", including extended producer responsibilities. For instance, it sets criteria for retailers and service providers to reduce single-use plastics, and manufacturers and retailers to develop a plan to collect and recycle their used products. It also requires development of guidelines for manufacturers to design products to be recyclable or reusable and the establishment of a mechanism to certify that products meet the guidelines. Under the Act on Promoting Green Procurement (Section 1.5.1), the government will prefer certified products in its procurement as an incentive to manufacturers.

Source: (MOE, 2024[45]).

In 2022, nearly 20% of all food loss and waste was of edible food (MOE, 2024[42]). The amount of wasted food decreased by over 25% from 2012 and seems on track to meet the domestic target of 4 Mt by FY2030. In FY2022, Japan had already achieved the goal of halving business-related food waste by FY2030 from the FY2000 level (MAFF, 2024[43]). The government promotes best practices for both business and individuals (e.g. bringing leftovers home "mottECO"). However, direct waste of non-used foods from homes remained almost constant over FY2012/22, and waste from retailers (e.g. out of shape, refunded products, unsold products) dropped only in FY2022 (MOE, 2024[42]). Major convenience stores started initiatives such as raising accuracy of food demand prediction and giving discounts on food nearing its best-before date. However, food waste from convenience stores remains substantial. This is partly due to their specific accounting system that incentivises headquarters to push franchises to over-order food (Kimura, 2022[44]), on top of consumers' expectations for food freshness.

1.2.5. Towards a nature-positive economy

Japan's wide latitude and extended coastline results in a wide diversity of flora and rich marine biodiversity. Over two-thirds of the country's land is mountainous and covered in forests, leaving relatively little space for agriculture, settlements, facilities and infrastructure. Indeed, Japan is one of the most forested countries in the OECD, with forests covering 68% of the country's land area. About 12% of land is cropland, with permanent meadows and pastures accounting for less than 1% of total land area. Built-up areas are concentrated along the coastline and occupy 3.4% of Japan's land, one of the highest shares in the OECD (OECD, 2024[2]).

Despite considerable policy efforts, pressures on ecosystems and species persist

Japan has made some progress in conserving its biodiversity in the last decade. The rapid post-war economic development continues to drive ecosystem degradation today, but the rate of biodiversity loss has been slowing in some regions and ecosystems in the last two decades. Conversion of natural land to built-up areas has progressed and continues to exert pressures on biodiversity, although at a lower rate than in the past. Other direct drivers of biodiversity loss in recent years include farmland abandonment, invasive alien species and climate change (Working Group for Comprehensive Assessment of Biodiversity and Ecosystem Services, 2021[46]).

Conservation and breeding projects have helped restore the populations of some threatened species.[14] However, many known species are at risk of extinction (Figure 1.13, panel A). The Red List Index of threatened species is among the lowest in the OECD and has declined further since 2010 (Figure 1.13, panel C). The risk of extinction of species has increased particularly in freshwater ecosystems (Working Group for Comprehensive Assessment of Biodiversity and Ecosystem Services, 2021[46]). The MOE intends to develop and implement a conservation and breeding project plan to protect highly threatened species in collaboration with relevant stakeholders.

Fisheries resources are also under strain. Fishing capacity and catch volume have declined, but half of the assessed commercial fish stocks is in unfavourable biological condition (Figure 1.13, panel B). Fishing is important in Japan, with seafood central to its diet. The government has strengthened regulations for sustainable fisheries management. The 2020 amendment of the Fishery Act in 2020 expanded the use of catch limits based on maximum sustainable yield. Japan is one of only three countries engaging in commercial whaling.

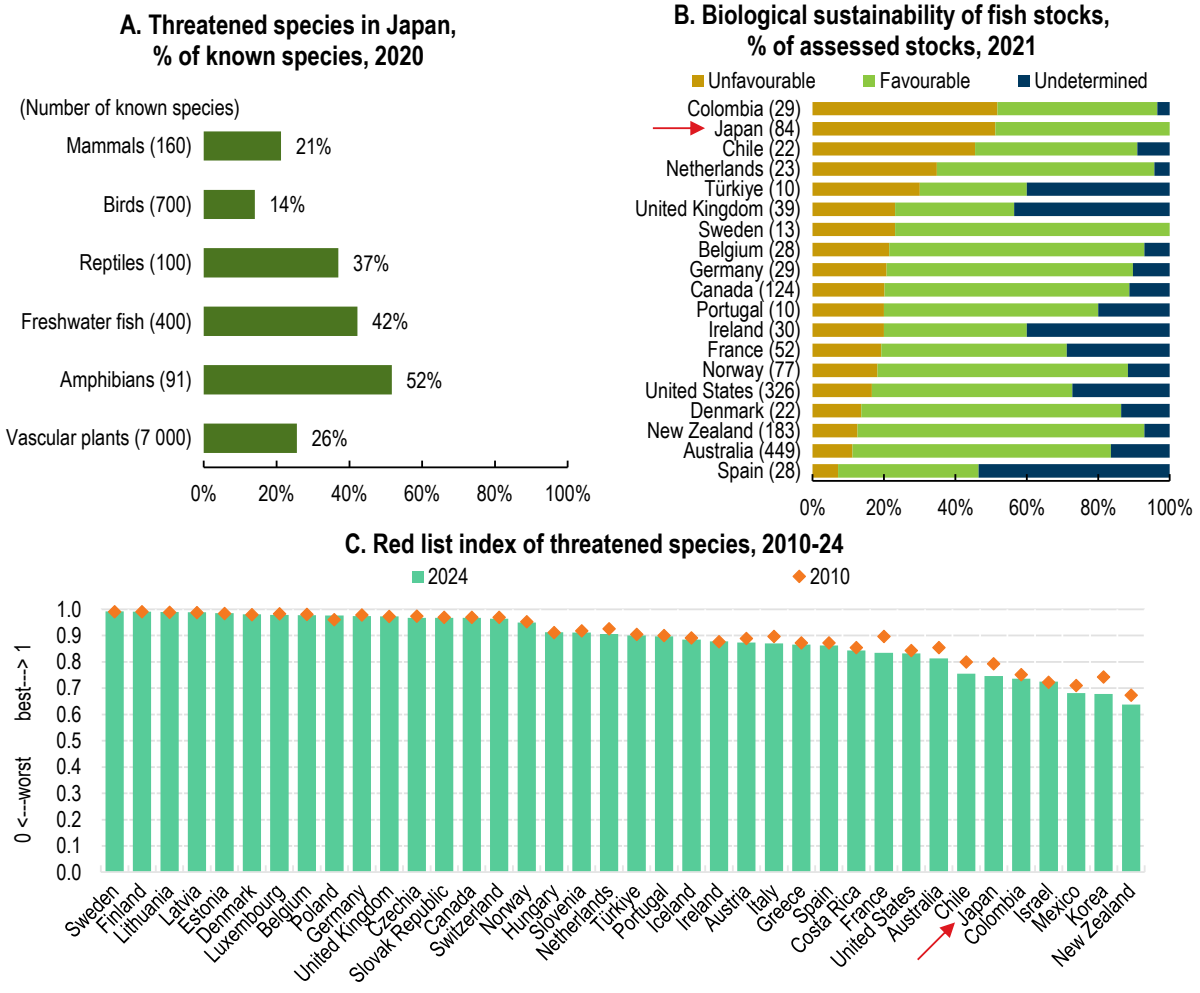
While forest, freshwater and urban ecosystem degradation has stabilised, the quality and extent of agricultural and coastal and marine ecosystems have continued to decline (Working Group for Comprehensive Assessment of Biodiversity and Ecosystem Services, 2021[46]). Agricultural ecosystems are central to Japan's biodiversity. The traditional and culturally significant *satochi-satoyama* rural mosaic landscape accounts for about 40% of Japan's total area but is threatened by farmers' ageing, farmland abandonment and conversion to other uses (OECD, 2023[47]). Over the last two decades, the government has actively promoted sustainable management initiatives from the private sector that contribute to biodiversity conservation in, and economic revitalisation of, *satoyama* landscapes.

The government has focused on supporting sustainable farming to reduce the potentially negative impact of agriculture on biodiversity, soil and water. With limited land available for farming, Japan's agriculture is intensive, with rice paddies occupying more than half of agricultural land. Water abstraction and intensity of use of chemical fertilisers and pesticides are high (FAO, 2024[48]). Some reports suggest a possible causal link between the use of some pesticides (notably systemic insecticides) and the reduction of dragonflies and other insects (Working Group for Comprehensive Assessment of Biodiversity and Ecosystem Services, 2021[46]). A negligible share of agricultural land is devoted to organic farming (OECD, 2024[2]). As in other countries, Japan's agricultural sector is also vulnerable to climate change. The MIDORI Strategy for Sustainable Food Systems is a promising initiative to improve the sustainability and productivity of Japan's agriculture (OECD, 2024[49]). It sets targets on agriculture's environmental performance (e.g. GHG emissions, organic farming, fertilisers). It also introduces farm certification and product labelling to encourage eco-friendly farming practices and consumption choices.

Nitrogen surplus is high in Japan due to a combination of high fertiliser use and livestock production on limited pastureland (OECD, 2024[49]). This has contributed to water and soil pollution, as well as eutrophication of lakes and enclosed coastal waters, although eutrophication has been declining over the past two decades (Working Group for Comprehensive Assessment of Biodiversity and Ecosystem Services, 2021[46]). While 88% of water bodies meet organic pollution standards, progress has stalled in the last decade. Organic pollution of lakes has worsened (Figure 1.14, panel A). Compliance with nitrogen

quality standards has improved, but still less than a quarter of lakes met nitrogen quality standards in 2022 (Figure 1.14, panel B). The third Japan Biodiversity Outlook recommended implementing regulations to prevent inappropriate use of chemical fertilisers and pesticides, while promoting technical innovation and investment to tackle chemical pollution and eutrophication. Regulatory measures and public investment in wastewater treatment aim to reduce water pollution. The government provides subsidies for advanced decentralised wastewater treatment systems (*johkasou*) in sparsely populated rural areas, which cover 9% of the population. As of 2023, 81% of the population had access to public wastewater treatment, mostly secondary treatment without nutrient removal (MOE, 2024[8]; OECD, 2024[2]).

Figure 1.13. A large proportion of species are under threat



Note: Threatened species are those at greatest risk of extinction, including "endangered", "critically endangered" and "vulnerable" species. Panel A: Freshwater fish include brackish species. Panel B: Number of fish stock assessed in brackets. Panel C: The Red List Index measures the extinction risk across groups of species based on the IUCN Red List of threatened species. The index varies from 1, if all species qualify as "Least Concern" (i.e. not expected to become extinct in the near future), to 0, if all species are categorised as "Extinct".
Source: OECD (2024), *OECD Environment Statistics* (database); UN (2024) *SDG Global Database*.

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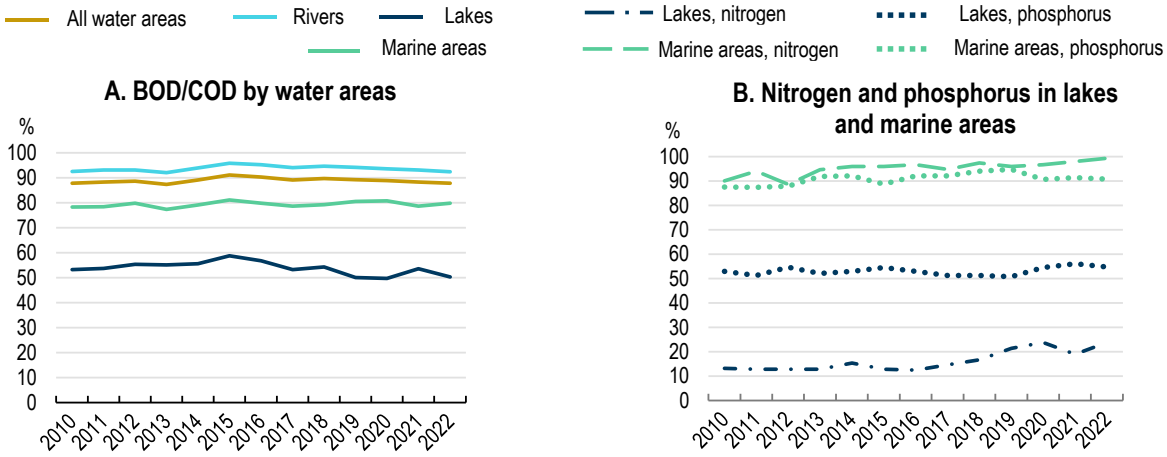
Figure 1.14. Water quality has generally improved but remains a concern for lakes

Conformity to water environmental quality standards by water areas, achievement rates, 2010-22



Notes: Panel A: BOD = biochemical oxygen demand (amount of dissolved oxygen consumed by biological organisms when they decompose organic matter in water). COD = chemical oxygen demand (amount of oxygen consumed when the water sample is chemically oxidised). BOD for rivers, COD for lakes and marine areas.
Source: MOE (2024), Results of water quality measurements in public waters for FY2022 (in Japanese).

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The biodiversity policy framework emphasises the transition to a nature-positive economy

Japan has strengthened its biodiversity policy framework and the measures to halt and reverse biodiversity loss. It has continued to provide financial assistance for biodiversity conservation in developing countries, including through the Japan Biodiversity Fund. Japan revised its National Biodiversity Strategy and Action Plan 2023-2030 (NBSAP) to reflect the findings of the third Japan Biodiversity Outlook and outline the roadmap to achieve the 30by30 target of the Kunming-Montreal Global Biodiversity Framework (GBF). In line with Japan Biodiversity Outlook, the NBSAP calls for a transformative approach to restoring the country's biodiversity. In addition to reinforcing biodiversity conservation and management measures, the NBSAP emphasises NbS (Section 1.2.6) and nature-positive economies that harness synergies between biodiversity conservation and economic opportunities, including at local level. The local biodiversity strategies and action plans (LBSAPs) should take these elements into account. All prefectures have adopted their LBSAPs, but only about 10% of municipalities have done so (Chapter 2).

Japan has increasingly engaged the business community in biodiversity conservation and in mainstreaming biodiversity into economic activities. The 2024 inter-ministerial Transition Strategies toward Nature-Positive Economy encourage companies to reduce environmental impacts and contribute to nature conservation throughout their value chain. The MOE estimated the transition to a nature-positive economy would create JPY 47 trillion in new business opportunities annually by 2030 (MOE et al., 2024[50]).

Japanese companies and financial institutions have shown increasing interests in biodiversity. The MOE supports the nature-related information disclosure in line with recommendations of the Taskforce on Nature-related Financial Disclosures (TNFD). It developed a guideline for the private sector to participate in biodiversity initiatives in 2023, which includes how to set quantified biodiversity-related targets. By October 2024, 133 Japanese institutions had adopted the TNFD recommendations, the world's highest

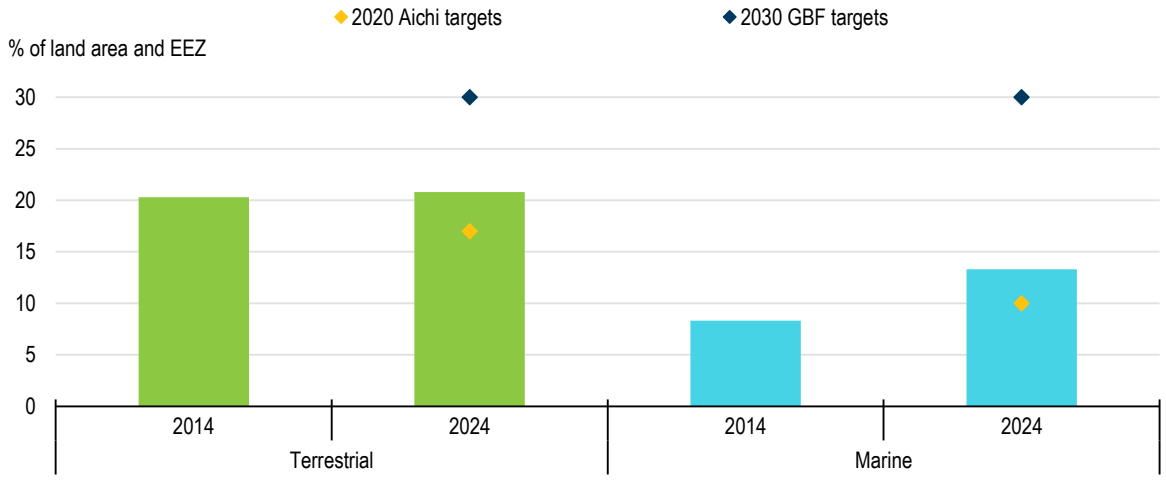
number. Keidanren also promotes biodiversity considerations within industry through its Nature Conservation Council.

Japan met the 2020 Aichi targets but must expand conservation areas for 2030

Japan met the 2020 Aichi targets for protected areas but needs to expand conservation areas to reach the 2030 target under the GBF (Figure 1.15). In 2024, 20.6% of the country's land was designated as protected in various forms, a rate that has changed only marginally in the last decade. In addition, about 0.1% of total land was under Other Effective area-based Conservation Measures (OECMs). Marine protected areas have expanded considerably with the establishment of a large offshore seabed nature conservation area, reaching 13.3% of Japan's territorial waters and exclusive economic zone.

Figure 1.15. Japan has expanded its protected areas in line with the 2020 targets

Share of terrestrial and marine protected areas and OECMs, Japan, 2014 and 2024



Note: nationally designated protected areas, excluding overlapping areas (20.6% of total land in 2024), and Other Effective area-based Conservation Measure (OECMs, about 0.1% of total land in 2024). EEZ = exclusive economic zone. GBF = Kunming-Montreal Global Biodiversity Framework.
Source: Country submission; MOE (2024), Annual Report on the Environment, the Sound Material-Cycle Society and Biodiversity in Japan.

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Protected areas have been moderately effective in preventing pressures on biodiversity, depending on strictness and location of the area (Shiono, Kubota and Kusumoto, 2021[51]). They have contributed to reducing the extinction risk of some rare species (Working Group for Comprehensive Assessment of Biodiversity and Ecosystem Services, 2021[46]). Protected areas in the strictest conservation categories have successfully limited land conversion to built-up areas. These are mostly located in remote, scenic regions, which generally face lower development pressures. However, nearly half of all protected areas fall under less strict categories, which have been less effective in preventing land conversion (Shiono, Kubota and Kusumoto, 2021[51]).

Further efforts are needed to strengthen the governance and management effectiveness of protected areas. Estimates indicate that human resources per national park are below international standards (Tanaka and Takashina, 2023[52]). Management effectiveness has only been evaluated for four national parks on a trial basis (CBD and UNDP, n.d.[53]). No assessment is reported in the global database of Protected Area Management Effectiveness (PAME) evaluations (UNEP-WCMC and IUCN, 2024[54]).[15]

To achieve the 30by30 target (protecting at least 30% of both terrestrial and marine areas by 2030), the government plans to expand officially protected areas and adopt OECMs in areas of high biodiversity value. The MOE has identified 14 potential terrestrial sites for new designation of national and quasi-national parks. The government also aims to double the area of Marine Special Zone by 2030. In expanding protected areas and OECMs, Japan should consider improving the ecological significance of protected areas. In 2023, protected areas covered about two-thirds of the country's terrestrial and marine key biodiversity areas (defined as sites that make significant contributions to the global persistence of biodiversity) (UNSD, 2024[55]). Privately managed lands used for agriculture or forestry and around/within urban areas are under more pressure. Modelling suggests that establishing OECMs in these areas to complement officially protected areas is effective at reducing pressures on biodiversity and increase connectivity among areas of high ecological value (Shiono, Kubota and Kusumoto, 2021[51]).

To facilitate identification of OECMs, the MOE established a scheme to certify areas hosting community or private biodiversity conservation initiatives. These sites include *satochi-satoyama* rural landscapes, forests, and urban and coastal areas. Some of these areas face higher risks of degradation but are challenging to designate as protected areas due to their significant economic and social value. The government spearheaded the 30by30 Alliance for Biodiversity – a network of citizens, local governments, business and non-business stakeholders – to encourage the certification. As of October 2024, 253 sites had been certified as Nationally Certified Sustainably Managed Natural Sites. These sites can qualify for registration as OECMs if outside officially protected areas. As of December 2024, Japan had registered 159 sites in the international OECM database (UNEP-WCMC and IUCN, 2024[56]).

Expanding the areas under conservation will require effective governance and management to address intricate land ownership patterns, overlapping laws and limited administrative resources. It will also call for appropriate incentives for engaging the private sector (Tanaka and Takashina, 2023[52]). With this aim, since September 2024, Japan has been piloting a scheme that issues certificates to individuals or entities supporting OECMs. These certificates can be leveraged for TNFD purposes and enhancing investor relations. Likewise, programmes of payments for ecosystem services (PES) can encourage local communities or private entities to undertake actions that maintain or improve ecosystem services in OECM sites and provide financial resources to support OECM implementation (Sharma et al., 2023[57]). A few PES programmes are implemented at subnational level.

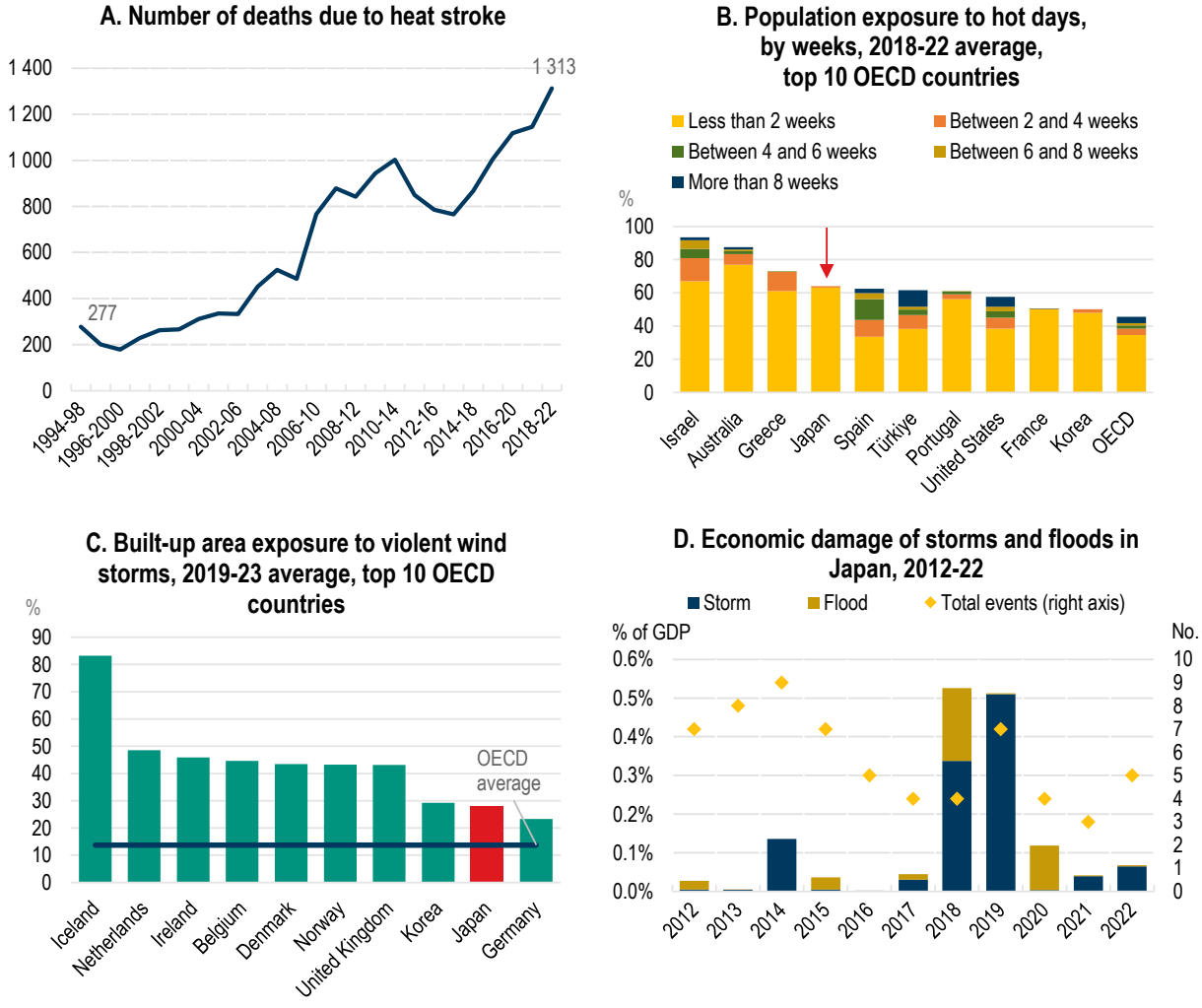
1.2.6. Enhancing resilience to the impact of a changing climate

Exposure to climate-related hazards is expected to intensify

More extreme and variable climatic conditions intensify Japan's exposure to weather-related hazards such as tropical cyclones, storm surges and floods. While population exposure to river and coastal flooding is lower than in many other countries, 28% of Japan's built-up area is exposed to violent windstorms – among the highest shares in the OECD (Figure 1.16, panel C). There have been several such events in the last decade (Figure 1.16, panel D). According to government estimates, extreme weather events caused 1 402 fatalities between 2000 and 2023. In the same period, losses and damages were estimated at USD 150.8 billion (at 2024 prices) (0.12% of cumulative GDP over the period) (CRED, 2024[58]).

Beyond their impact on human lives and high costs, extreme weather events pose a severe risk to Japan's energy supply reliability, as the country lacks electricity connection with neighbouring countries that could provide support during shortages. Japan has managed the impact of climate-related disasters on the energy system effectively through established natural disaster risk management strategies (IEA, 2022[59]). The overall temperature increase has reduced winter heating needs but boosted cooling in the summer. Summer peak electricity demand may increase further, except in the northern island of Hokkaido. Diversifying the power mix, strengthening incentives for energy savings and upgrading grids are, therefore, important to reach both mitigation and adaptation goals (Section 1.2.2).

Figure 1.16. Japan is significantly exposed to climate-related hazards



Note: Panel A: five-year moving average.
Source: CRED (2024), *EM-DAT* (database), www.emdat.be; MOE (2024), White Paper on the Environment, Recycling-Oriented Society, and Biodiversity; OECD (2024), Climate Action Dashboard.

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Japan has stepped up efforts to prevent the health impacts of extreme heat

Hotter temperatures will expose more people to periods of extreme heat, with considerable health impacts. The annual average temperature is 0.98°C higher than in the baseline period of 1981-2010 (OECD, 2024[60]) and is set to rise further (World Bank, 2023[61]). Over 60% of the country's population is exposed to hot summer days with temperatures above 35°C, some of the highest exposure levels in the OECD (Figure 1.16, panel B). The health impact has been evident, with growing numbers of heat-related illnesses and fatalities, especially among the elderly. Heatstroke fatalities have dramatically increased, exceeding 1 000 per year since the mid-2010s (Figure 1.16, panel A).

In 2023, to strengthen the prevention framework and ensure stronger government co-operation, Japan amended its Climate Change Adaptation Act to require adoption of the Heat Illness Prevention Action Plan by cabinet decision, thereby ensuring stronger government co-operation on the matter. The plan was

approved the same year, setting the target of halving the number of annual fatalities due to heat illness by 2030. The amendment also mandates local authorities to issue special heatstroke alerts and allows for the opening of designated heat shelters during such alerts (MOE, 2024[8]).

The increase in temperature has been more pronounced in urban areas than in rural ones. For example, Tokyo's average temperature has risen twice as quickly as that of rural areas (IEA, 2022[59]). Stricter energy performance standards for new buildings and ongoing investments in improving the energy efficiency and earthquake resistance of buildings can simultaneously bolster their capacity to withstand extreme heat (Section 1.5.3). These efforts should be part of urban neighbourhood regeneration plans that include green spaces, renewables-powered community cool spaces and access to sustainable transport modes. For example, regulations in the Tokyo Metropolitan Area require new developments to incorporate green spaces, such as rooftop gardens and vertical vegetation (OECD, 2023[62]). Urban green spaces lower the urban heat island effect. This helps reduce energy demand for cooling and related GHG emissions. Furthermore, urban green spaces contribute to carbon sequestration and increase water absorption capacity, thereby mitigating the risk of urban flooding (OECD, 2021[63]).

Japan's solid framework for climate adaptation has increasingly integrated nature-based solutions

Japan has strong capacity to cope with extreme weather-related disasters and a well-developed framework for climate change adaptation (IMF, 2022[64]). It played a key role in steering the development of the Sendai Framework for Disaster Risk Reduction 2015-2030 and has shared knowledge and technology for mitigating climate-related risks with developing economies (IMF, 2022[64]).

As a country that has long dealt with natural disasters, including earthquakes and typhoons, Japan has significant expertise in disaster risk management and resilience building. It has an advanced, satellite-based early warning system (J-Alert), which facilitates timely evacuations and resource mobilisation. Japan prioritises preventive maintenance to enhance infrastructure resilience to climate impacts. This approach allows to reduce maintenance costs compared to reactive methods and enhance the quality and resilience of infrastructure (OECD, 2024[65]). Insurance coverage is more developed than in many other countries, with about 45% of damages due to weather-related events insured in 2000-23 (CRED, 2024[58]). This helps alleviate the financial burden on the public budget for disaster relief and reconstruction. Two government-subsidised insurance programmes are available to help farmers mitigate climate risks (OECD, 2023[47]).

By adopting the Climate Change Adaptation Act in 2018, Japan established a legal foundation for adaptation. The Act mandates the formulation of the Climate Change Adaptation Plan, requires the development of information systems and promotes subnational adaptation initiatives. A comprehensive assessment of climate change impacts is expected to be conducted about every five years. The 2021 revision of the adaptation plan includes actions to mainstream adaptation into relevant policies. It also identifies key performance indicators for adaptation measures and introduces a system for monitoring progress, in line with best international practice (OECD, 2024[66]).

Japan has historically used "natural infrastructure" to limit damage from erosion, floods and natural hazards while conserving ecosystems. However, NbS have gained renewed traction in the context of disaster risk reduction after the 2011 earthquake (SIP, 2022[67]). The adaptation plan and the NBSAP 2023-2030 highlight the contribution of NbS to enhancing climate resilience and halting and reversing biodiversity loss, but also to mitigating GHG emissions and promoting sustainable local development. Various NbS initiatives are aimed at increasing carbon removal capacity of soil, forests and coastal ecosystems to help Japan achieve its emission reduction targets (Section 1.2.1).[16] Such initiatives include sustainable forest management and conservation, enhancing urban green spaces, supporting agricultural practices that increase soil carbon storage and researching blue carbon ecosystems (MOE, 2024[8]).[17]

Ecosystem-based Disaster Risk Reduction (Eco-DRR), which aims at managing disaster risks by harnessing the disaster mitigation functions of healthy ecosystems, has been increasingly incorporated into national policies (SIP, 2022[67]). The national and local governments have gradually developed Eco-DRR projects for coastal system restoration, flood management and reforestation in the six prefectures affected by the 2011 earthquake (Nakamura, 2022[68]). For example, extending the coastal forest within the Sanriku Fukko Reconstruction National Park protects against tsunamis, while revitalising the regional economy. This initiative is projected to save more than JPY 2.5 billion compared to raising high sea walls (IUCN, 2017[69]). The government supports local governments in integrating NbS into their adaptation plans and biodiversity strategies, offering resources like the "Potential Map of Ecosystem Conservation/Restoration" to identify suitable areas for Eco-DRR and the Green Infrastructure Public-Private Partnership Platform to share information and raise awareness.[18] These efforts are welcome and should be continued to foster wider adoption and integration of NbS.

Promoting adaptation efforts by local governments and the private sector should continue

As in all countries, local authorities in Japan play a crucial role in building climate resilience through their responsibility for territorial development (OECD, 2023[62]). Japan's national adaptation legislation encourages local governments to formulate their local plans and set up adaptation centres to collect and share local climate risk data and adaptation information. As of July 2024, all 47 prefectures had formulated Local Climate Change Adaptation Plans, while only 303 municipalities (or 17.6% of municipalities) had done so. Meanwhile, 66 local governments had established Local Climate Change Adaptation Centers (NIES, 2024[70]). These centres serve as the primary source of information for developing local adaptation plans and designing effective adaptation measures.

As in many countries, many local governments, especially smaller municipalities, lack the technical and financial capacity to develop adaptation plans and invest in climate resilience (OECD, 2023[62]). To address these challenges, the MOE provides guidance to municipalities. However, as in many other countries, local authorities may have insufficient incentives to make proactive resilience investments. This is because the national government steps in to finance most post-disaster recovery costs. Delegating specific adaptation responsibilities to local governments, along with enhancing their revenue-raising capacity, could help mobilise local resources for adaptation actions (OECD, 2023[62]).

Japan has developed several initiatives to share information about climate-related hazards and adaptation measures with local governments, the business community and civil society. These include the Climate Change Adaptation Information Platform (A-PLAT), established in 2016. The platform provides forecasts on climate change impacts, as well as adaptation plans, case studies and guidelines. In 2022, the MOE revised its guidelines on climate adaptation for businesses, introducing the approach of the Task Force on Climate-related Financial Disclosures to managing physical risks. The Climate Change Risk Industry-Government-Academia Collaboration Network, established in 2021, fosters collaboration to enhance use of climate risk data (MOE, 2024[8]). All these initiatives are welcome, as sharing information among all policy-making levels is key to scale up preventive adaptation action at the local level (OECD, 2023[62]).

1.3. Improving environmental governance for policy coherence

1.3.1. Enhancing the environmental policy and institutional frameworks

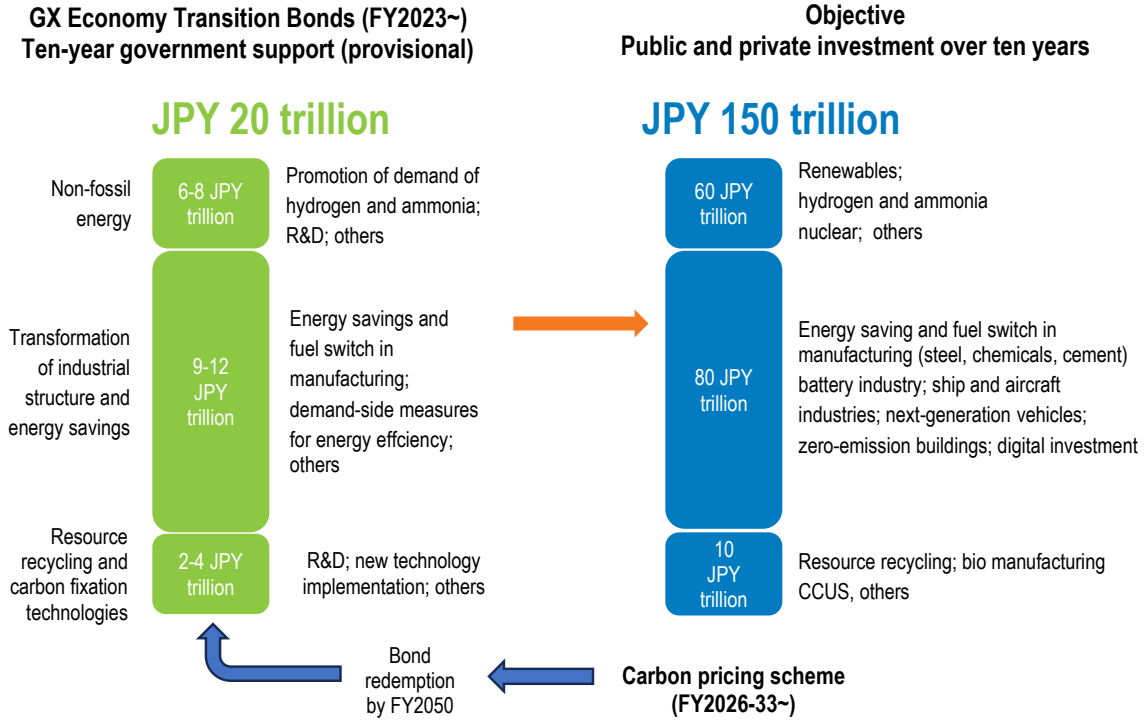
Japan has a comprehensive strategic framework for the green transformation

As in other policy areas, Japan's approach to environmental policy planning is based on Basic Environment Plans (BEPs) developed every six years. The BEP is a multi-annual framework that outlines the long-term

objective and measures of Japan's environmental policy. The MOE and the Central Environmental Council – an advisory body to the MOE (see below) – assess implementation of the BEP. Prefectures often develop multi-year environment plans as well. The Sixth BEP approved in 2024 builds on the Fifth BEP's "Circular and Ecological Economy" concept, which aimed for self-sustaining regional societies to address environmental, economic and social challenges holistically. The Sixth BEP focuses on improving citizens' well-being and quality of life and emphasises synergies across net-zero, circular and nature-positive objectives, including through regional development. Numerous other plans address each environmental policy area, as well as sectors related to the environment, such as energy, transport and agriculture.

The 2023 GX Basic Policy, along with its related legislation, strategies and plans, brought welcome and important novelties to Japan's environmental and climate policy frameworks. It jointly pursues decarbonisation, energy security and economic competitiveness. As such, it has become the cornerstone of Japan's climate mitigation policy (Box 1.5). The GX Basic Policy aims to leverage public and private investment for the net-zero, clean energy and circular transition for JPY 150 trillion (about USD 980 billion) over ten years (Figure 1.17). To achieve this goal, it merges Japan's traditional policy approach based on close collaboration with industry and strong government support for investment and R&D, alongside new instruments such as sovereign transition bonds and carbon pricing.

Figure 1.17. A mix of government support, transition finance and carbon pricing will drive green investment



Source: Adapted from METI (2023), Realising and Implementing Pro-Growth Carbon Pricing Initiative Related to the Draft of Basic Policy for Realising GX.

While commendable, the GX could be more effective with a synergistic vision of the country's transformation towards net zero, and circular and nature-positive economic and social systems. The government aims to develop a GX2040 vision as a more concrete long-term strategy that provides clarity for investors. The GX2040 provides scope for better integrating into the GX vision underrepresented

aspects. These include policy measures to encourage sustainable consumption choices, incentives to engage in nature-positive activities, and mechanisms to engage local communities in the green transformation and share its benefits.

Box 1.5. Japan's Green Transformation (GX) Policy

The Basic Policy for the Realization of the Green Transformation ("GX Basic Policy"), approved in February 2023, outlines a ten-year roadmap towards realisation of GX. It aims to achieve decarbonisation with an investment plan for 22 industrial sectors, while ensuring stable energy supply and economic growth. The GX Basic Policy emphasises energy security based on further energy savings and decarbonising power generation through renewables, nuclear power and emerging technology such as hydrogen, ammonia and carbon capture (Section 1.2.2). A core element of the GX Basic Policy is Pro-Growth Carbon Pricing, which comprises three main components.

First: financial assistance to business investments in expanding non-fossil fuel energy sources and R&D in innovative green technologies for JPY 20 trillion (about USD 130 billion) over ten years (Figure 1.17). This investment support is equivalent to 3.4% of Japan's GDP in 2023. For comparison, this investment size is larger than the US Inflation Reduction Act in 2022 (1.5% of 2022 GDP, over USD 369 billion for ten years), and smaller than the European Green Deal Investment Plan in 2020 (6.5% of the European Union's 2020 GDP, EUR 1 trillion for ten years).

Second: raising finance to support business investment through GX Economy Transition Bonds, whose complete redemption is intended for FY2050. Japan will issue bonds for JPY 20 trillion over FY2023-32. The government developed the framework for Japan Climate Transition Bonds, the world's first government-labelled transition bonds, as part of the GX Economy Transition Bonds. It then issued the first two bond offerings equivalent to JPY 1.6 trillion (about USD 11 billion) in February 2024. Proceeds will be allocated to the projects described in the framework. In line with the GX Promotion Strategy, these projects are broadly classified into six categories and should aim to reduce emissions and enhance industrial competitiveness.[19] Priority will be given to investment projects that can leverage additional private sector finance.

Third: the introduction of carbon pricing instruments, including a GX surcharge (fossil fuel levy) from FY2028 and a mandatory emissions trading system (ETS) gradually phased in between FY2026 and FY2033 (Section 1.4.3). Revenue from carbon pricing will be used to repay the bonds (Figure 1.17).

The GX Basic Policy also foresees implementation of new financing methods to support companies promoted through international rule making, as well as support for global and regional decarbonisation plans. The inter-ministerial GX Implementation Council oversees implementation of the GX Basic Policy and provides strategic guidance. The GX Acceleration Agency, established in April 2024, provides financial support to companies' GX investments through direct financing and loan guarantees. It will operate the ETS and collect the GX surcharge proceeds.

Source: Cabinet Secretariat et al. (2023[71]); METI (2023[72]); IEA (2024[73]).

Better co-ordination is needed to enhance policy coherence

Like many OECD countries, Japan has a line ministry responsible for environmental policy (the MOE), alongside other ministries and agencies responsible for sectoral policies with significant environmental dimensions. These include the Ministry of Agriculture, Forestry and Fisheries (MAFF); the Ministry of Land, Infrastructure, Transport and Tourism (MLIT); and the Ministry of Economy, Trade and Industry (METI). The Central Environment Council (CEC), composed of non-governmental experts, is the major advisory

body to the MOE for environmental policies, including on climate. Still, the CEC is positioned within the MOE, which selects members. Establishing an independent body providing science-based advice to the whole government could help enhance coherence and better address synergies across environmental, social and economic objectives and policies. Some European countries have set up such independent advisory bodies for climate policies (Box 1.6).

Box 1.6. Examples of independent advisory bodies for climate policies

United Kingdom: Climate Change Committee (CCC)

The CCC is an independent, statutory body established under the Climate Change Act 2008. It advises the United Kingdom and devolved governments on emission targets and reports to Parliament on progress in reducing GHG emissions and preparing for, and adapting to, the impacts of climate change. The government must consult the CCC before amending the country's long-term targets.

France: High Council on Climate (HCC)

Established in 2018, the HCC comprises independent experts in the fields of climate science, economics, agronomy and energy transition. The HCC submits an annual report on France's adherence to its GHG emissions reduction trajectory and on the effective delivery of measures and policies to reduce GHG emissions and develop carbon sinks.

Germany: The Council of Experts on Climate Change

The Council of Experts on Climate Change has a statutory mandate based on the 2019 Federal Climate Change Act. The Council reviews the annual GHG emissions data and submits an evaluation to the federal government and the German Bundestag. Every two years, it submits an expert report to the German Bundestag and the federal government on GHG emission trends and the effectiveness of measures towards the targets. The federal government shall seek the opinion of the Council before updating the Climate Action Plan.

Source: Evans and Duwe (2021[74]); OECD (2023[10]); OECD (2022[11]).

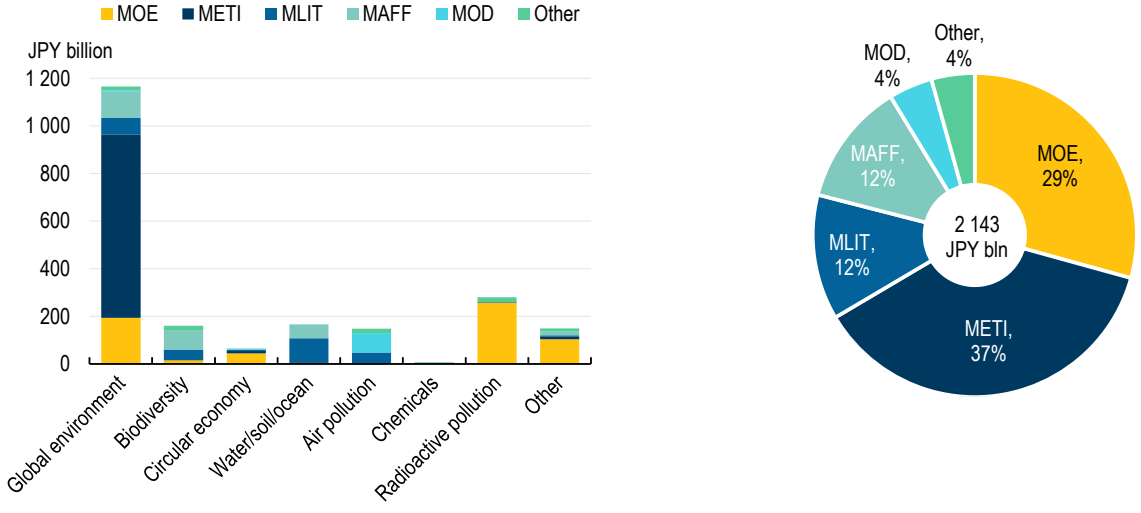
Japan has continued to strengthen inter-institutional co-operation in environment-related matters. It has established several inter-ministerial bodies to promote a whole-of-government approach to policy making. These include the Sustainable Development Goals (SDGs) Promotion Headquarters, the Global Warming Prevention Headquarters and the GX Implementation Council. Despite progress, however, a "silos" administrative culture and practice (*tatewari gyōsei*) tend to persist. Different government ministries and agencies operate with a high degree of independence and limited co-ordination (Aoki, 2023[75]). Many countries face similar institutional challenges, which can hinder comprehensive policy making and lead to inefficiency in tackling multifaceted environmental and socio-economic problems. Some countries have established government secretariats directly attached to the Prime Minister to co-ordinate development of national strategies for climate, energy, biodiversity and the circular economy, such as France's General Secretariat for Ecological Planning.

In Japan, as in most countries, the environment-related budget is dispersed across multiple ministries. This may lead to policy misalignment in the absence of appropriate co-ordination mechanisms. The FY2024 preliminary budget for environment-related policies doubled compared to the previous year, reaching about 2% of the total government budget. This mostly reflects allocations to the METI for implementation of the GX Basic Policy. As a result, in FY2024, the METI received more than one-third of the environment-related budget, mostly for "global environment matters", which include climate change (Figure 1.18). The MOE

was allocated the second largest share (mostly for radioactive pollution, global environment and circular economy), followed by the MLIT (mainly for water, soil, ocean) and the MAFF (which handles half of the biodiversity budget). However, the initial budget allocations provide only a partial view of environment-related outlays, as Japan's government often approves supplementary budgets during the fiscal year. This lowers the consistency of annual budgets and the reliability and transparency of fiscal projections and targets (OECD, 2024[6]).

Figure 1.18. The environment-related budget is spread across ministries

Environment-related budget allocations by objective and ministry, FY2024



Note: Provisional budget data, fiscal year 2024. Percentages may not add to 100% due to rounding. MAFF = Ministry of Agriculture, Forestry and Fisheries; METI = Ministry of Economy, Trade and Industry; MLIT = Ministry of Land, Infrastructure, Transport and Tourism; MOD = Ministry of Defence; MOE = Ministry of the Environment. Other expenditure covers research and development, general administration and management, noise and other activities not elsewhere classified. Activities covered under multiple domains are included in the main category.
Source: MOE (2024), Environmental Protection Expenditure, website.

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Adopting a green budgeting approach could help Japan strengthen policy synergies and enhance the transparency of budget allocations. While Japan tags environment-related budget allocations, it has not fully integrated climate and environmental considerations into its budget and fiscal frameworks (OECD, 2024[76]). The government does not systematically evaluate the environmental impacts of budgetary and fiscal policies, including taxes and subsidies, or assess their alignment with environmental goals (Section 1.4.4). Adopting green budgeting tools could also help boost public credibility by improving transparency of government spending decisions. Publishing green budgeting information promotes accountability and encourages citizen engagement. Some OECD countries incorporate civil society into budget processes through methods like citizens' commissions and public inquiries (OECD, 2024[76]).

Japan is a decentralised country, and subnational expenditure is higher than the OECD average for most large categories of spending. Local governments have regulatory and enforcement power, such as setting emission standards (Section 1.4.1). They formulate and implement environmental conservation measures in accordance with national policies. Several local governments, especially prefectures and large municipalities, have been increasingly engaged in environmental and climate policies. The national government has also spearheaded local actions through, for example, the Regional Decarbonization

Roadmap, and provides financial and technical assistance for implementation. “Regional energy and global warming mitigation councils” co-ordinate regional climate action, including efforts by local governments (Chapter 2).

Japan is an active player in international environmental co-operation

Japan actively supports international environmental initiatives and institutions. In the last decade, it has given more importance to regional and bilateral co-operation in the Asian region. The country’s absolute level of official development assistance (ODA) increased steadily between 2018 and 2023 and is among the highest in the world. However, Japan’s ODA is 0.44% of gross national income, below the 0.7% UN target. Environment is a prominent component of Japan’s development assistance. In 2021-22, Japan committed 69% of its total bilateral allocable aid in support of the environment and the Rio Conventions (the DAC average was 35%), mostly for climate change mitigation (OECD, 2024[77]). Moreover, the GX Basic Policy highlights Japan’s commitment to contribute to decarbonisation overseas, particularly in Asia. Still, OECD (2020[78]) noted that Japan could improve coherence between domestic policies and its aid policy towards global sustainable development objectives, including the Paris Agreement goals.

1.3.2. Promoting public awareness and stakeholder engagement

Education initiatives have helped raise environmental awareness

Progress has been made on environmental education under the 2003 law on promotion of environmental education. The Education for Sustainable Development (ESD) domestic action plan aligns with UNESCO’s 2019 ESD framework, integrating ESD into school curricula. Environmental education initiatives include a certification system for teachers, counsellors and organisations; training; ESD support centres in eight regions; and activities through a learning platform.

The MOE has implemented various initiatives to promote disclosure of environmental information. The ministry collects, organises and publishes environmental statistic data, as well as annual reports, on its website. The MOE also supports establishment of open data platforms[20] and launched its data management policy in 2021 to promote information transparency and provision based on users’ needs. The National Institute for Environmental Studies operates a website called the Environmental Observatory to share recent environment-related studies and technology, using geographic information systems data for visual descriptions.

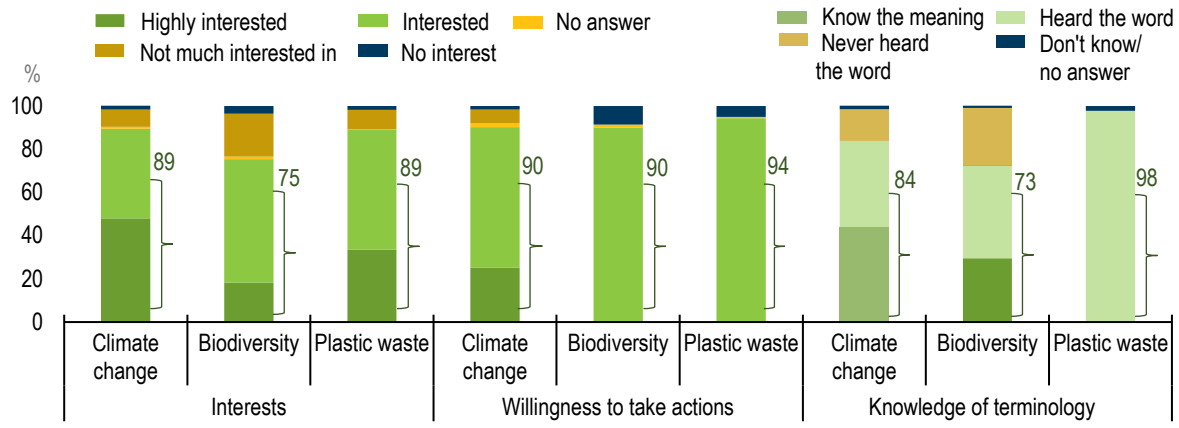
These efforts contributed to the high public interest in environmental issues such as climate change and plastic waste (Figure 1.19). More than 90% of public opinion survey respondents expressed willingness to take actions in these fields. In the 2023 survey, 30% of respondents cited lack of information as the reason for their “unwillingness to take action”, down from 45% in the 2020 survey. This suggests an improvement in the availability of environmental information (Cabinet Office, 2023[79]). Regarding plastic waste, 75% of respondents reported that the new plastic bag fee raised their interest in the issue, and 50% said the fee changed their behaviour (e.g. more use of reusable bags) (Cabinet Office, 2022[80]). However, interest in, and knowledge of, biodiversity issues remained lower (Figure 1.19). Still, this area shows signs of improvement, especially among younger respondents (Cabinet Office, 2019[81]).

Public participation could be more meaningful with more balanced representation

Public participation in policy formulation is secured by established mechanisms. These include the public consultation processes in developing the BEP and in formulating cabinet orders and ministerial ordinances (for 30 days in general). When laws are established, the opinions submitted and response to them are published via the Internet.

Figure 1.19. Environmental awareness is high

Citizens' awareness by environmental domain, percentage of respondents



Note: Knowledge of terminology: in relation to climate change, the question related to understanding of the word "decarbonisation".
Source: Cabinet Office, Government of Japan (2024), Public Opinion Surveys (several issues).

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However, there is room to improve such mechanisms for communication, consultation and stakeholder engagement in decision making. Overall, stakeholder engagement in Japan is relatively low. Japan ranked among the lowest in the share of those who think their government would adopt opinions expressed in a public consultation, as well as in the stakeholder engagement score for developing primary laws (OECD, 2023[82]). Efforts to foster a more inclusive and participatory approach to environmental policy making are particularly important for decisions about reactivating nuclear power plants and the siting of renewable energy infrastructure, which have faced opposition from local communities, as well as of emerging technology installation, such as CCUS and hydrogen transport infrastructure.

Japan has been working to improve the balance in gender and age representation. Women and youth appear to have fewer opportunities to participate and influence government decisions. The inequality index on "having a say to the government" in Japan is worse than the OECD average, in both gender and age group categories (OECD, 2024[83]). For instance, members of 15 working groups to form the Sixth SEP turned out to be skewed to the 50-70 age group and male (over 75%), with limited participation from the energy demand-side companies and non-profit organisations (Climate Integrate, 2024[84]).

1.4. Towards a more comprehensive and cost-effective environmental policy mix

1.4.1. Strengthening the regulatory framework for environmental management

The effectiveness of environmental impact assessments could be enhanced

Environmental impact assessment (EIA) has been routinely implemented in Japan since 1997. It is required for a wide variety of projects, including infrastructure, power plants, and industrial, commercial and residential developments (Box 1.7). The EIA scope could be broadened to cover some activities with potentially high environmental impacts that are excluded, such as mining or aquaculture (OECD, 2024[85]). The EIA procedure must be conducted prior to the permitting decision, and the EIA outcome is considered when granting a licence permit (Box 1.7). All major cities and prefectures developed their own EIA

ordinance to ensure that smaller projects, with potential local environmental impact, undergo an EIA process. These ordinances require the creation of independent review commissions, which provide "expert opinions", and in some prefectures, stipulate a power for the local administrative chief to call public hearings as necessary (Takao, 2016[86]).

Box 1.7. Japan's environmental impact assessment process

The EIA Law identifies 13 types of projects (including solar since 2020) classified as Class-1 or Class-2 projects according to their size. All Class-1 projects must undergo an EIA process. Ministers responsible for the project sector determine the need for an EIA for smaller Class-2 projects based on the potential environmental impact and screening parameters defined by the MOE.

The project proponent assesses the project's environmental impact and presents an environmental impact study (EIS), which should consider local opinions. All proponents of Class-1 projects must also consider alternative projects or project features, such as location and scale (primary environmental impact consideration). The MOE and the licensing authority review the EIS, and the project proponent needs to revise it based on the views of the licensing authority. The licensing authority considers the opinion of the environment minister on the EIS in granting the permit.

Source: Environmental Impact Assessment Act (No. 81 of June 13, 1997), https://www.japaneselawtranslation.go.jp/en/laws/view/3375/en#je_ch8at3; (Kitamura, 2023[87]).

As of March 2024, most EIAs had been conducted for power plants since the promulgation of the EIA Act in 1997, with the largest number for wind farms in recent years (MOE, 2024[88]). Wind power plants accounted for more than 80% of the EIAs in process as of March 2024. This reflects developers' interest in renewables but also the complexity and length of the procedure. The government has taken several steps to streamline the EIA process for renewable power plants (Section 1.5.2). However, Japan needs a more adaptive EIA framework that can address the challenges posed by emerging technologies, especially those needed by the clean energy transition. For example, photovoltaics (PV) plants were included in the EIA scope only in 2020, well after the start of the PV boom in the country (Section 1.5.2).

In the EIA process, it is critical to systematically ensure effective participation of local stakeholders. Local citizens and governments can provide their views at several stages of the EIA process, including during the scoping for determining the EIA methodology and the EIS development. However, more inclusive and effective public engagement methods can be pursued (Kitamura, 2023[87]). Japan would also benefit from introducing environmental assessments at the level of plans, programmes or policies (strategic environmental assessment, or SEA) as recommended by the OECD (OECD, 2024[85]), while ensuring effective public participation during the SEA process. Improving communication is essential for renewable energy projects, which have been facing opposition from local communities. This is even more relevant for installations of emerging technology, such as hydrogen, ammonia and CCUS, to enhance local buy-in and propose mitigation measures to address potential conflicts.

Integrated environmental permitting would help improve pollution control at the source

Japan establishes EQSs on air, noise, water and soil, and emission standards on air and water pollution. While emission standards require penalties for non-compliance, EQSs function as an administrative target value to protect human health and environment, based on the Basic Environmental Law. Even when there is no EQS, a guideline value can be set as needed, such as noise value for wind power plants. Prefectures can establish stricter emission standards than those set by the central government. As in several other OECD countries, local authorities in Japan monitor quality regulations and operate the permitting system.

If EQSs are not achieved, the local government can ask stationary sources to reduce emission-causing activities.

Japan's permitting system for economic activities is medium-specific, with separate permits for air, water and waste releases. EU member states and several other countries issue integrated environmental permits that cover all releases and processes, in line with the OECD Recommendations on Integrated Pollution Prevention and Control (IPPC). Japan would benefit from transitioning to an integrated approach that covers all releases to air, water and land, and all processes of a facility. This would allow consideration of cross-media effects, such as preventing shifting pollution from air to water.

In Japan, licensing conditions for pollution sources on air emissions, as well as water and waste discharges, are set based on EQSs and technological feasibility. These conditions consider best available techniques (BATs), defined as the most environmentally effective and economically viable proven techniques within each sector, for certain substances such as mercury. To promote BATs further, Japan could implement a stepwise approach that identifies BATs by sector and establishes national BAT-based standards systematically, in line with the OECD IPPC Recommendation.[21] BAT-based emission/effluent limit values are set in other OECD economies such as the European Union and the United Kingdom.

Establishing BATs by sector, such as BAT Reference Documents in the European Union, can be a starting point. In Japan, this type of practice exists in some sectors such as for thermal power plants. The country may also consider adopting BATs of other countries, with the necessary adjustments to national circumstances (OECD, 2020[89]). Using BAT-based standards to set permitting conditions would increase the effectiveness of the permitting system in continuously minimising pollution. Permits would systematically reflect the latest available knowledge and incorporate increasingly stringent conditions as technology develops.

Chemical management has further improved, resulting in lower releases

Chemical management has further improved in the last decade in Japan. In 2012, the country compiled the national plan for the implementation of the Strategic Approach to International Chemicals Management (SAICM). This aims to minimise the significant adverse effects on human health and the environment of chemicals production and use by 2020. Japan has initiated chemical management measures aligned with the Global Framework on Chemicals, adopted in 2023 as the successor of SAICM.

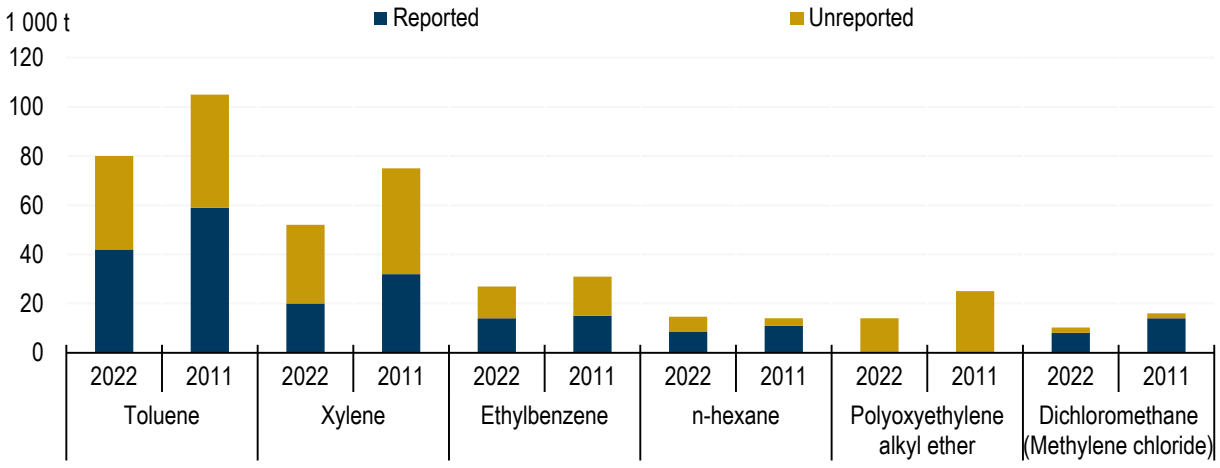
Regarding general purpose (industrial use) chemical substances that are to be newly manufactured or imported, the government evaluates the hazard and other aspects of substances based on the Chemical Substances Control Law in line with best international practices. For existing chemicals, the government identifies Priority Assessment Chemical Substances (PACS) through screening assessments. In the screening assessment, chemical substances with high hazard and exposure index values are judged to be equivalent to PACS. As of April 2024, 225 substances were designated as PACS, and the results of the detailed risk assessments were discussed for 46 substances by April 2024.

Monitoring of chemicals in the environment has been an important element of Japanese chemicals management since 1973. Japan established its Pollutant Release and Transfer Register (PRTR) system in 1999. The PRTR legislation requires designated facilities to report annually on the quantities of specified chemicals released to the environment (air, water, land) and transferred for disposal as waste. The government complements the reported data with estimates of amounts of these chemicals released to the environment that are not reported. Releases decreased across all top six chemicals with high-volume of reported and estimated releases over 2011-22 (Figure 1.20).

Japan showed leadership in management of mercury in particular, based on historical lessons. The Minamata Convention on Mercury, adopted in 2013, was named after the city of Minamata, which recorded an outbreak of mercury poisoning. In 2015, to comply with the convention, Japan adopted specific

legislation on prevention of environmental pollution by mercury. Moreover, Japan is providing international support to promote implementation of the Minamata Convention in developing countries, especially in Asia.

Figure 1.20. Release of chemical pollutants decreased over the last decade



Source: MOE (2024), White paper on Environment, Circular Economy and Biodiversity.

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A strong culture of compliance limits the need for enforcement actions

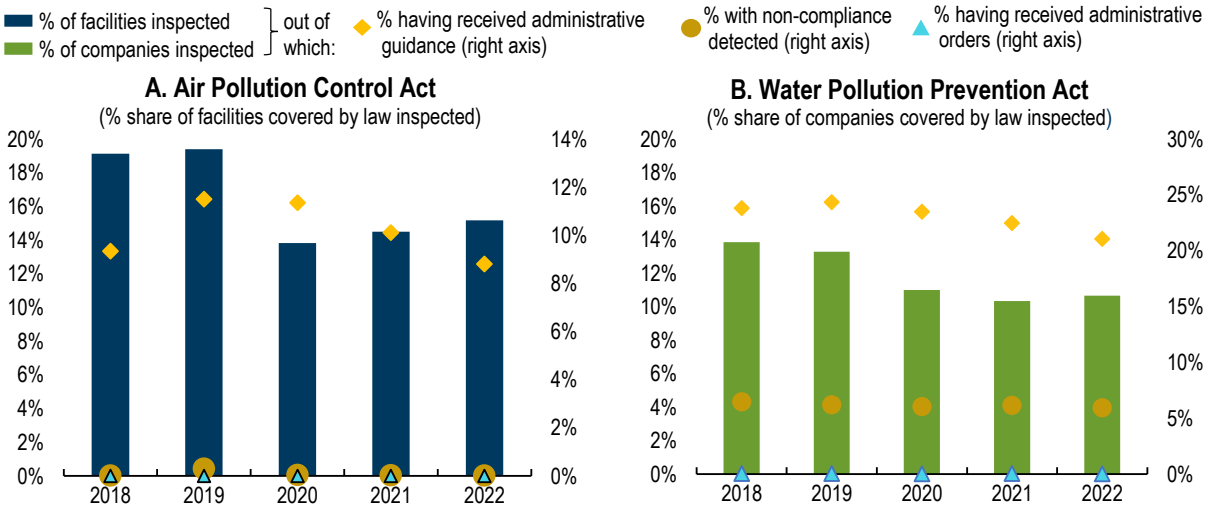
Japan's toolbox for compliance promotion includes training or guidance provided to the controlled facilities during inspections. Numerous governmental and business organisations, such as the Japan Environmental Association for Industry, help disseminate information on environmental laws and pollution control technologies. This helps ensure that regulated entities are aware of their environmental responsibilities and possess the capacity to comply. Disclosing non-compliance also helps promote adherence to environmental laws. For instance, the MOE discloses the results on the attainment rate of air quality standards and provides almost real-time information on the concentration of certain pollutants through its Atmospheric Environmental Regional Observation System (*Soramamekun*). Inspection activity data are collected at national level and published annually in aggregated reports.

Compliance monitoring activities are based on self-monitoring and on-site inspections. Authorities check reports from business operators to verify compliance with the regulations under each individual law (Miyagawa, Kurano and Kagawa, 2023[90]). Either the regulated firm or third parties (i.e. accredited laboratories) perform the measurements (Botta and Yamasaki, 2020[34]).

The Air Pollution Control Act and the Water Pollution Prevention Act request local governments to measure and monitor the status of air and water pollution through inspections on facilities in their territory. The number of inspections has decreased since 2019 due to COVID-19 (Figure 1.21). The MOE has released guidelines for the organisation and design of inspections, which encourage regular inspections of all facilities. Local governments can develop their own priorities (e.g. levels and hazardousness of emission, compliance record). This allows for a prioritisation of inspections for higher-risk facilities, in line with the OECD Council Recommendation on Environmental Compliance Assurance. The MOE also issues guidelines on how to draft inspection manuals, but local authorities' approaches to inspections range from detailed manuals to simple checklists. While prefectures have the autonomy to adjust inspection strategies to local needs, there is limited oversight to ensure consistent standards across regions.

Figure 1.21. The number of inspections has decreased since 2019

Monitoring and enforcement of Air Pollution Control Act and Water Pollution Prevention Act



Note: Panel A: compliance with emission standards for smoke and soot. Panel B: compliance with wastewater discharge in public waters and "structural standards" related to groundwater.
Source: E-Stat (2023), *Survey on the status of enforcement of the Air Pollution Control Act FY 2023* (database).

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In cases of non-compliance, and before issuing a sanction, inspectors provide administrative guidance with recommendations to improve pollution control. This non-binding act is an effective way to help the facility return to compliance. When administrative guidance fails to bring the necessary corrective actions, or in the case of major non-compliance, inspectors issue administrative orders. These are binding legal acts requiring firms to improve or suspend operations (Botta and Yamasaki, 2020[34]). After receiving a guidance or an order, a firm must submit an improvement plan and timeline, which local governments use to schedule follow-up inspections. Sanctions are specified in individual laws. They usually range from suspension of the use of facilities necessary for the business to revocation of the business licence, from fines to imprisonment with labour (Miyagawa, Kurano and Kagawa, 2023[90]). In case of incidents, the local government can also order to take the necessary measure to prevent worse environmental consequences.

There is limited information sharing on violation and inspections results between prefectures. This information is first reported to the national government that decides whether to initiate further investigations and/or inform other prefectures. Establishing direct information-sharing mechanisms among prefectures would speed up identification of similar violations in other regions (OECD, 2018[91]).

A strong culture of compliance results in a low ratio of non-compliance, ranging from almost full compliance with air emission standards to 6% non-compliance with water effluent standards. The number of cases of administrative guidance for operators to return to compliance has accounted for around 10% of inspections for air and 20% for water. Meanwhile, administrative orders are rarely seen (Figure 1.21). The intervention of the authority is already regarded as a sanction due to the potentially high damage to reputation.

1.4.2. Fostering voluntary measures and corporate social responsibility

Close collaboration with industry is a pillar of Japan's environmental policy

In Japan, voluntary approaches play an important role for environmental management. The longstanding Keidanren's Voluntary Action Plan (VAP) (Box 1.8) encouraged the industry to improve its environmental performance, with a focus on GHG emissions, energy efficiency and waste management. As part of the 2023 GX Basic Policy, large companies are encouraged to participate in the GX League (Box 1.8). Keidanren has also been promoting consideration of biodiversity in industrial activity through its sister organisation Keidanren Nature Conservation Council (Box 1.8).

Box 1.8. Main voluntary actions by businesses

Voluntary approaches by Keidanren

Keidanren launched the Voluntary Action Plan (VAP) on the Environment in 1997. Several VAPs have followed since, such as the Action Plan for Achieving a Low-carbon Society in 2013 and Carbon Neutral Action Plan in 2020. Each sector stipulates its own target and emission reduction measures in the VAP in consultation with the government. For the 2013-20 phase, 43 of 58 industries achieved their targets. As of 2023, 45 of 63 industries set a vision to achieve net zero under the Carbon Neutral Action Plan, which accounted for 97% of CO_2 emissions from industries participating in Keidanren. Keidanren's Evaluation Committee carries out independent reviews of voluntary activities, including target setting. When the target is achieved, the industries are encouraged to reset the target higher as needed.

Keidanren also formulated the VAP for establishing a sound material-cycle society, setting targets such as a 75% reduction of final disposal of industrial waste volume between 2000 to 2025 (achieved as of 2022). This VAP places more weight now on industry-specific resource circularity and targets related to plastics.

For biodiversity initiatives, the Keidanren Nature Conservation Council was established in 1992 with over 1 500 member companies as a platform of biodiversity in the Japanese business community. It connects diverse stakeholders including the government and academia, supports non-governmental organisations through Keidanren Nature Conservation Fund and promotes nature-positive management in the industry. It also raises awareness, contributing to adoption of the recommendations of the Taskforce on Nature-related Financial Disclosures.

GX League

The GX League, established in 2023, is a co-operative framework between companies, the government and academic institutions. Each company sets its own target in the GX League. As of April 2024, the GX League had over 700 companies registered across various sectors such as manufacturing and finance. Those companies accounted for more than half of all CO_2 emissions in the country. The companies joining the GX League need to participate in the voluntary phase of the ETS under the Pro-Growth Carbon Pricing (Section 1.4.3). They must disclose GHG emission reduction targets and achievement status.

Source: Keidanren (2024[93]); METI (2024[92]).

The VAP has triggered visible commitment of industry to reduce GHG emissions and waste generation, but it is not clear whether the progress made goes beyond business-as-usual. The VAP has tended to promote incremental rather than fundamental changes in products and processes. At the same time, investing in energy-saving technology or waste recycling to meet the targets is in the first interest of companies as it confers them a competitive advantage. The VAP does not secure a cost-effective and well-balanced distribution of mitigation efforts across industries and companies, and it does not necessarily motivate them to go beyond their voluntary commitments (OECD, 2010[94]; IEA, 2021[15]).

The level of ambition of industry targets and the potential for further energy improvements should be carefully considered. The government regularly reviews progress and is consulted when industries set their targets. However, the target-setting process should be made more transparent. For example, it should consider the information advantage of the business sector (e.g. on emission abatement costs) and the incentive for businesses to slow down progress towards targets to avoid stricter targets in the future. A broader involvement of the public in setting the targets would help counterbalance the demands of the business sector and economic decision makers.

Corporate social responsibility is pursued with increasing disclosure and due diligence

Large corporations are required to publish environmental reports following MOE guidelines, which include information on environmental compliance. The MOE has also promoted Environmental Due Diligence, drawing on the OECD Due Diligence Guidance for Responsible Business Conduct. Moreover, more companies disclose non-financial information in line with the corporate governance code by the Financial Services Agency (FSA). As of 2022, about 80% of 400 surveyed companies listed on the Tokyo Stock Exchange have published integrated reports, and about 35% have published reports on topics like environment, social and governance, and corporate social responsibility (Japan Exchange Group, 2023[95]).

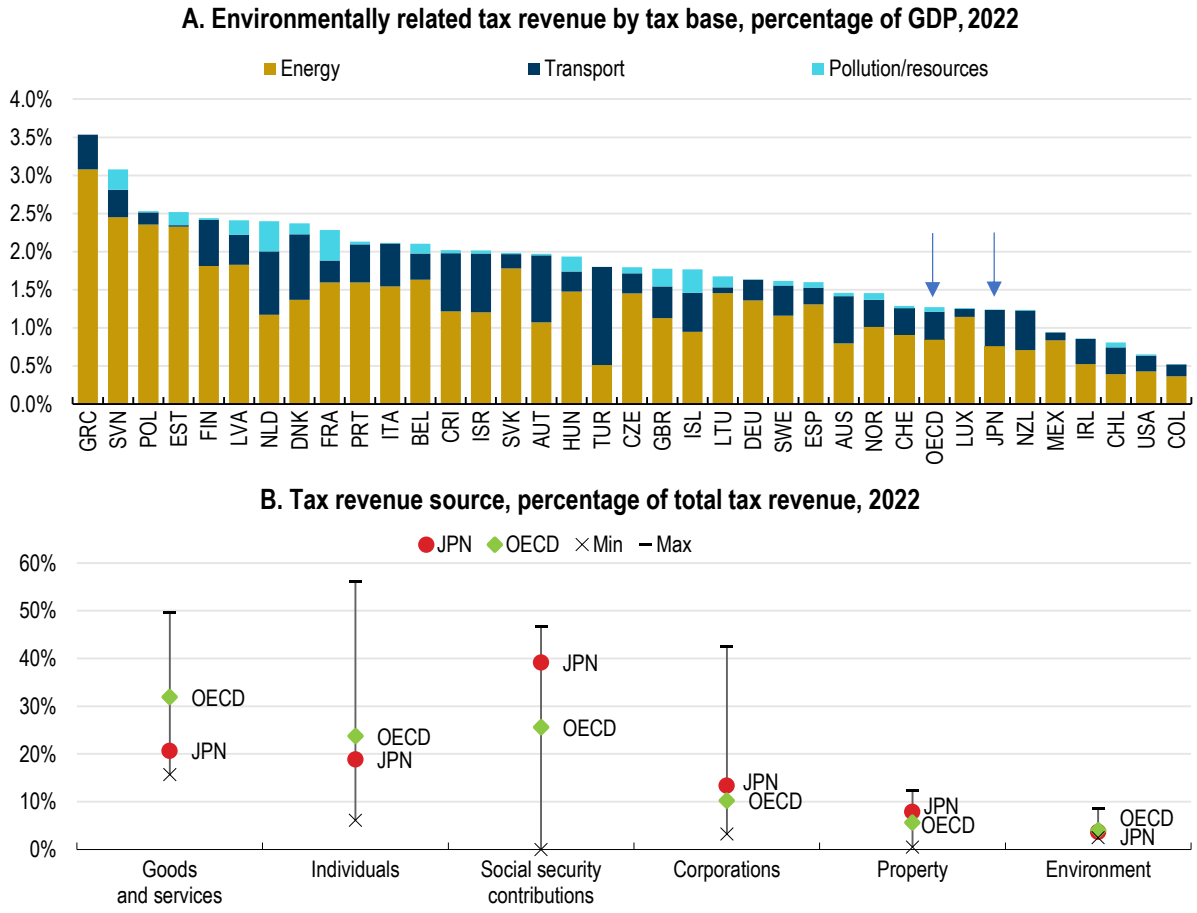
Japan has strongly supported initiatives for disclosing financial information related to climate change and biodiversity. By March 2024, Japan had the largest number of institutions supporting recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) (MOE, 2024[8]), the international initiative aiming to help companies improve transparency on climate-related financial risks. As of November 2024, Japan also had the largest number of institutions adopting the recommendations of the international Taskforce on Nature-related Financial Disclosures (TNFD), which aims to help organisations disclose and manage nature-related risks and opportunities (TNFD, 2021[96]). In 2022, Japan became one of the first six countries/regions with a TNFD Forum. Since 2023, the FSA has required companies listed on the Tokyo Stock Exchange Prime Market to disclose climate information following the TCFD recommendations or an equivalent framework. The FSA has also promoted impact investing – an investment that intends to yield positive environmental or social outcomes while securing financial return – through guidelines and a consortium.

1.4.3. Greening the tax system and improving carbon pricing

There is scope to expand environment-related taxation

Expanding the use of environmental taxation and reforming environmentally harmful subsidies would provide more consistent price signals, while helping to generate revenues. With the highest public debt-to-GDP ratio among OECD countries, Japan needs to consolidate its fiscal position to rebuild buffers amid rising pensions and health care costs and high investment needs for the green and digital transformation (IMF, 2024[5]; OECD, 2024[6]). The country's tax revenue is in line with the OECD average (at about 34% of GDP). Its tax system is skewed towards social security contributions and features a low consumption tax rate, which can lower employment and investment incentives (OECD, 2024[6]) (Figure 1.22, panel B).

Figure 1.22. The share of environmental taxes is relatively low



Note: 2022 or latest available year. Japan's data are presented for fiscal years (1 April to 31 March). Tax revenues include social security contributions according to the OECD Revenue Statistics methodology.
Source: OECD (2024), *OECD Revenue Statistics* (database); OECD (2024), *OECD Environment Statistics* (database).

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Environmental taxes account for a lower share of GDP (1.2%) and total tax revenue (3.6%) than in most other OECD countries (Figure 1.22, panel A). This reflects the lower tax rates on energy and vehicles – the main environmental tax bases – compared to many other countries. As elsewhere, taxes on pollution and resource use are negligible. The main pollution-related tax is on sulphur dioxide (SO_x) emissions. Some prefectures and ordinance-designated cities[22] have also introduced environment-related taxes, such as one based on the amount of industrial waste generated or disposed of and a tax for forest development.

Vehicle taxes and subsidies could be better targeted

Japan has made progress in linking vehicle taxes to fuel efficiency and exhaust emissions of vehicles, but better taxes and subsidies are needed to accelerate the transition to electromobility, reduce GHG emissions from transport and contain fiscal costs. The government has long provided support to lower-emission vehicles through tax incentives and purchase subsidies. It applies several taxes to vehicle purchase and ownership.[23] Electric vehicles or EVs (battery electric and plug-in hybrid electric) and hydrogen fuel cell vehicles benefit from purchase subsidies and are fully exempt from most vehicle taxes. As of 2024, cars running on natural gas benefited from the same tax treatment as EVs. Hybrid and internal

combustion engine vehicles (ICEVs) were fully or partially exempt depending on their fuel efficiency and exhaust emission levels (JAMA, 2024[97]). Criteria for tax exemptions for hybrid and ICE vehicles have been tightened progressively. However, continuing to exempt vehicles running on fossil fuels from taxes could delay the transition to truly zero-emission vehicles. The government should limit eligibility for full vehicle tax exemptions to EVs.

Subsidies to electric vehicles aim to boost demand by reducing the gap in purchase price between EVs and traditional cars. Even the small EV models remain more expensive than best-selling small ICE cars in Japan (IEA, 2024[98]). Subsidies have stimulated sales of electric cars in recent years. Sales grew from around 1% of total car sales in 2010-19 to 3.6% in 2023. However, this remains the lowest share among G7 countries (IEA, 2024[99]), while hybrid vehicles dominate Japan's car market (Section 1.5.3).

Like other countries, Japan should carefully manage the cost effectiveness and fiscal implications of EV purchase subsidies. These subsidies are generally a costly way to abate CO_2 and pollutant emissions from transport, mainly benefiting those who would buy these cars regardless. They are also regressive, as only households that can afford to purchase a new vehicle can access them. To address the regressive impact of EV subsidies, the government could increase the subsidy amount for low-income buyers, as seen in France, or fund low-interest loans for low-income households, like in Scotland.

The fiscal cost of purchase subsidies has been substantial and increasing. Budget allocations to cover the fiscal costs of EV purchase subsidies tripled in FY2021/23.[24] These subsidies are part of Japan's strategy to build a competitive domestic EV industry and supply chain. However, they risk leading to ongoing financial support for the industry, straining government finances. As the country's EV market matures, purchase subsidies should be gradually replaced by higher taxes on ICEVs to narrow the EV-ICEV cost gap (ITF, 2023[100]). For example, France introduced a fee-bate system that combines an EV purchase subsidy and hefty registration taxes on high-emitting cars. Reducing and better targeting subsidies to vehicle purchase would free up resources that could be redirected to initiatives like expanding charging infrastructure. With the gradual shift to electromobility, Japan will need to further boost its comprehensive road use toll system to internalise costs of car use and substitute transport fuel tax revenues (OECD, 2024[101]).

In 2024, the government revised EV subsidy criteria to encourage private investment in charging networks and services that enable wider EV adoption. The subsidy amount differs across manufacturers based on factors like provision of EV charging points, maintenance services, disaster response agreements and used battery collection systems. This aims to address the main barriers to EV deployments, namely the lack of charging infrastructure and inadequate post-sale services, in addition to the high prices of the vehicles (Section 1.5.3). In addition, the new subsidy scheme helps reduce pressures on the public budget.

Energy taxes and effective carbon prices are low

Energy taxes are broadly applied in Japan and the main instrument to price GHG emissions from fuel combustion (Box 1.9). However, tax rates are relatively low and reduced in several sectors. The overall tax burden on fuels is lower than in many OECD countries (IEA, 2024[102]). Energy-related GHG emissions are also priced through a carbon tax and two subnational ETSs in Tokyo Metropolitan City and Saitama prefectures. The headline carbon tax rate and the emission coverage of the ETSs are the lowest among the OECD countries that implement these instruments (Box 1.9).

Box 1.9. Existing and planned carbon pricing instruments in Japan

Excise duties on energy products

All fuels are subject to excise duties at varying rates according to the type of fuel. A petroleum and coal tax applies to crude oil, coal, oil products and hydrocarbon-based gases, including those used for power generation and aviation. Petrol and diesel, as well as liquefied petroleum gas used in road transport and aviation fuel, are subject to additional excise taxes. Japan is one of the few countries taxing aviation fuels used domestically. It also applies an electricity output tax. Most of the tax revenue is earmarked for specific purposes.

Tax for Climate Change Mitigation

Japan introduced a carbon tax (Tax for Climate Change Mitigation) in 2012, the first Asian country to do so (World Bank, 2024[103]). The carbon tax is a component of the petroleum and coal tax and applies to CO_2 emissions from the combustion of fossil fuels across all sectors, with various exemptions (industry, power, agriculture, fishery and forestry, shipping, aviation and rail transport). At JPY 289/tCO_2 (USD 1.9), the headline carbon tax rate is the lowest in the OECD and has remained unchanged since 2016. For comparison, as of 2024, Switzerland had the highest headline carbon tax rate in the OECD at USD 132 (World Bank, 2024[103]). The revenue from the carbon tax (JPY 220 billion in 2022) is earmarked for the promotion of renewables and energy savings.

Subnational emission trading systems

The Tokyo and Saitama ETSs are baseline-and-credit systems with free emission allowance allocations. Allowances are mutually exchangeable between the two jurisdictions. While the Tokyo ETS covers large-scale commercial and office buildings, the Saitama system covers large manufacturing facilities. The systems jointly covered 1.6% of the country's emissions in 2023, the lowest scope among ETSs in OECD countries (the OECD average coverage is 31%) (OECD, 2024[104]). Trade volume of allowances is low and price setting is non-transparent (Gokhale, 2021[105]). Emissions covered by the two ETS effectively paid only EUR 0.07/tCO_2 on average in 2023 (OECD, 2024[104]).

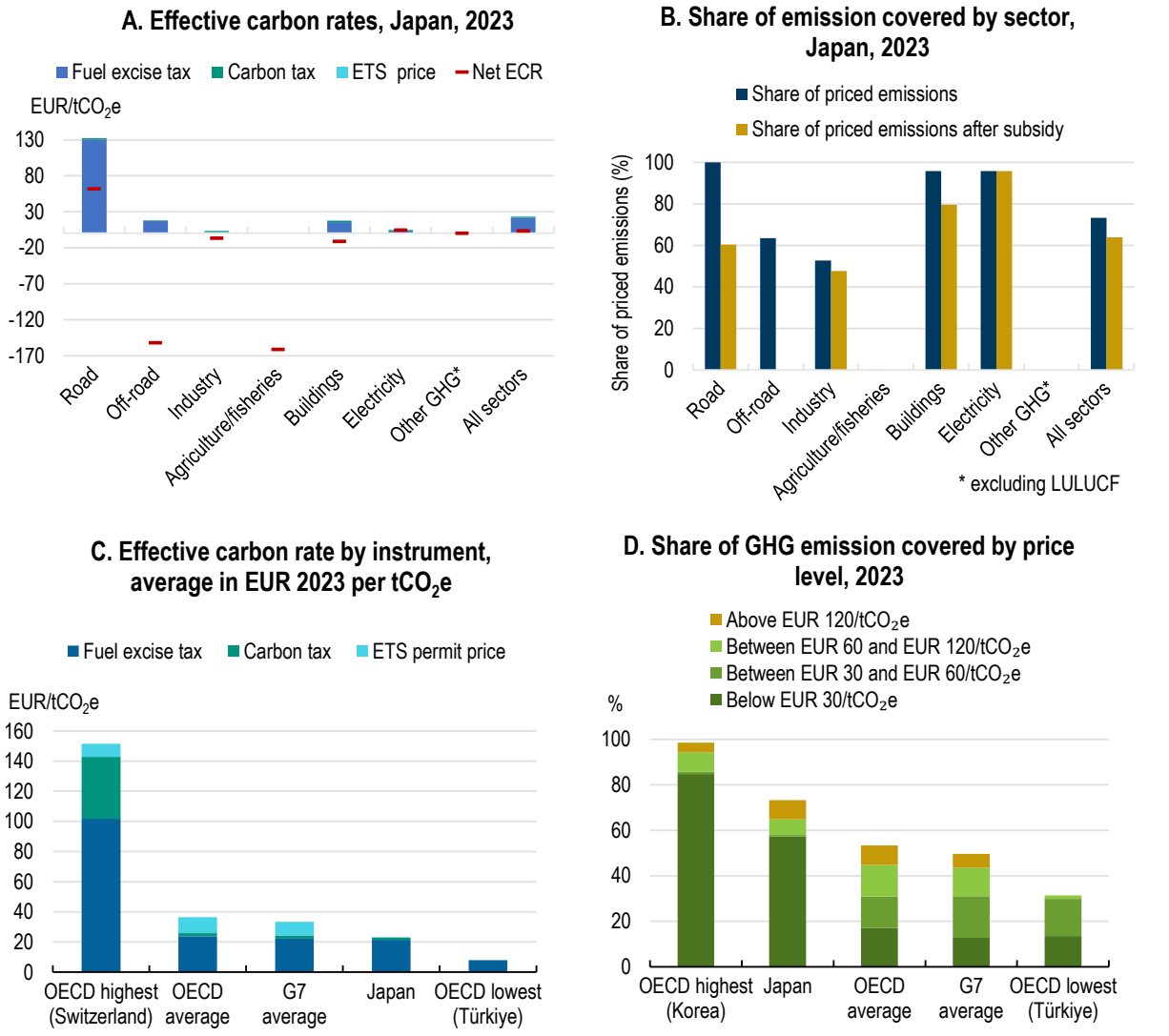
The planned carbon levy and ETS under the Pro-Growth Carbon Pricing

The country-wide ETS will be introduced in three phases. The first phase, begun in April 2023, is a voluntary baseline-and-credit system among participants of the GX League (Box 1.8). The system is akin to the existing J-Credit Scheme, whereby participating companies receive tradable credits in exchange for reducing emissions from their baselines. The J-Credits can be used to comply with companies' commitments under the Keidanren Voluntary Action Plans (Box 1.8) and the new ETS. The ETS will become mandatory in FY2026 for companies exceeding a certain emission threshold, with participants receiving free CO_2 emission allowance allocations. In FY2033, allowances will be auctioned to power companies. The GX surcharge is scheduled for introduction in FY2028.

The coverage and level of carbon pricing are limited in Japan. In 2023, fuel and carbon taxes and the subnational ETSs together covered nearly three-quarters of GHG emissions, mostly at an effective carbon rate (ECR) below EUR 30/tCO_2 (Figure 1.23, panel D). The average ECR (excluding pre-tax subsidies) was EUR 23/tCO_2, among the lowest rates in the OECD (Figure 1.23, panels A and C). This is also below EUR 120/tCO_2, which is the mid-range estimate of the carbon price that would be needed by 2030 to be consistent with net-zero goals (OECD, 2023[106]). Only 15% of Japan's emissions were priced at an ECR at or above EUR 60/tCO_2 (Figure 1.23, panel D). Emissions priced at this level mainly originated from the road transport sector. While all transport emissions and nearly all emissions from buildings and electricity

faced a carbon price, about half of industrial emissions and all emissions from agriculture and fishery, as well as non-CO_2 emissions, were not priced at all (Figure 1.23, panel B).

Figure 1.23. Carbon pricing has been limited so far



Note: ETS = emissions trading system. The sum of carbon taxes, ETS permit prices and fuel excise taxes is the aggregate Effective Carbon Rate (ECR) paid on emissions. The Net ECR is the difference between the ECR and subsidies that decrease pre-tax prices of domestic fossil fuels. Negative Net ECRs indicate that subsidies exceed the sum of fuel taxes, carbon taxes and ETS permit prices.
Source: OECD (2024), Companion dataset to the OECD Series on Carbon Pricing and Energy Taxation.

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In 2022, the government introduced a fuel price stabilisation mechanism in response to soaring energy prices (Section 1.4.4). As in many countries, fuel price support has had a considerable impact on pricing of GHG emissions across sectors (OECD, 2024[101]). Japan's effective carbon price dropped to EUR 3/tCO2 in 2023 (Figure 1.23, panel A), with only 60% of road transport emissions priced and 64% of emissions priced across the economy (Figure 1.23, panel B).

As in all countries, the ECR varies widely across fuels and users, leading to inconsistent abatement incentives (Figure 1.23, panel A). The effective CO_2 price is particularly low in industry, power generation, and agriculture and fishery. Coal is taxed at a particularly low level, despite its carbon intensity, because it is considered critical for energy security. As in all countries, ECRs on transport fuels are higher than on other fuels because taxes on petrol and diesel have historically been levied to raise revenue. Higher tax rates on transport fuels may be justified to reflect other externalities of road transport (air pollution, noise, accidents and congestion) in addition to GHG emissions (OECD, 2023[106]). As in most OECD countries, petrol faces higher effective energy and carbon rates than diesel. This preferential tax treatment for diesel is unjustified on environmental grounds as the fuel emits more CO_2 per litre than petrol. Moreover, diesel vehicles generally produce higher emissions of local air pollutants, although regulations and emission control technologies could reduce the difference (OECD, 2022[107]).

The effectiveness of Japan's carbon tax and subnational ETSs has been limited, due to the low prices and scope. Estimates indicate that Japan's carbon tax has helped reduce CO_2 emissions by 0.5% below 1990 levels by 2020. Other countries with higher carbon tax rates have reduced emissions by a similar or greater amount in a shorter period (Gokhale, 2021[105]). Analysis suggests the two ETSs contributed to reducing GHG emissions in the covered sectors (Arimura, 2024[108]), but other drivers have played a bigger role, notably the impact of the 2011 earthquake on electricity supply and prices (Wakabayashi and Kimura, 2018[109]).

The Pro-growth Carbon Pricing is a positive step but has room for improvement

Against this backdrop, the Pro-Growth Carbon Pricing, part of the GX Basic Policy, represents a welcome breakthrough in Japan's environmental policy. It provides immediate subsidies to industry for investment in decarbonisation technology followed by a country-wide ETS for large emitters and a carbon levy on fossil fuels (GX surcharge) introduced later in the decade (Box 1.9). Revenue from the new carbon levy and ETS will be used to repay the GX Economy Transition Bonds, which will finance the investment in low-carbon energy technologies that are not yet cost competitive such as hydrogen, ammonia and CCUS (Box 1.5).

Future carbon pricing level and coverage are still undefined, with implementation details set to be legislated in 2025. The GX surcharge is scheduled for FY2028 and the ETS will be implemented in three phases over ten years, starting with a voluntary system in FY2023 (Box 1.9). Annual performance assessments of the first phase should be conducted to point to any needed adjustments and clarify design of the next phases.

Allowances could be auctioned ahead of the scheduled start in FY2033 (Box 1.9). While free allocation might help safeguard competitiveness, prevent carbon leakage and build support for the policy, it may distort markets and weaken abatement incentives. Analysis suggests that free allowance allocations have reduced the effectiveness of the EU ETS system (Dechezleprêtre, Nachtigall and Venmans, 2023[110]). They also represent a subsidy to ETS participants that receive them (IEA, 2020[111]), which comprise power generation facilities based on fossil fuel (including coal). In addition, the free allowance allocation, along with the late introduction of the carbon levy, will hinder revenue generation. Japan could consider a border carbon adjustment for energy-intensive, trade-exposed industries as an alternative to free allocation (OECD, 2023[106]).

The GX surcharge should be set at an adequate rate and gradually raised to provide sufficient incentives. An estimated GX surcharge rate between JPY 1 000 and JPY 2 750/tCO_2 (about USD 6.70 to USD 18.40/tCO_2) would be required, assuming that the GX Economy Transition Bonds of JPY 20 trillion are fully repaid through revenue from the GX surcharge over FY2028-50 (Nikkei, 2022[112]; Hachiya, 2023[113]). However, such a carbon tax rate would be well below the level required to accelerate GHG emission reductions in line with the Paris Agreement. OECD (2023[106]) indicates that EUR 120/tCO_2 is the mid-range estimate of the carbon price that would be needed by 2030 to be consistent with net-zero goals.

IMF (2024[5]) estimates that increasing the carbon tax rate linearly to USD 75/tCO_2eq by 2030 would contribute to substantially reducing GHG emissions (-17.6% from business-as-usual) and raising fiscal revenue (1% of GDP) by 2030. Recycling half of the carbon tax revenue to finance targeted social benefits would offset the negative impact on vulnerable households (see below).

Japan would benefit from bringing forward the implementation of the GX surcharge and ETS to encourage low-carbon investment and reduce the fiscal costs of the transition. While the GX Economy Transition Bonds will provide a substantial low-carbon investment push, the long phase-in of the mandatory ETS and carbon levy may limit their contribution to achieving the 2030 emission reduction target (OECD, 2024[6]). Modelling suggests that carbon pricing needs to be introduced around 2025 to promote behavioural changes and industrial restructuring effectively (Kuriyama et al., 2023[23]). For the ETS and carbon levy to work effectively, it is essential to enshrine in legislation an automatic tightening of the emissions cap and increases in the levy rate, which will create certainty for investors.

Accelerating implementation of the GX surcharge and mandatory ETS could enhance the economic efficiency and effectiveness of Japan's climate policy mix and help put the country on the net-zero trajectory. Evidence suggests that, as part of a broad policy mix, carbon pricing is effective in reducing emissions and amplifies the effectiveness of other policy instruments (D'Arcangelo et al., 2022[114]; D'Arcangelo, Kruse and Pisu, 2023[13]; Stechemesser et al., 2024[115]). In addition to encouraging production and consumption choices that reduce GHG emissions in a cost-effective way, carbon pricing can generate government revenues, at least until higher prices achieve their goal of substantially lowering emissions.

The Pro-Growth Carbon Pricing has helped gain acceptance of carbon pricing from the regulated business community. Meanwhile, subsidies for decarbonisation technologies that are not yet cost competitive (such as hydrogen and CCUS) aim to lower their costs and pave the way for large-scale deployment. However, like green industrial policies worldwide based on government financial support, the GX Basic Policy (Box 1.5) entails risks such as market distortion, picking winners, political capture and windfall gains for companies that would invest even without financial assistance (Millot and Rawdanowicz, 2024[116]; OECD, 2024[117]). To manage these risks, it is necessary to ensure additionality of the financial support provided under the GX Basic Policy and implement a competitive and transparent selection process for businesses and technologies receiving support. The GX Basic Policy would also gain in effectiveness and transparency if it incorporated regular review and feedback mechanisms, including to enable independent scrutiny of supported investments to protect against political capture.

Carbon pricing revenue could help alleviate energy affordability risks

As in other countries, raising carbon prices, as well as removing support to fossil fuel use (Section 1.4.4), can have important distributional implications in Japan. They would lead to higher energy costs, with potentially heavier impacts on the population groups at risk of energy poverty (Inoue, Matsumoto and Morita, 2020[118]). Japan's high dependence on imported energy and lack of electricity import options as an island country make its energy supply vulnerable to external price shocks, increasing vulnerability to energy poverty.

Poverty among the working-age population and income inequality have been rising in Japan (IMF, 2024[5]; IMF, 2023[119]). Official data on the population at risk of energy poverty are lacking, but analysis indicates it is a significant issue, with considerable regional and seasonal variations (Castaño-Rosa and Okushima, 2021[120]). Some population groups face higher energy affordability risks, including the elderly and single-person households, as well as residents of rural areas that depend on cars for their mobility and kerosene for heating (Okushima and Simcock, 2024[121]).[25] To address energy affordability risks, Japan provides means-tested social schemes to low-income households and generalised energy price subsidies for the broader population (Section 1.4.4).

Using revenues from carbon prices and subsidy removals (Section 1.4.4) to finance means-tested social benefits for vulnerable households would mitigate energy affordability risk due to higher energy prices (Flues and van Dender, 2017[122]; Hodok and Kozluk, 2024[123]). This, along with information campaigns explaining the effectiveness and distributional effects of carbon pricing, could help boost public acceptance of these reforms (Dechezleprêtre et al., 2022[124]). Several economies have used carbon pricing revenue to finance social benefits, such as Ireland, the European Union and the US state of California (OECD, 2023[106]; OECD, 2021[125]). Analysis shows that recycling revenues to lower social security contributions could mitigate the impact of carbon prices on households in Japan effectively (Asakawa et al., 2020[126]). At the same time, transparency and clear communication of carbon pricing revenue-use decisions are essential to reduce the risks of spending inefficiency linked to earmarking (Marten and van Dender, 2019[127]).

1.4.4. Reforming potentially environmentally harmful subsidies

Reforming subsidies that are potentially harmful to the environment and repurposing the saved financial resources for social spending or reducing distortive taxes can help meet Japan's environmental goals, while delivering better economic and distributional outcomes. This would ensure that public funds are not supporting practices that undermine climate and biodiversity objectives, in line with the SDG target 12.c on reforming inefficient fossil fuel subsidies that lead to wasteful consumption and environmental harm, and the GBF target 18 on reducing incentives that are harmful for biodiversity by 2030.

Support to fossil fuel production and use is substantial and weakens price signals

In Japan, as in most countries, the government implemented several economic packages to shield households and businesses from the rapid energy price increase that began in 2021. In January 2022, the government introduced a mechanism to mitigate the increase in fuel prices (the "Project to mitigate drastic changes in fuel oil prices"). The scheme subsidises wholesalers when market prices of petroleum products, including transport fuels, are above certain thresholds. The subsidy has been repeatedly extended and was still in place in December 2024, with plans to gradually reduce the subsidy rate. In addition, discounts on electricity and city gas rates, first put in place in 2023, were reinstated from January to March 2025.

The main support measures have been sizeable and have helped mitigate the impact of high prices on household budgets (Monshauer and Bizeul, 2023[128]). However, they have been predominantly untargeted (IMF, 2023[129]; OECD, 2024[6]). Energy price subsidies like those implemented in Japan tend to benefit the entire population rather than just protecting vulnerable groups. These measures distort price signals and weaken the incentive for consumers to save energy or to switch to cleaner fuels. For example, they narrowed the cost savings of switching to EVs in Japan (Monshauer and Bizeul, 2023[128]). In addition, being extended over long periods, such measures exacerbate Japan's fiscal sustainability challenges (OECD, 2024[6]). The fiscal cost of the fuel price stabilisation mechanism was JPY 3.5 trillion in 2022, or 84% of the energy tax revenue that year.[26] As a result, direct budgetary support to fossil fuels spiked to JPY 3.9 trillion (or 0.7% of GDP) in 2022. This is 15 times higher than the average annual budgetary support in the previous decade, which mostly financed business investment in energy projects overseas (OECD, 2023[130]) (see below).

Japan should phase out support measures for energy prices, as they dramatically reduce the already low ECRs (Figure 1.23, panel A). Any further public support, if needed, should focus on vulnerable people not adequately covered by the social protection system. Targeted income relief or lump-sum payments, untied from energy prices, would be more cost-effective and equitable measures to protect those most in need. At the same time, such an approach would maintain incentives towards low-carbon energy choices (Hemmerlé et al., 2023[131]). Improving knowledge of energy poverty and information sharing across government agencies would enable more effective targeting of support policies.

Several other exemptions and discounts apply to the energy and carbon taxes, often provided as tax refunds. These include exemptions for fuels used in agriculture, fishery, shipping and certain energy-intensive industrial sectors (IEA, 2021[15]). Like the fuel price stabilisation mechanism, these concessions lower effective carbon prices, reducing the incentive for fuel efficiency and potentially increasing emissions. They may also entail sizeable fiscal cost, although comprehensive data on the fiscal revenue losses due to these fuel tax concessions are not available.

Removing inefficient fossil fuel subsidies will be essential for the GX subsidies and carbon pricing to deliver effective incentives. Japan should establish a transparent and systematic mapping of fossil fuel subsidies and other potentially environmentally harmful support measures and evaluate their economic, social and environmental impacts. This would help identify reform priorities in line with the SDG target and develop a subsidy reform plan in consultation with relevant stakeholders. On the one hand, the plan should outline a stepwise phase-out of inefficient fossil fuel subsidies to prevent sudden energy price hikes. On the other, it should implement appropriate measures to support vulnerable households and facilitate business adjustments during the transition (Elgouacem, 2020[132]).

Restricting overseas financing for unabated fossil fuel projects is a priority

Japan has long provided direct public support for oil, gas and coal exploration and development projects overseas with a view to increasing energy security. The available data, though incomplete, suggest that in 2019-22, Japan's international public finance institutions provided on average USD 8.7 billion per year to fossil fuel projects, compared to USD 3.7 billion to clean energy projects and other non-fossil fuel investment (e.g. grids and energy savings) (OCI, 2024[133]). The biggest Japanese commercial banks also provide finance to the fossil fuel sector and increased lending in 2017-21 compared to 2010-16 (Romanello et al., 2023[134]). However, these figures may not fully capture the overall financing landscape.

As a participant to the OECD Arrangement on Officially Supported Export Credits, Japan agreed to halt officially supported export credits and tied aid for unabated coal-fired power plants as of 2021.[27] In 2022, along with other G7 countries and recognising the importance of national security and geostrategic interests, Japan committed to ending new direct public support for the international unabated fossil fuel energy sector by the end of 2022, except in limited circumstances consistent with the goals of the Paris Agreement, as defined by countries.[28] Support will continue for existing projects (METI, 2023[135]). According to Japan's definition of "limited circumstances", an unabated fossil fuel project can be financed if Japan considers that it aligns with the decarbonisation strategy of the host country. In addition, financing can be allowed if the project serves Japan's national security, energy security or geopolitical interests (METI, 2023[135]).

It would be prudent to periodically review the implementation of the "limited circumstances" conditions to ensure that financed projects fully align with climate goals and contribute to transitioning away from fossil fuels in energy systems as agreed at the 2023 Dubai COP28. Given the lifetime of energy infrastructure, today's financing and investment decisions in developing countries have the potential of either accelerating their shift to clean energy sources or locking in emissions for decades (IEA, 2021[136]).

The government should consider ensuring more granular and detailed reporting of overseas energy investments by public financial institutions and better disseminating this information to the public. It could also explore ways to track overseas energy investments by commercial financial institutions and enhance public access to this data. This would support transparent monitoring of the implementation of the G7 pledge and help regulators and institutions identify the potential climate-related financial risks.

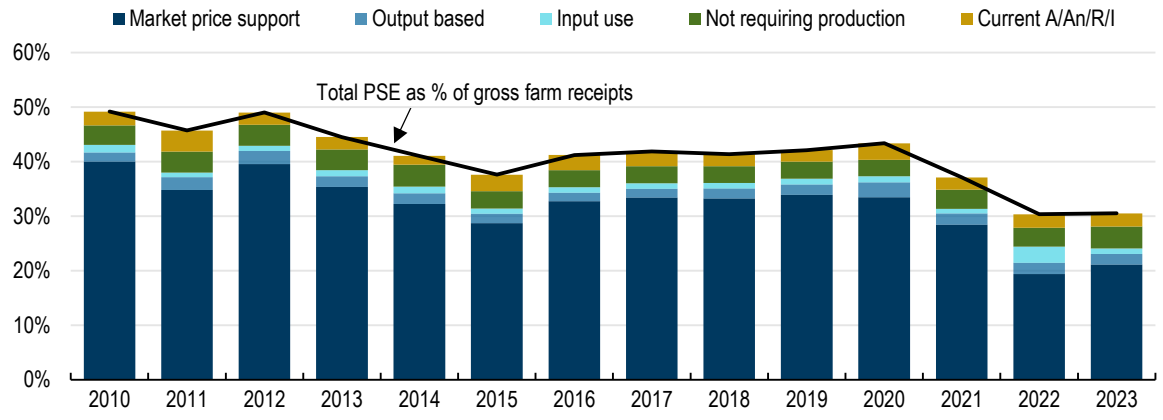
Japan's large support to farming and fishing can have unintended environmental impacts

Japan provides considerable support to agriculture. Support to farmers, as measured by the Producer Support Estimate (PSE), declined in the last decade. However, it still averaged 33% of gross farm receipts in 2021-23 – more than twice the OECD average and among the highest in the OECD (OECD, 2024[49]). Part of this support aims to encourage farmers' environment-friendly investments, such as through the MIDORI Strategy for Sustainable Food Systems. Support includes financial assistance for organic farming, adoption of climate-smart technologies, and less use of synthetic fertilisers and pesticides (OECD, 2023[47]).

The share of potentially most distorting support (i.e. market price support; support based on output; and variable input use without input constraint) declined. However, it still accounted for 26% of gross farm receipts and 78% of PSE in 2021-23 (OECD, 2024[49]) (Figure 1.24). Market price support is largely sustained by border measures, while farmers benefit from refunds of the excise duty and carbon tax on fuel used in agriculture.

Figure 1.24. Support to farmers has declined but most remains potentially distorting

Level and composition of Producer Support Estimates (PSE) by support categories, percentage of gross farm receipts, Japan, 2010-23



Notes: A/An/R/I: Area planted/Animal numbers/Receipts/Income. Payments not requiring production include payments based on non-current A/An/R/I (production not required) and payments based on non-commodity criteria.
Source: OECD (2024), "Producer and Consumer Support Estimates", *OECD Agriculture Statistics* (database).

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Agriculture support linked to production, such as market price support and other commodity-specific subsidies, potentially distorts markets and contributes to high domestic food prices. OECD work has shown that these measures are also potentially harmful to the environment. Support linked to production and input use can increase pressures on natural resources, increase GHG emissions and discourage innovation (OECD, 2023[47]; FAO, 2024[137]), although the actual environmental impacts of these policies depend on several local context-specific factors. Intensive farming on limited agriculture has contributed to water pollution and biodiversity pressures in Japan (Section 1.2.5). Japan should reform support to agricultural producers that is tied to production and input use, including fuels. The government could replace them with payments targeted to producers in need and to encourage green farming practices and technology, including for reducing use of fertilisers and pesticides, and enhancing climate resilience (OECD, 2024[49]).

Japan provides some of the highest support for fisheries among OECD countries, primarily funding general services such as capital investment in infrastructure (OECD, 2022[138]). In a welcome move, Japan accepted the World Trade Organization's Agreement on Fisheries Subsidies in 2023. However, the government exempts fuel for fishing boats from excise duties. It also implements a fuel price stabilisation mechanism (Fishery Management Safety Net), where both the government and fishing companies contribute to a fund to prepare for possible fuel price hikes. The mechanism is activated if fuel prices rise above a certain threshold, as has been the case since 2022.

In general, support to fuel presents a high risk of encouraging unsustainable fishing in the absence of effective fisheries management. This, in turn, could negatively affect marine species and ecosystems and increase GHG emissions. In addition, it tends to disproportionally benefit large companies over small-scale coastal fishers (OECD, 2022[138]). Japan should carefully review fishery support linked to input use, primarily fuel use. If necessary, it should consider providing alternative, more targeted forms of support, such as targeted direct income support to fishers in need and for improving the social, economic and environmental sustainability of fishing. Removing fuel subsidies would lead to resource savings that could be reinvested in sustainable fisheries management, enforcement and research into the health of fish stocks and the impact of climate change (OECD, 2022[138]).

1.5. Investing in green growth

1.5.1. Investing in environmental protection and the clean energy transition

Public spending on environmental protection has risen

Public investment for environmental protection grew by 20% between 2010 and 2022, to JPY 2.5 trillion or 1.7% of the country's total capital investment (ESRI, 2024[139]; OECD, 2024[140]).[29] As in many countries, this investment mostly targeted wastewater treatment (65%) and waste management (31%). Large government spending in extending and upgrading centralised and decentralised wastewater systems has contributed to improved water quality (Section 1.2.5). Meanwhile, local governments have increasingly invested to expand incineration and recycling facilities (Section 1.2.4).

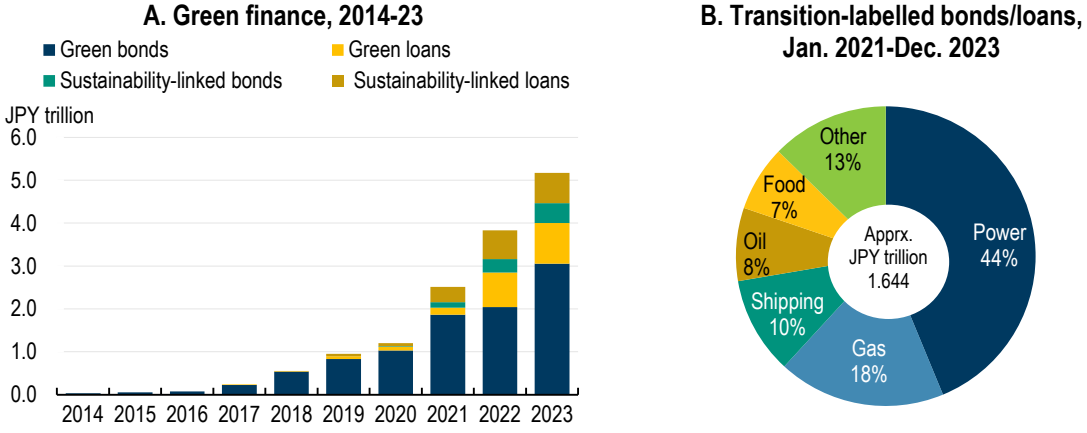
With large spending on procuring goods and services, the government has used its public procurement policy to create demand for greener goods and services and encourage environmentally responsible production. In 2021, public procurement spending was 41% of Japan's general government expenditure and 18% of GDP, among the highest shares in the OECD. Environmental protection accounted for 5.2% of public procurement spending, also among the largest shares in the OECD and nearly double the OECD average (OECD, 2023[82]). The 2001 law for promoting green public procurement (GPP) requires all government institutions to develop GPP policies, set annual targets and report to the MOE each year. The government updates the list of covered items and the applicable standards annually. In FY2023, it updated standards for 23 items, bringing the total to 280 items. The MOE maintains a database of GPP initiatives and conducts training sessions for national and local government branches and businesses. Progress has also been made to help local governments with GPP implementation, which has resulted in improved outcomes.

The green finance market has expanded rapidly

The government has supported development of the domestic market for green finance products, i.e. financial instruments designed to support environmentally sustainable projects or initiatives. It issued guidelines to address greenwashing risks and established platforms to encourage collaboration among relevant stakeholders. As a result, sustainable debt issuances have grown considerably in Japan since

2014, reaching over JPY 5 trillion (about USD 38 billion) in 2023 (Figure 1.25, panel A). The market has continued to expand since 2021, bucking the global trend (IEA, 2024[73]).

Figure 1.25. Japan's green finance market has grown rapidly



Note: Panel A: Excludes transition-labelled finance. Panel B: Other includes iron and steel, cement, chemicals, aviation, etc.
Source: METI (2023), Pathways to Japan's Green Transformation (GX); MOE (2024), Green Finance Portal.

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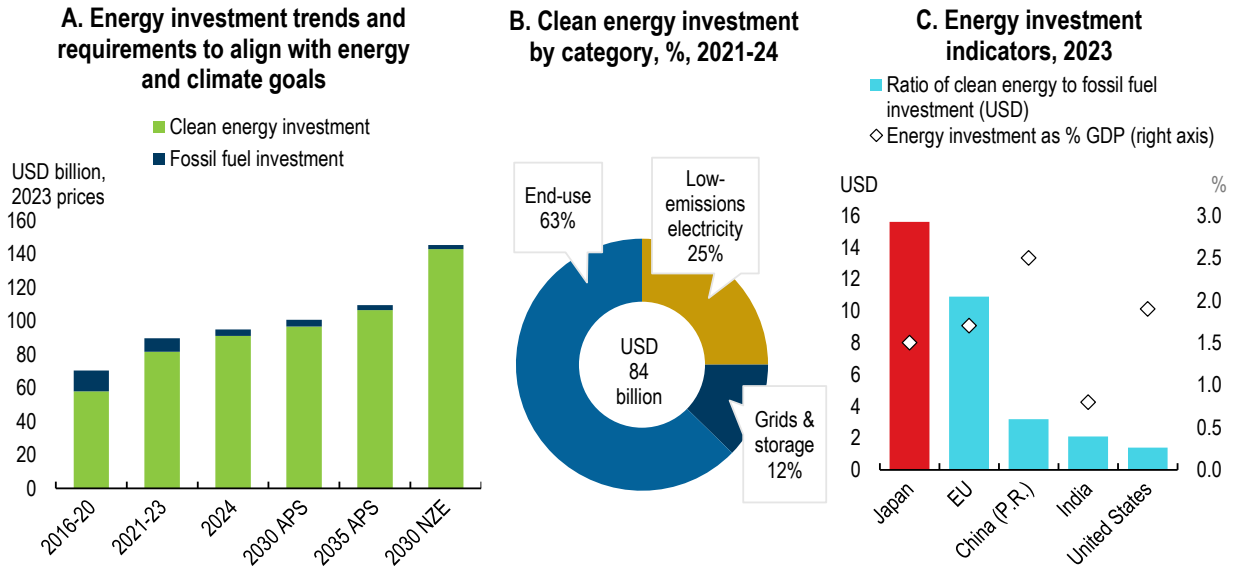
Japan leads globally in transition finance – funding raised by corporations to implement their net-zero transition through credible transition plans (OECD, 2022[141]). While transition-labelled debt issuance is a small share of global sustainable debt, Japan accounted for over half of its global amount in 2022-23 (IEA, 2024[73]). The energy sector (power, gas and oil) accounts for 70% of transition-labelled debt in 2021-23 (Figure 1.25, panel B). To support this market and promote credibility, the FSA, MOE and METI formulated the "Basic Guidelines on Climate Transition Finance" in 2021. This accompanied transition roadmaps that identify financeable technologies in eight sectors.[30] According to the guidelines, to issue transition-labelled instruments, the fundraiser must set climate targets in line with the Paris Agreement, have a science-based climate transition strategy and ensure transparent implementation, among other criteria. The government also developed the framework for Japan Climate Transition Bonds, the world's first sovereign transition-labelled bonds (Box 1.5).

Japan is a leader in clean energy transition investment

Japan has increasingly invested in the clean energy transition, but higher investment will be needed. The country has entered the top ten of major investors in the sector, along with countries such as the People's Republic of China, United States, Germany and Brazil (BNEF, 2024[142]). Average annual (public and private) investment grew by 40% from 2016-20 to 2021-23 (Figure 1.26, panel A), with energy efficiency in end-uses attracting over half of investment (Figure 1.26, panel B). Out of total energy investment amounting to 1.5% of GDP, Japan invested about USD 15 in clean energy for each dollar invested in fossil fuels, over eight times the global average (USD 1.8) and much above the ratios in other major economies (Figure 1.26, panel C) (IEA, 2024[73]). IEA (2024[73]) estimates that clean energy investment should increase by 17% between 2024 and 2035 for Japan to align with its own climate goals. However, this would not be enough to be on the path to net zero (Figure 1.26, panel A). As in all countries, timing and co-ordinating the increase in clean energy investment and divestment in unabated fossil fuels will be vital to secure energy supply and avoid high energy costs (IEA, 2023[25]).

Figure 1.26. Japan's clean energy investment has grown but will need to be scaled up



Note: Clean energy includes low-emission electricity, grids and storage, efficiency in end-uses and clean supply chains. Fossil fuels investment includes fossil fuel supply and fossil power. Panels A and B: 2024 data are estimates. Panel A: The columns 2016-20 and 2021-23 are annual averages over the periods. APS: Announced Pledges Scenario, which assumes climate commitments by a country (including the NDC and long-term net-zero pledge) are met in full and on time. NZE: Net-Zero Emissions by 2050 Scenario.
Source: IEA (2024), World Energy Investment 2024; IEA preliminary data.

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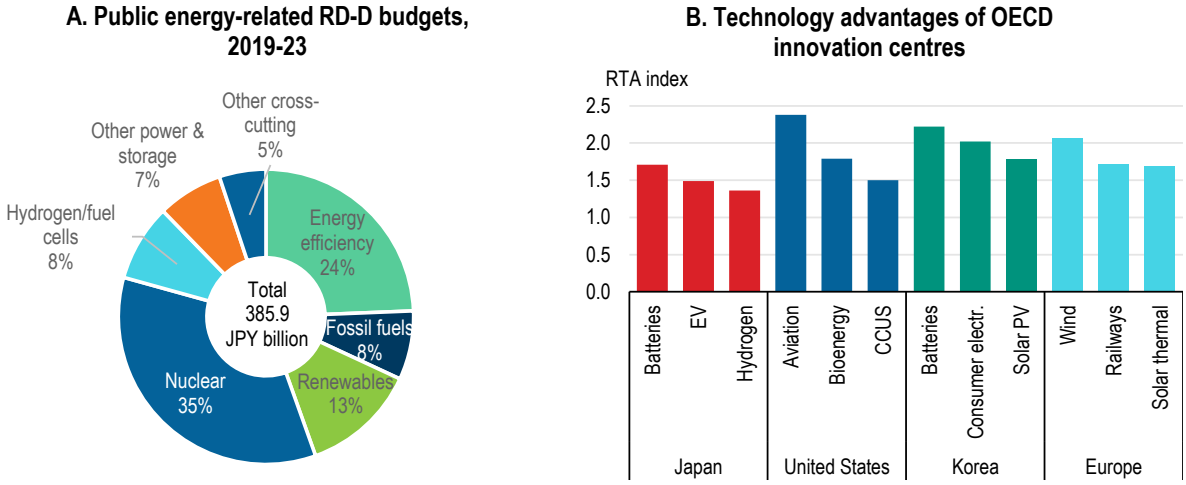
Clean energy investment could boost technological innovation and business investment, with positive effect on Japan's productivity and economic growth (Kurachi et al., 2022[143]). The government has supported business innovation in climate mitigation technology and development of related supply chains. Initiatives include the METI's Green Innovation Fund and the more recent GX Basic Policy (Box 1.5). Japan is among the leading producers and exporters of electronics, machinery and basic metals, all industries essential for manufacturing clean technology (IEA, 2024[144]). Large manufacturing businesses account for most of the country's R&D spending (OECD, 2024[6]). Gross domestic R&D expenditure amounted to 3.4% of GDP in 2022, among the highest in the OECD. Meanwhile, environment averaged 2.6% of government R&D budgets in 2019-23, with energy at 8.5% (OECD, 2024[145]). Nuclear power has traditionally been the most highly funded field in public energy research. Clean energy R&D, including energy efficiency, renewables and hydrogen, averaged nearly half of public energy R&D outlays in 2019-23 (Figure 1.27, panel A). This reflects the government's policy focus on these areas. As a result, Japan has built a relative specialisation in climate change mitigation technologies, such as batteries, EVs and hydrogen (Figure 1.27, panel B).

The shift to a clean energy system will change skill needs and contribute to reallocations of workers across sectors and regions in Japan, like elsewhere in the world. The government should ensure adequate support to workers and communities potentially affected by the transition (Hodok and Kozluk, 2024[123]). This requires an effective mix of active labour market policies, local investments and measures to remove obstacles to geographical labour mobility. To seize the economic opportunities and minimise the costs of the transition, Japan will need structural reforms that facilitate reallocation of capital and labour resources and help the country adjust more quickly to economic shifts (Kurachi et al., 2022[143]; OECD, 2024[6]).

Figure 1.27. Public R&D funding and number of patents for the clean energy transition are high



Notes: Panel A: RD&D = research, development and demonstration. Cumulative amounts in 2019-23, JPY in 2023 prices. Panel B: CCUS = carbon capture, utilisation and storage; EV = electrical vehicle. The revealed technology advantage (RTA) index measures technology specialisation. It is the share of patents filed for a specific technology relative to the share of total patents owned. The index equals 0 if the country has no patents in the given field and is above 1 when a specialisation is observed. Only RTAs close or greater than 1.5 are considered.
Source: IEA (2024), *Energy Technology RD&D Budgets* (database); IEA (2021), Patents and Energy Transition.

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1.5.2. Encouraging investment in low-carbon power generation

Japan has expanded renewable power capacity, but more investment is needed

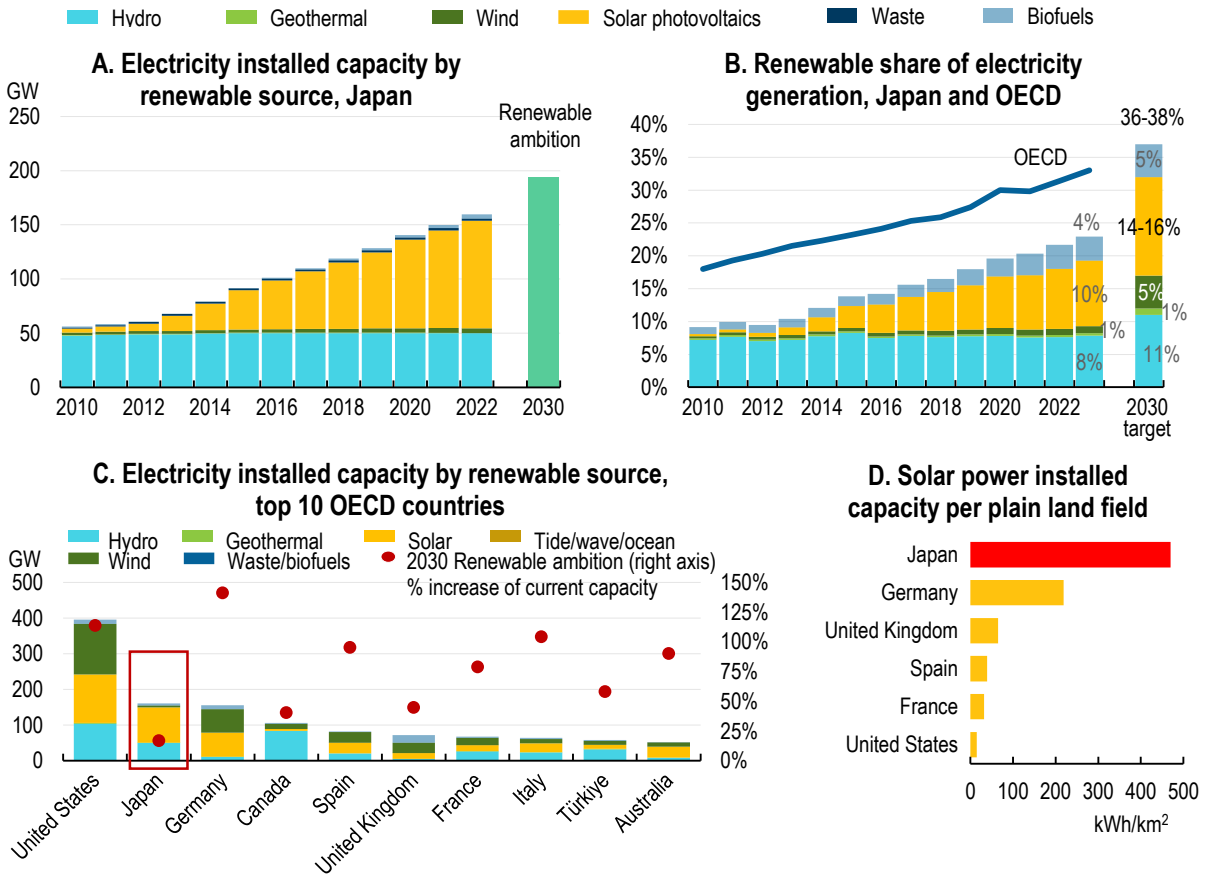
In the last decade, Japan saw significant investment in renewables electricity, partly to offset lower nuclear power generation after the 2011 accident. Renewable capacity more than doubled between 2010 and 2023, with nearly all new capacity coming from a surge in solar PV (Figure 1.28, panel A). Generous feed-in tariffs spurred PV growth but increased costs for electricity consumers (METI, 2024[33]). In a welcome move, the government introduced a feed-in-premium scheme in 2022 to encourage further renewable investment while reducing costs for customers and boosting generation during peak demand.[31] Today, Japan is among the global and OECD leaders in PV installations, while wind power accounts for a relatively low share of renewable capacity compared to other OECD countries (Figure 1.28, panel C). Despite this progress, renewables accounted for 23% of electricity generation in 2023, a little over two-thirds of the OECD average (Figure 1.28, panel B).

More investment in renewables and storage capacity will be needed to compensate for expected lower fossil fuel-based capacity, produce low-emission hydrogen and move towards further electrification of the economy. Japan plans to reach 36-38% of renewables in power generation by 2030 (Figure 1.6), mainly by expanding solar and wind capacity. The IEA estimates that Japan's 2030 target translates into 187-201 GW of renewable power capacity, or some 17-25% above the 2022 level. While this is a considerable increase, it is below the level of ambition shown by other G7 countries (Figure 1.28, panel C). In addition, Japan should assess whether its plan to expand renewable power generation capacity is ambitious enough to produce sufficient carbon-free hydrogen and ammonia to meet the country's growing demand of these fuels (see below).

Japan has vast potential for renewable electricity generation, particularly from offshore wind, tidal power and geothermal resources.[32] The IEA estimates the country will exceed its 2030 capacity target under current policy and market conditions and could increase renewables capacity further by introducing policy

changes to address its challenges (IEA, 2024[146]). Other analysis indicates that renewables could account for 70-80% of Japan's total power generation by 2035, more than double the government's target for 2030 (Box 1.3). Modelling suggests further expansion of renewables would reduce the need for higher-cost technologies such as hydrogen and CCUS and, in turn, the average cost of abating GHG emissions from the electricity system (Kuwabara et al., 2021[19]). It could also create job opportunities in rural areas, where renewable energy potential is high. This could help counteract economic and population decline in these regions and, ultimately, improve overall welfare in Japan (IRENA, 2022[147]) (Chapter 2).

Figure 1.28. Solar power is leading Japan's renewable electricity expansion



Source: IEA (2024), *Renewables Information* (database); METI (2024), Japan's Energy; METI (2024), "What are perovskite solar cells, Japan's trump card for expanding renewable energy?" (in Japanese), www.enecho.meti.go.jp/about/special/johoteikyo/perovskite_solar_cell_01.html.

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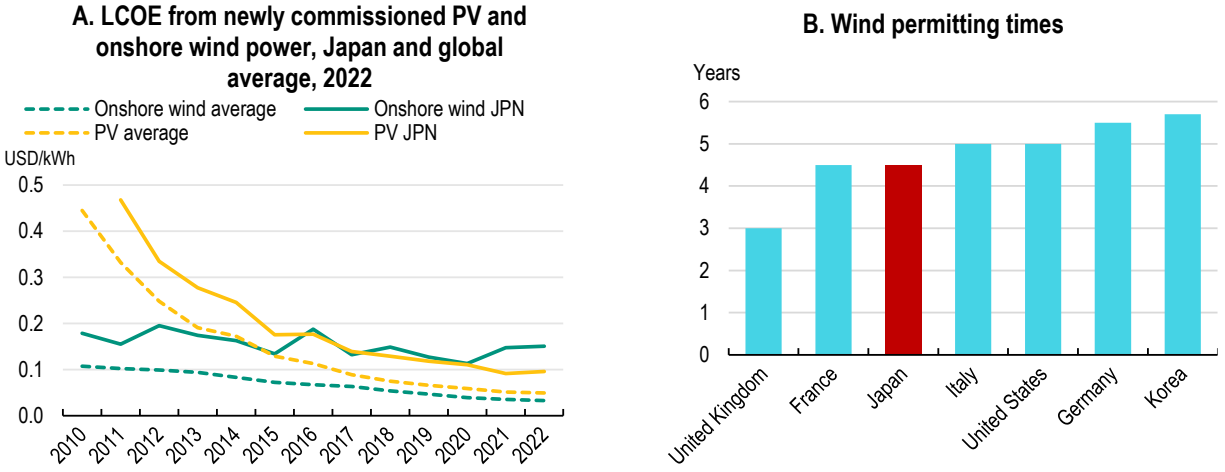
Japan needs to continue to address the barriers to renewables deployment

To fully harness its renewables potential, Japan needs to address key bottlenecks that contribute to the relatively high costs of renewables in the country. The costs of electricity from PV and onshore wind have declined in Japan in the last decade, in line with global trends. PV and onshore became cost competitive with fossil fuel electricity generation in recent years (IRENA, 2023[148]). However, costs are higher in Japan than in many other countries, especially for onshore wind (Figure 1.29, panel A), primarily due to high installation costs (IRENA, 2023[148]).

Figure 1.29. Administrative hurdles contribute to the relatively high cost of renewable energy installations



Notes: Panel A: LCOE: levelised cost of energy. Panel B: Japan: 4-5 years. Korea and United States: offshore wind permitting times only.
Source: Irena (2023), Renewable Power Generation Costs in 2022; Japan Wind Power Association (2021), "Wind power deployment targets for 2030: Toward carbon neutrality by 2050" (in Japanese), presentation at the 28th meeting of the Subcommittee on Large-scale Introduction of Renewable Energy and Nex-Generation Electricity Network, www.meti.go.jp/shingikai/enecho/denryoku_gas/saisei_kano/pdf/028_05_00.pdf.

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The scarcity of cheap, suitable land is a major factor driving up costs (Kuwabara et al., 2021[19]), with Japan having the highest density of PV-installed capacity per plain field (Figure 1.28, panel D). The GX Basic Policy promotes solar PV installations in public buildings to help address land-use conflicts. In addition, the country's deep coastal waters make fixed offshore wind turbines costly, favouring floating turbines. Meanwhile, its geothermal resources are mostly in protected areas and interact with hot springs operations. Other causes of high costs include grid constraints, special safety requirements for equipment against natural disasters, lengthy and complex permitting procedures and social resistance.

Japan has taken steps to address administrative and social barriers to renewables deployment. Like many other countries, Japan has a complex and time-consuming permitting process for renewable electricity projects, which typically take several years to complete (Figure 1.29, panel B). As of March 2024, wind power plants accounted for more than 80% of the ongoing EIA procedures, which is preliminary to permitting (Section 1.4.1). The government has amended the EIA regulations to expedite the procedure for wind power projects and enabled local governments to designate renewables energy promotion zones with faster EIA and permitting processes (Box 1.10). Japan should ensure that ongoing administrative streamlining does not compromise the effectiveness of the EIA and permitting processes in mitigating potential environmental impacts.

The renewable promotion areas may facilitate the engagement of local communities in the decision-making process (Chapter 2). This would help address local opposition, which has increased with the rapid growth of utility-scale PV plants. Nonetheless, Japan should ensure that sufficient time is devoted to public consultations in identifying renewable promotion areas and in specific siting decisions. It also needs adequate mechanisms to share the benefits of renewable energy projects with hosting communities (e.g. through tenders).[33] Dual-use land systems, like combining renewable energy generation with farming (solar sharing or agrivoltaics), can address social resistance by supporting traditional land use, preserving local landscapes and providing economic benefits. Solar sharing has been successfully implemented in some rural areas in Japan (Chapter 2). Other OECD countries have taken steps to address public resistance. For example, France's 2023 Renewable Energy Acceleration Law strengthens local

communities' decision-making power in siting renewable energy projects and enhances mechanisms for sharing the economic benefits of these installations. The law also established an observatory to monitor the impact of renewable energy on biodiversity (Ministère de la Transition Énergétique, 2023[149]).

Box 1.10. Streamlining permitting and spatial planning for renewable power installations

Amendments to the EIA legislation passed since 2021 to accelerate the permitting process of wind power plants include: easing certain assessment requirements for wind power projects (e.g. infrasound, vibration and NOx emission and dust during construction); and raising the installed capacity thresholds that necessitate an EIA, thereby exempting from the procedures small-scale developments.

To facilitate access to information relevant for the EIA of wind power projects, the MOE developed the Environmental Assessment Database System (EADAS). The system summarises local environmental information across the country and provides sensitivity maps and climate geodata in a publicly accessible manner. Similar sensitivity mapping tools to assist project siting are developed in other OECD countries, such as Spain and the United States (OECD, 2024[150]).

A specific zoning process identifies the promotion area where offshore wind power projects can be tendered. After passing a government-led screening process, a council of government officials, local stakeholders and experts evaluate "promising areas" to determine their designation as promotion areas suitable for development. The Council must engage in dialogue with local stakeholders, including representatives of local fisheries, and make recommendations to address their concerns before the area progresses to the tendering stage. As of October 2023, 10 of 21 promising areas had been identified as promotion areas. All these areas are in Japan's territorial waters. In 2024, the government also discussed the opening of the exclusive economic zone to floating wind projects.

Since 2016, the MOE has developed pilot zoning methods for renewable energy and has formulated guidelines to help local government planning. As of 2022, local governments can designate renewable energy promotion zones outside disaster-prone and biodiversity-sensitive areas identified by the national government or prefectures. Projects within renewable promotion zones benefit from simplified EIA procedures. As of October 2023, there were 16 such zones.

Other countries have adopted a similar renewable zoning approach. For example, the US state of California identified low-biodiversity value renewable power zones, tripling permitting speed and cutting costs of PV projects by 7-14% (OECD, 2024[150]). Italy's "suitable areas reform" requires regional governments to identify suitable and unsuitable locations for renewable installations based on uniform national criteria. The reform streamlines project approvals in suitable areas and introduces a burden-sharing mechanism, setting regional renewables targets to 2030 (OECD, 2024[151]). Similarly, the European Union requires member states to identify "renewables acceleration areas" (RAA) where projects benefit from simplified permitting. RAAs should prioritise artificial surfaces and degraded land, while excluding high-value environmental areas. Member states' RAA plans must undergo strategic environmental assessment and ensure public participation.

Source: Council of the European Union (2023[152]); Miyagawa, Kurano and Kagawa (2023[153]); METI and MLIT (2024[154]); MOE (2024[45]).

Japan has planned considerable investment in grid and storage infrastructure to facilitate the integration of renewables into the electricity system. The fragmentation of the electricity network into regional grids constrains the dispatch of renewable power, whose best potential lies in areas located far from demand centres (IEA, 2021[15]). This has often led to curtailment of electricity generated from renewables, especially in the Kyushu area which hosts large capacities of both nuclear and solar power (Zissler, 2024[155]). The 2023 national plan for grid development foresees investment of JPY 7 trillion (about USD 55 billion) in

regional grid interconnectors to 2050. However, estimates indicate that much higher grid investment (nearly USD 490 billion over 2022-40) – including for interconnecting regional grids – will be needed to stay on the path to net zero (BNEF, 2023[20]). Japan should continue investments in transmission and distribution infrastructure, based on cost-benefit analysis (IEA, 2021[15]; OECD, 2024[6]). The government needs to consider reforms to enable more grid investment, particularly from the private sector (BNEF, 2023[20]).

Recycling of critical minerals and solar PV panels need to be promoted

Japan has taken steps for recycling critical minerals to help ensure their supply security, which is crucial in a decarbonised energy system (IEA, 2023[156]). The country has potential to leverage high un-managed electrical and electronic waste (e-waste). It has among the highest levels of e-waste generation per capita in the OECD but one of the lowest e-waste collected and recycled volumes per capita (OECD, 2024[157]). The Fifth Fundamental Plan for Establishing a Sound Material-Cycle Society aims to increase the amount of electronic scrap recycled and processed to about 500 000 tonnes by 2030 (a 50% increase from 2020).

In 2022, Japan established a system for setting aside funds to cover dismantling and other costs of utility-scale solar power generation equipment to prevent such facilities being abandoned or illegally dumped.[34] The MOE also updated the guidelines on PV panel recycling. The MOE and METI are considering a system to address the expected peak in PV panel dismissal beginning in the late 2030s, while supporting the development of appropriate recycling facilities. To accelerate progress, Japan could set targets for PV panel recycling, as done in the European Union since 2018, with a target of 80% of waste from PV panels recycled or prepared for reuse. Japan has commendably worked with international partners to enhance critical mineral security, including by establishing partnerships with the Association of Southeast Asian Nations.

Japan has been increasingly investing in hydrogen, ammonia and CCS technology

Japan was an early developer of ammonia, hydrogen, CCUS and carbon recycling technologies. In 2017, it became the first country in the world to develop a national hydrogen strategy, which was last revised in 2023. The country has increasingly invested in R&D of these technologies, with successful pilot applications in industry and power generation (IEA, 2023[26]). Hydrogen, ammonia and CCUS technologies are expected to play an important role in decarbonising Japan's power mix and economy at large (Section 1.2.2). The Sixth SEP projects Japan's demand for hydrogen to grow more than ten-fold to 2050, which underlies the need to decarbonise hydrogen production and supply chains.

However, production and deployment of low-emission hydrogen and ammonia, as well as CCUS, have remained modest in Japan, as elsewhere in the world. This is due to high costs, uncertainty around future demand for low-emission hydrogen and recycled CO_2, lack of infrastructure and underdeveloped supply chains, among other reasons. Low-emission hydrogen still accounts for less than 1% of global hydrogen production and use.[35] Producing low-emission hydrogen is more expensive than producing it using unabated fossil fuels. Much investment is needed in infrastructure to deliver hydrogen safely and to transport and store CO_2 (IEA, 2023[25]; IEA, 2023[26]). The government plans to considerably extend its CO_2 storage capacity, but most of Japan's CCS potential is offshore, which makes it more costly to exploit. GHG emission abatement solutions using hydrogen and CCUS technologies are unlikely to be economically competitive in Japan in the absence of a sufficiently high carbon price that keeps unabated fossil-based power generation out of the market (BNEF, 2023[20]) (Section 1.4.3).

Japan has started to address the barriers to the large-scale deployment of low-emission hydrogen, ammonia and CCUS. The GX Basic Policy provides considerable funding for developing CCUS and hydrogen and ammonia infrastructure and the related supply chains (Figure 1.17). In 2024, Japan enacted legislation to regulate and promote the commercial use of these technologies (Box 1.11). Both pieces of legislation are broadly in line with IEA recommendations for these sectors (IEA, 2024[158]; IEA, 2023[26]).

Box 1.11. Japan's Hydrogen Society Promotion Act and the CCS Business Act

The Hydrogen Society Promotion Act provides the framework for defining low-carbon hydrogen (and derived fuels like ammonia). It establishes a licensing system for businesses and provides subsidies to supply low-carbon hydrogen and to build common infrastructure. The Act and its implementing ordinances classify hydrogen as low carbon if its well-to-gate CO_2 emissions intensity (covering upstream, midstream and production emissions) is at or below 3.4 kg-CO_2eq/kg-H_2. This threshold represents about a 70% reduction in emissions compared to hydrogen from natural gas. Japan's emission intensity criteria are less stringent than those in the European Union, United Kingdom, Germany and France, as well as several voluntary international certification standards (IEA, 2023[159]).

The CCS Business Act outlines the process to designate suitable geological storage areas and established a licensing system for operators. It also sets safety and monitoring requirements and provides a framework to manage the long-term liabilities associated with the risk of leakage or release of captured CO_2. Operators are liable for accidents, regardless of intent or negligence (no-fault liability), and are required to set aside funds for this purpose. Operators must also contribute funds to the Japan Organization for Metals and Energy Security (JOGMEC) to cover monitoring and management costs following the termination of the operator's storage licence. Subsequently, JOGMEC will take over storage rights and responsibilities.

Source: Agency for Natural Resources and Energy (2024[160]); Bocobza, Tanabe and Takahashi (2024[161]).

1.5.3. Mobilising efforts to reduce and decarbonise final energy use

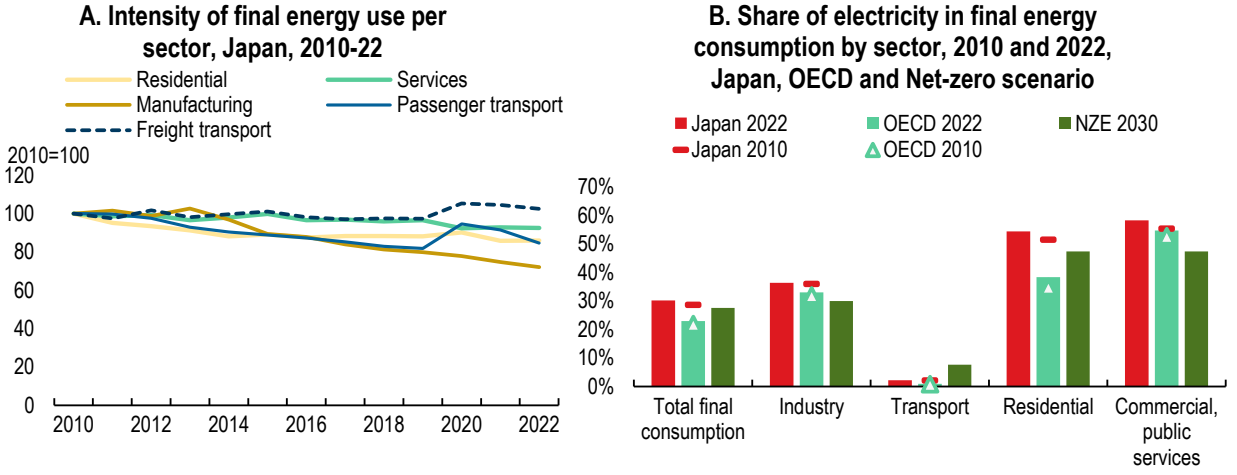
Significant investments in energy efficiency have yielded results

Japan rightly prioritises further reducing energy use to achieve its climate and energy security goals. Consistent with past trends, energy captured over 60% of clean energy investment in 2021-24 (Figure 1.26, panel B), a higher share than in many other world regions (IEA, 2024[73]). Longstanding policy measures, such as the Top Runner Programme (Box 1.12), voluntary agreements with industry and considerable financial support, have encouraged investment and helped reduce the energy intensity of all sectors but freight transport (Figure 1.30, panel A). In addition, government-led energy-saving initiatives in the aftermath of the 2011 accident have brought lasting efficiency improvements (IEA, 2021[15]).[36] Japan's high level of electrification also contributes to saving energy. In 2022, electricity covered a larger share of energy use across all sectors (except transport) than the OECD average, as well as the global levels needed by 2030 to align with the IEA's net-zero scenario (Figure 1.30, panel B). The Sixth SEP expects that continuous progress in energy efficiency and electrification will contribute to reducing final energy consumption by 20% by 2030 compared to business-as-usual (Figure 1.5).

Industry energy efficiency has further improved, but more stringent policies may be needed

Japan's large manufacturing sector has traditionally been at the forefront of energy efficiency investment. Industry is the country's largest energy user and the second largest source of GHG emissions (Figure 1.3, panel C). Intensity of energy use in the industrial sector has continued to decline (Figure 1.30, panel A), driven both by reduced output in energy-intensive industries (such as cement and steel) and energy efficiency advancements.

Figure 1.30. Progress in energy efficiency and electrifications is well under way



Note: Panel A: Energy intensities in the residential and service areas are calculated as energy use corrected for temperature variations per floor area; energy intensity in the manufacturing sector is defined as energy use per value added; energy intensities of passenger and freight transport are energy use per passenger-kilometre and tonne-kilometre, respectively. Panel B: NZE = Net-zero scenario.
Source: IEA (2024), *Energy End-uses and Efficiency Indicators* (database); IEA (2024), *IEA World Energy Balances* (database).

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Box 1.12. Japan's flagship Top Runner Programme for energy efficiency

The Top Runner Programme, launched in 1998, is a system of energy efficiency targets for a variety of products, including household electric appliances, office devices, vehicles and building materials. The coverage of the programme was extended from 23 to 32 product categories in the last decade, including some building-related materials. Targets are set by product category at the level of the best performing model on the market and are to be achieved within a given number of years. Unlike minimum energy performance standards in many countries, the target refers to the weighted average energy performance of the products sold by a company in the target year, and not to the individual product sold. Various measures contribute to achieving Top Runner objectives, including fiscal incentives for purchasing products that meet or exceed the programme's targets.

The Top Runner Programme focuses on realistic levels of energy efficiency, thereby encouraging incremental improvements. The "top runners", i.e. companies with the most energy-efficient products at the start of a target cycle, do not need to invest further. Since compliance is assessed by comparing performance in the base and target years, target setting does not consider potential technological improvements that would occur in the absence of the programme, or of developments already available but commercially untapped. Comparing performance in the target year with baseline projections would be more appropriate. The Top Runner Programme targets should be assessed in terms of their level of ambition, capability of inducing breakthrough innovations and cost effectiveness.

Source: IEA (2021[15]); METI (2024), Energy Conservation Portal, Energy-saving information for businesses (in Japanese) www.enecho.meti.go.jp/category/saving_and_new/saving/enterprise/equipment/; OECD (2010[94]).

Japan's policy to encourage industry's investment in energy efficiency and GHG emission reduction relies on subsidies and tax incentives, as well as reporting requirements, benchmarking and voluntary industry

commitments under the Keidanren voluntary action plans (Box 1.8). Large companies in major industrial and commercial sectors are required to meet energy efficiency targets based on the best performers in each sector. However, in 2022, only about a quarter of reporting companies complied with the benchmarks, with no sector reaching full compliance (METI, 2023[162]). Large companies are also required to improve energy efficiency by 1% a year, which is not an ambitious target for companies that regularly renew their equipment. The government should assess the effectiveness of the target and benchmarking system, consider raising the target and reinforcing deterrence for non-compliance (IEA, 2021[15]). While there is no penalty for missing the targets, companies that meet them may benefit from financial support. More efforts are also needed to encourage energy efficiency improvements in small and medium enterprises, which are the majority of businesses in Japan, as well as in the expanding service sector.

Improving the energy performance of buildings has gained traction in Japan

Much government efforts focus on energy savings in the residential sector. Residential energy consumption declined by 17% between 2010 and 2022 (Figure 1.5, panel B). Energy intensities of space and water heating, cooking and appliances also decreased (Figure 1.31, panel A). The space heating energy intensity is among the lowest in the OECD, including countries with similar climates. However, space cooling intensity is among the highest in the OECD and has been rising (Figure 1.31, panels A and B). This reflects the nearly ubiquitous presence of air conditioning systems, albeit highly efficient ones.[37] In addition, the carbon intensity of space heating and cooling (when CO_2 emissions from electricity are factored in) has increased with the rising carbon intensity of Japan's power generation after the 2011 accident (Section 1.2.2) (Figure 1.31, panel A).

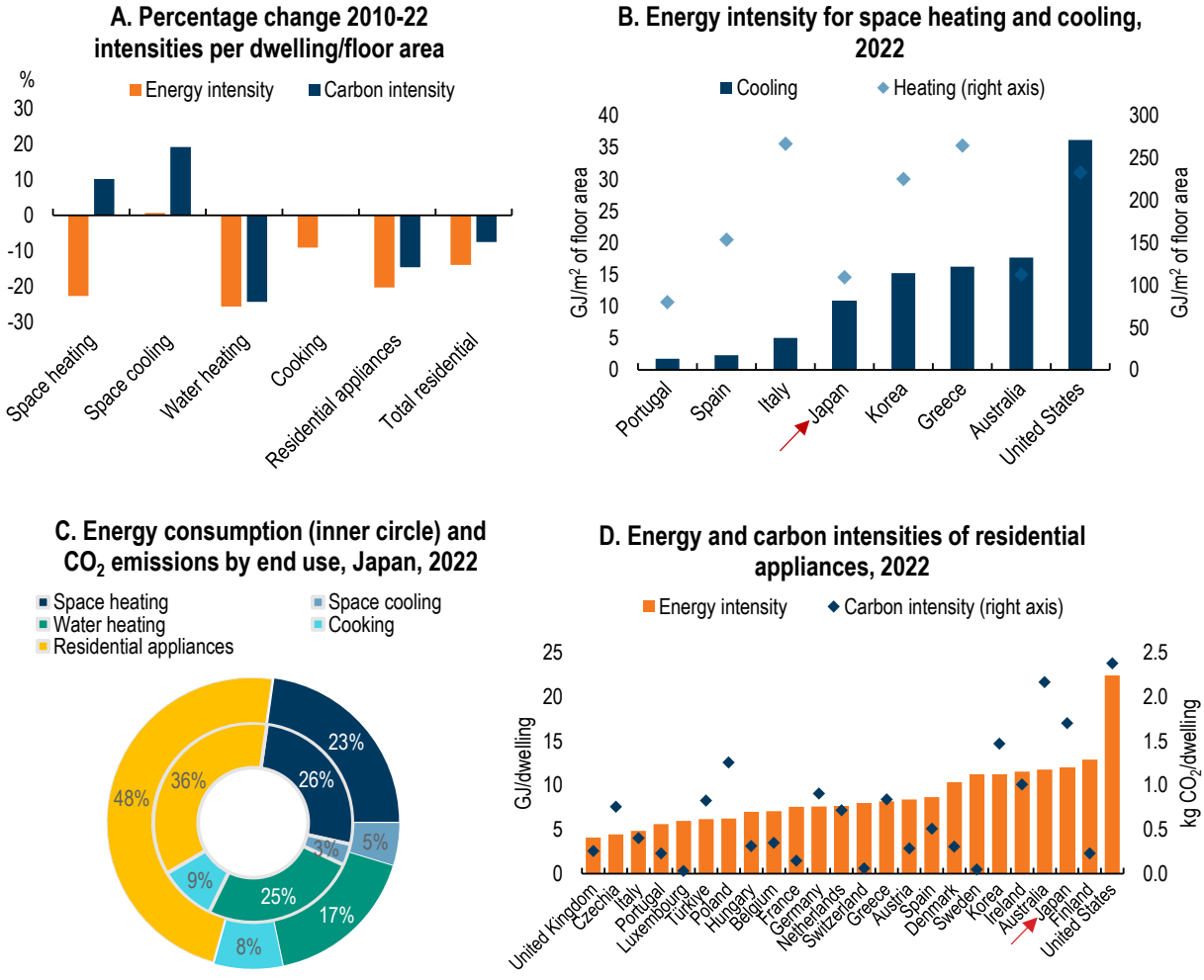
The recent reform of energy performance regulations for buildings is welcome. Given long lifespans of buildings, energy codes are essential for improving efficiency and must align with long-term climate goals to prevent lock-in, especially in countries like Japan with relatively high rates of new construction (IEA, 2024[163]; OECD, 2024[164]). Despite a relatively young building stock, with only a quarter of housing built prior to 1980 (OECD, 2024[164]), 80% of homes and 60% of non-residential buildings do not meet current energy performance standards (MOE, 2024[8]). Unlike most OECD countries, energy performance standards are mandatory only for new mid- to large-scale non-residential buildings in Japan (IEA, 2024[163]). They will become compulsory for all new buildings as from 2025, four years after the European Union implemented its nearly zero-energy building mandate for new buildings. The revised Building Energy Conservation Act also aims for zero-energy buildings and zero-energy houses (ZEH) for all new buildings by 2030 and on average for the building stock by 2050.[38] In 2022, a third of new houses met the ZEH standard, up from 12% in 2016. The new requirements are broadly in line with the IEA's Net-Zero Emissions scenario and standards in the European Union.[39]

Japan has been providing financial support for energy efficiency retrofitting and integrating the use of renewable energy into buildings. Frequent retrofitting for earthquake resilience provides opportunities to improve energy efficiency in existing buildings (Kuwabara et al., 2021[19]). Nonetheless, Japan should strengthen efficiency requirements for major building renovations, as done in several European countries. It could consider introducing energy performance standards and certification for existing homes when sold or rented, aiming to encourage the retrofitting of the worst-performing buildings. France has been implementing a similar policy since 2023. In addition, Japan should mandate renewable energy integration into new and retrofitted buildings, as this will be key for reducing the carbon intensity of energy use in homes and commercial buildings and fully reap the benefits of electrification. The MOE's initiative to source all its energy needs from renewables by 2030 is an exemplary action that could be replicated.

Decarbonising buildings also requires considering GHG emissions across the entire building life cycle. Japan established a standardised method for this assessment. It could go further by introducing mandatory CO_2 declarations and limit values for new buildings, following the lead of countries such as Finland, France, the Netherlands, Norway and Sweden (OECD, 2024[164]). This would help minimise the sector's carbon

footprint, from construction materials onward, and enhance resource circularity. The government's plan to raise the Top Runner standards for building materials and equipment goes in the right direction (Box 1.12).

Figure 1.31. Intensity of household energy use has improved, but carbon intensity of space cooling and appliance use is high



Note: Panels A and B: Temperature-adjusted energy intensity for space heating and cooling per floor area. Panel A: Energy intensity of water heating, cooking, residential appliances and total residential per dwelling.
Source: IEA (2024), *Energy End-uses and Efficiency Indicators* (database).

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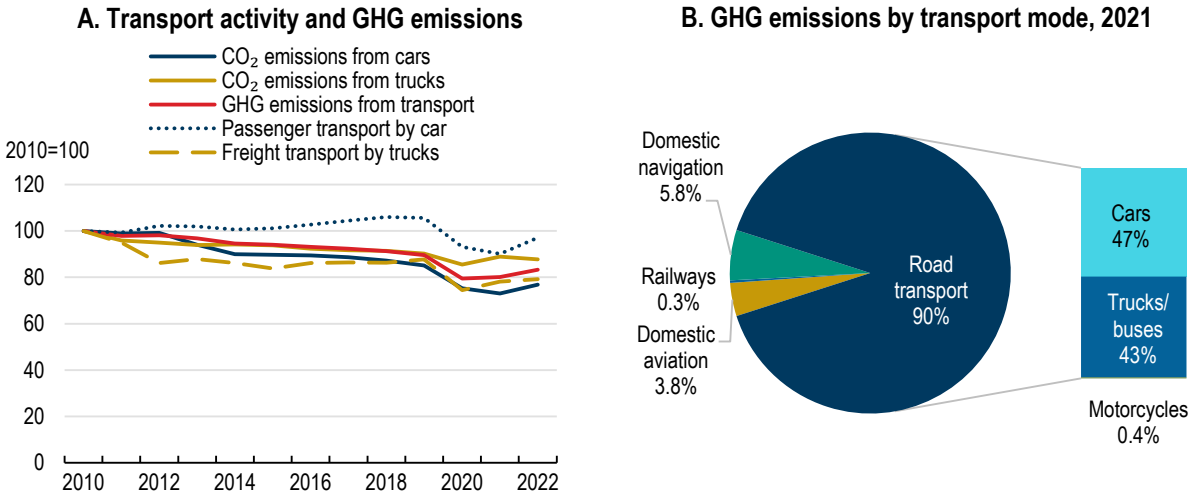
Beyond reducing energy use and GHG emissions, energy efficiency renovations and renewables integration contribute to enhancing comfort and health outcomes, including by increasing the resilience of homes to more frequent extreme heat events (Section 1.2.6). They could also reduce energy bills and help address energy poverty. Targeting aid for renovations to vulnerable and credit-constrained households could prevent the benefits from accruing only to wealthier homeowners (Hemmerlé et al., 2023[131]). Offering financial support for the solar PV home installation in rural areas without access to the natural gas network and among vulnerable population groups could be particularly beneficial (Chapman and Okushima, 2019[165]).

Greater focus on encouraging behavioural changes, alongside technical efficiency gains, is needed. The flagship Top Runner Programme has driven improvements in energy performance of appliances, office equipment and vehicles for more than two decades. However, its energy performance targets may lack ambition (Box 1.12). Rising size, number and usage of electric appliances have partly offset the technical energy efficiency gains (Inoue and Matsumoto, 2019[166]). Japan has one of the highest energy and carbon intensities of appliance use in the OECD (Figure 1.31, panel D). In 2022, residential appliances accounted for the largest share of Japan's household energy use and CO_2 emissions (Figure 1.31, panel C). Demand-side initiatives like the 2015 "Cool Choice Campaign" and the more recent *Decokatsu* information sharing and collaboration platform are positive steps to encourage changes in consumption behaviours and lifestyles. They could be expanded.

Improved fuel economy has helped contain GHG emissions from transport

Japan's GHG emissions from transport have steadily declined over the past two decades in light of improving fuel efficiency of passenger cars and decreasing freight transport volumes. Emissions decreased by 10% between 2010 and 2019, prior to the sudden drop in 2020 during the COVID-19 pandemic, but have been on the rise since (Figure 1.32, panel A). Japan's excellent rail system and coastal shipping play a significant role in passenger and freight transport, respectively. Yet, road transport is the dominant mode and accounts for 90% of GHG emissions from transportation (Figure 1.32, panel B). While the freight modal split has remained virtually unchanged in the last decade, the COVID-19 pandemic shifted people's travel preferences towards private cars.

Figure 1.32. GHG emissions from transport, mainly on roads, have declined



Note: Panel A: Passenger and freight transport indexes based on data expressed in passenger-km and tonne-km, respectively.
Source: IEA (2024), *CO_2 Emissions from Fuel Combustion* (database); ITF (2024), *Transport Statistics* (database); UNFCCC (2024), *GHG Data Interface* (database).

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Transport modes differ significantly between metropolitan and rural areas in Japan. Public transport in Japanese metropolitan regions is widely regarded as reliable, convenient and affordable. For example, Tokyo boasts the world's busiest and most densely populated urban railway network (OECD, 2024[167]). On weekdays in 2021, train usage accounted for about 25% of trips in the three major metropolitan areas, compared to only 3.7% in rural areas. In these rural regions, over half of transportation relies on private

cars (MOE, 2024[8]). Depopulation in rural areas further reduces the economic viability of public transport services, leading to fewer shared mobility options and exacerbating car dependency (Chapter 2). Hence, people in rural areas, who are often older and with lower income, are more vulnerable to higher prices of transport fuels, in addition to be more likely to suffer from energy poverty for home needs (Okushima and Simcock, 2024[121]). Appropriate spatial planning, support for shared mobility and demand-side initiatives are needed to reduce private car use and boost alternative modes of transport in rural areas. This would help decarbonise the transport sector. Steps have been taken in this direction, with the promotion of community buses and on-demand transport services, as well as some local initiatives with self-driving buses.

CO_2 emissions from passenger car use have declined despite increasing traffic volumes (Figure 1.32, panel A), indicating a shift towards more fuel-efficient and lower-emission vehicles. This shift has been primarily promoted through fuel economy targets under the Top Runner Programme (Box 1.12). Vehicles that meet or exceed these fuel efficiency standards receive reductions in purchase and ownership taxes (Section 1.4.3). Since 2010, the average fuel efficiency of new petrol cars has improved significantly. The 2020 average fuel efficiency target was surpassed as early as 2013, though gains since then have been modest (JAMA, 2024[97]). Recognising the need for continued progress, Japan introduced a new 2030 target that is 25% stricter than the previous one. This new standard for cars is less stringent than the 2030 standards in the European Union but more ambitious than those in the United States (IEA, 2021[15]). Japan has also tightened standards for heavy-goods vehicles, with new targets to be met by 2025. Japan was an early adopter of fuel efficiency standards for heavy-duty vehicles. However, the stringency of its regulations has since fallen behind those in other major countries and regions, such as Canada, the European Union and the United States (IEA, 2021[15]). The government should consider further tightening fuel efficiency targets for vehicles.

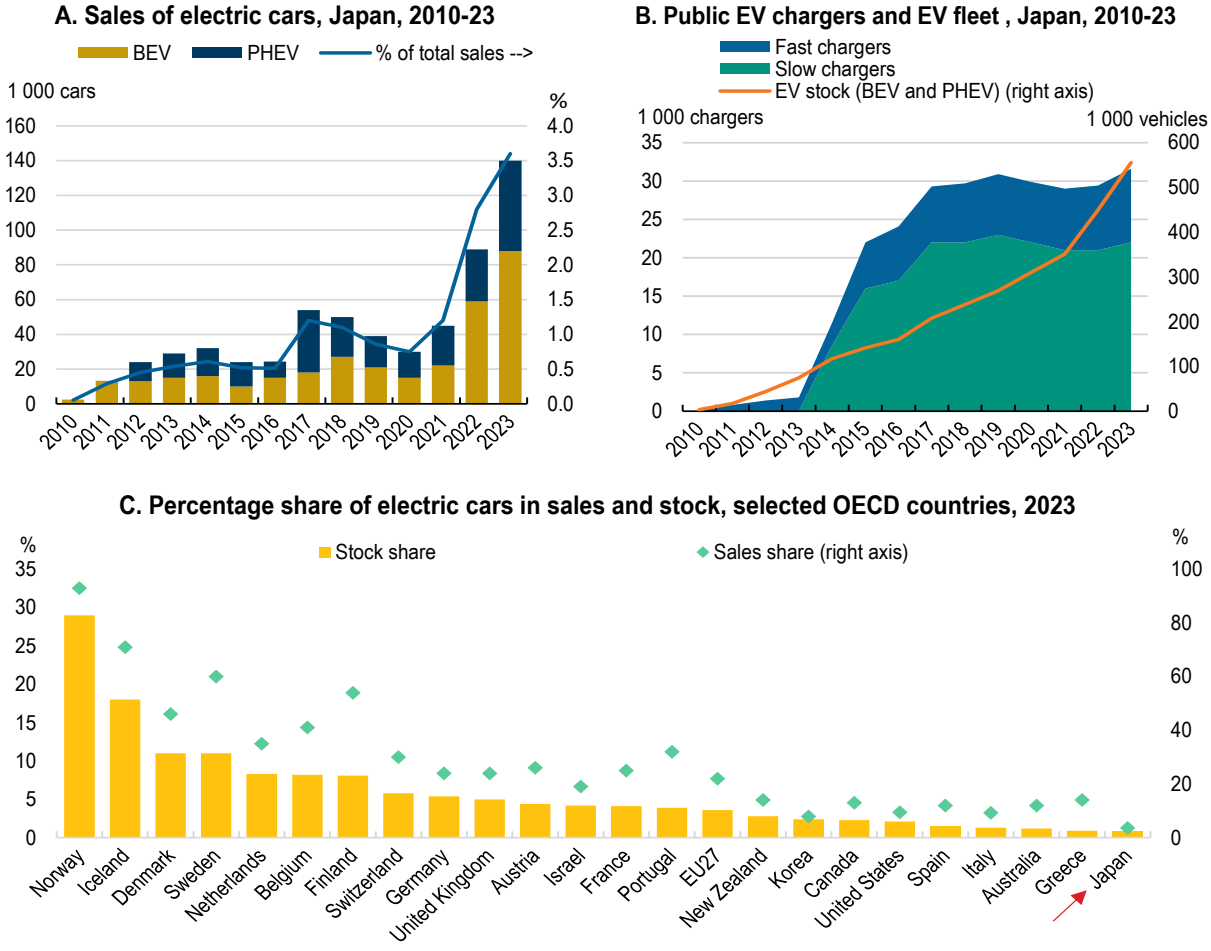
The transition to electromobility could be accelerated

Japan is home to one of the world's largest automotive industries and has been a frontrunner in the development of hybrid, electric and fuel cell vehicles. It has long provided subsidies and tax incentives for the purchase of electrified vehicles, including hybrid cars (Section 1.4.3). However, sales of EVs (BEV and PHEV) have been stagnant for the best part of the decade, while those of hybrid cars increased to over half of new domestic car sales. EV sales rose only recently to 3.6% of new passenger car sales in 2023 (Figure 1.33, panel A), likely thanks to higher purchase subsidies for EVs and the subsidy removal for hybrids. Despite this growth, the shares of EVs in car sales and stock (less than 1%) are far below other OECD countries (IEA, 2024[99]) (Figure 1.33, panel C).

Electric and fuel cell vehicles could make a key contribution to emission reductions for transport. The government targets 100% sales of "next-generation vehicles" (including hybrid, PHEV, BEV and fuel cell) by 2035. Modelling suggests that, if power generation quickly shifts to low-carbon sources, a 90% share of battery electric in new vehicle sales by 2030 would help meet the NDC in a more cost-effective manner (Kuwabara et al., 2021[19]). Shifting to fully electric and fuel cell vehicles will require more ambitious targets on EVs and fuel cells and improved regulations. The government should consider setting a phase-out target for all fossil-fuelled vehicles (BNEF, 2023[20]).

The rising global demand for EVs and regulations in Japan's export markets, such as the upcoming ban in the European Union on new internal combustion vehicles (including hybrids) from 2035, could pose risks for Japan's automobile industry, which has focused on hybrids until recently (OECD, 2024[6]). The auto industry would have to ramp up production of EVs and hydrogen-powered vehicles. Battery manufacturers would also need to adjust production to meet the new demand, which would increase eight-fold in the next decade.

Figure 1.33. Sales of EVs have grown over 2010-23, but growth is relatively limited



Note: BEV = battery electric vehicle; PHEV = plug-in hybrid electric vehicle. Panel B: cars, buses, vans and trucks.
Source: IEA (2024), Global EV Outlook 2024, www.iea.org/data-and-statistics/data-product/global-ev-outlook-2024.

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Expanding Japan's EV charging network in co-ordination with renewables and power grid development is essential to support the transition to electromobility. As the home to the world's most populous city, Tokyo, and two other densely populated megacities – Osaka and Nagoya – Japan also faces spatial challenges in rolling out public and private charging stations and other infrastructure required for electric and hydrogen-fuelled vehicles (Kuwabara et al., 2021[19]). The public charging network has grown slowly and has not kept pace with sales of electric cars, hindering EV deployment (Figure 1.33, panel B). The government aims to install 300 000 charging plugs by 2030, a ten-fold increase from 2023. In a welcome development, the government linked the EV subsidy to manufacturers' investment in EV infrastructure provision in 2024 (Section 1.4.3).

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Notes

[1] On 11 March 2011, a magnitude 9.0 earthquake off the coast of Japan generated a tsunami that caused massive damage across northeastern Japan, including to the Fukushima Daiichi Nuclear Power Station run by the Tokyo Electric Power Company (TEPCO).

[2] Energy-related GHG emissions include emissions from burning fossil fuels for power and heat generation (energy industries) and direct fossil fuel use in manufacturing, transport and buildings.

[3] In its previous NDC, submitted to the UNFCCC in 2020, Japan pledged to reduce emissions by 26% by 2030 from 2013 levels and by 80% by 2050, and to become a decarbonised society soon after.

[4] Energy self-sufficiency (as measured by the ratio of domestic energy production to total energy supply) would increase from 15% in 2023 to 30% in 2030.

[5] The IEA (2023[25]) defines unabated fossil fuel facilities as those without CCUS equipment.

[6] As of January 2024, 12 of the country's 36 operational reactors had restarted, 5 had passed the regulator's review and 10 were under assessment (METI, 2024[33]).

[7] A February 2024 Asahi Shimbun poll shows that for the second year in a row half of the population supports restarting reactors, up from about 30% in previous years.

[8] Total maximum electric capacity of coal power plants run by electric utilities increased from GW 45.6 in April 2016 to GW 54 in March 2024.

[9] The SEP indicates that regulations would be tightened to require efficiency levels equivalent to ultra-supercritical coal technology.

[10] Japan has not specified what it considers to be abated coal power plants. While there is no internationally agreed definition, IEA (2023[25]) defines abated fossil fuel facilities as those equipped with CCUS technology. IPPC (2022[7]) considers unabated fossil fuels as those produced and used "without interventions that substantially reduce the amount of GHG emitted throughout the life cycle; for example, capturing 90% or more CO_2 from power plants, or 50-80% of fugitive methane emissions from energy supply". The OECD Arrangement on Officially Supported Export Credits bans officially supported export credits and tied aid for new coal-fired power plants without operational CCUS facilities.

[11] A new coal plant of 0.5 GW, whose construction is planned to start in 2026, is intended to co-fire biomass, ammonia and hydrogen with coal and test CCUS technology.

[12] The number of days of Ox alerts decreased from 123 days in 2011 to 41 days in 2022.

[13] In the definition by the World Food Programme, food loss happens at the production, post-harvest and processing stages of the food chain when food becomes unfit for human consumption. Food waste happens when people discard food that is still fit for human consumption (corresponding to *Shokuhin rosu* in Japanese).

[14] Examples include the Amami rabbit, the Japanese crested ibis and the grouse.

[15] A PAME evaluation is the assessment of how well protected areas are being managed – primarily the extent to which management is protecting values and achieving goals and objectives (CBD and UNDP, 2021[53]).

[16] Japan's Nationally Determined Contribution aims to remove emissions for about 38 Mt CO_2 from forest management, 1.2 Mt CO_2 from urban greening and 8.5 Mt CO_2 from agricultural soil carbon sink measures by FY2030.

[17] Blue carbon ecosystems refer to coastal and marine habitats that capture and store carbon from the atmosphere and ocean, helping mitigate climate change. These ecosystems include mangroves (coastal forests found in tropical and subtropical regions), seagrass meadows and salt marshes.

[18] In Japan, green infrastructure is an initiative that leverages the diverse functions of nature for regional development, aligning with the broader concept of NbS.

[19] Six categories are energy efficiency; renewable energy; low-carbon and decarbonised energy; clean transportation; circular economy adapted products, production technologies and processes; environmentally sustainable management of living natural resources and land use, circular economy.

[20] Examples include A-PLAT (Climate Change Adaptation Information Platform), EADAS (Environmental Assessment Environmental Basic Information Database System) and REPOS (Renewable Energy Information Provision System).

[21] The OECD IPPC Recommendation suggests to determine BAT through a stepwise process that includes identifying the sectors or subsectors amenable to adoption of BAT; obtaining multi-stakeholder technical and economic input on the considered techniques, including their environmental performance; collecting and evaluating data; establishing national BAT-based standards; deriving permit limits; establishing monitoring requirements and other permit conditions; and continuous collection of information on emerging techniques.

[22] An ordinance-designated city is a major city (with over a half million inhabitants) with higher administrative autonomy than other cities. Such cities have powers more similar to those of prefectures.

[23] Vehicle taxes include the vehicle tonnage tax (based on weight and paid upon mandatory vehicle inspections), the annual automobile tax (based on engine size) and the environmental performance-based tax paid on acquisition of a vehicle.

[24] The initial and supplementary budgets allocated to EV purchase subsidies were about JPY 53 billion in FY2021, JPY 85.5 billion in FY2022 and JPY 149 billion in FY2023.

[25] Energy poverty is broadly understood as the inability to achieve a socially and materially sufficient level of domestic energy services.

[26] The revenue from taxes on energy products in 2022 was JPY 4.2 trillion, as reported in the OECD Policy Instruments for the Environment (PINE) database.

[27] The ban applies to new coal-fired power plants without operational carbon capture, utilisation and storage (CCUS) facilities; and to existing coal-fired power plants, unless the purpose of the equipment supplied is pollution or CO_2 abatement and such equipment does not extend the useful lifetime or capacity of the plant, or unless it is for retrofitting to install CCUS.

[28] The G7 Elmau Leaders' Communiqué of 2022 states: “recognising the importance of national security and geostrategic interests we commit to end new direct public support for the international unabated fossil fuel energy sector by the end of 2022, except in limited circumstances clearly defined by each country consistent with a 1.5°C warming limit and the goals of the Paris Agreement.”

[29] The amount indicated are based on the Classification of Function of Government of the national accounts. Environmental protection investment includes investment on pollution abatement (air, water, soil and noise), waste and wastewater management, protection of biodiversity, and related research and development, education and training activities.

[30] Iron & steel; chemical; electricity; gas; oil; cement and paper & pulp; and automobiles.

[31] A feed-in tariff system guarantees renewable energy producers a fixed, above-market price for the electricity they generate. A feed-in-premium pays generators a fixed subsidy on top of the wholesale market price. This reduces the subsidy cost and links the revenue the generator receives to the market price, thereby providing incentives to increase supply during peak demand hours.

[32] Japan has the world’s third largest geothermal potential, after the United States and Indonesia. The SEP aims to double the number of geothermal power plants and install 10 GW of floating wind farms by 2030.

[33] For example, the offshore wind promotion areas have been designated with only a two-week window for public consultation. The tender guidelines for offshore wind plants allocate just 10 out of 240 points to factors like co-ordination with local government authorities and ensuring “harmony and symbiosis” with shipping lanes and fisheries (EC, 2022[169]).

[34] Solar power facilities for business purposes, with a capacity of 10 kilowatts or more.

[35] The IEA defines “low-emission hydrogen” as that produced through water electrolysis with electricity generated from a low-emission source (renewables or nuclear), as well as hydrogen produced from biomass or from fossil fuels with CCUS technology. Production from fossil fuels with CCUS is considered low-emission only if upstream emissions are sufficiently low, if capture – at high rates – is applied to all CO_2 streams associated with the production route and if all CO_2 is permanently stored (IEA, 2023[26]).

[36] Following the 2011 nuclear accident, the government launched the *Setsuden* energy-saving movement requiring households and businesses to save electricity by adjusting operational hours, switching off lights and limiting air conditioning during peak times. There has been no visible rebound effect after the programme ended in 2015 (IEA, 2021[15]).

[37] More than 85% of households are equipped with air conditioning systems in Japan, Korea and the United States (IEA, 2024[170]). The stock of air conditioners increased by 20% between 2010 and 2022 (IEA, 2024[168]).

[38] A zero-energy building is a non-residential building that aims to achieve a 50-100% reduction in energy consumption compared to conventional buildings, with the remainder being offset by renewable energy; a zero-energy house is a residential home that reduces primary energy consumption by at least 20% compared to standard energy efficiency requirements, with the remainder typically being offset by renewable energy.

[39] The IEA Net-Zero scenario calls for all countries to establish energy codes for zero carbon-ready buildings for both residential and non-residential buildings by 2030 at the latest, and for all new buildings to meet this standard from 2030. The 2024 revision of the EU Energy Performance of Buildings Directive requires all new buildings to meet zero-emission building standards by 2030, with public buildings by 2028.

Chapter 2. Leveraging synergies and place-based approaches for the green transformation

This chapter examines how a place-based, territorial approach to environmental action could allow Japan to accelerate its green transition. As in other countries, Japan's diverse geographical, climatic and socio-economic landscapes require locally tailored environmental policy solutions. Integrating local environmental action into national plans and strategies presents an opportunity to identify synergies and minimise trade-offs across environmental objectives (climate, biodiversity, pollution and circular economy) and across social and economic objectives.

2.1. The need for a place-based approach to environmental action

2.1.1. Japan is promoting synergy solutions to tackle interconnected environmental challenges

Like many other OECD countries, Japan is grappling with the triple planetary crisis of climate change, biodiversity loss and pollution. These three crises are deeply interconnected; actions in one area often influence outcomes in others. For example, if not adequately planned, large-scale renewable energy projects to reduce greenhouse gas (GHG) emissions may affect ecosystems, while preserving and conserving forests and marine ecosystems enhance carbon sequestration. Finding ways to minimise trade-offs and maximise synergies is crucially important.

To address the crises effectively, Japan has been promoting, both domestically and internationally, the importance of a "synergistic approach" to climate change, biodiversity loss and pollution. Some major national environmental plans and strategies already reflect this approach, as discussed in the next section. Moreover, buoyed by Japan's advocacy, recent international commitment statements have encouraged the pursuit of synergies across environmental policies and plans, including the 2023 G7 Hiroshima Leaders' Communiqué (G7, 2023[1]) and the 2024 United Nations Environment Assembly resolution on promoting synergies, co-operation or collaboration for national implementation of multilateral environmental agreements and other relevant environmental instruments (UN and UNEP, 2024[2]).

2.1.2. A place-based approach to environmental action could allow Japan to accelerate its green transition

Japan recognises the importance of a place-based or territorial approach and the role of subnational governments in addressing the multifaceted and interconnected environmental challenges. This approach has emerged from the understanding that policy challenges and opportunities vary significantly across places, requiring targeted solutions for more effective outcomes. A one-size-fits-all approach is insufficient to address these challenges adequately. In climate policy, for example, GHG emissions, as well as the potential for reductions, can vary significantly across places, as do climate impacts like heat waves, droughts, floods and mudslides. A place-based approach allows national governments to tap the significant potential of subnational governments. In 2019, Japan's subnational governments were responsible for over 85% of climate-significant public expenditure, well above the OECD average of 63% (OECD, 2024[3]).

Place-based environmental policies can break down siloed, sector-based approaches, facilitating holistic, systems-wide approaches that address not only environmental challenges (e.g. climate mitigation and adaptation, biodiversity loss, pollution and waste) but also broader economic and social challenges (e.g. economic decline, depopulation). This approach fosters multi-level governance by clarifying the roles of subnational governments and supporting collaboration between these entities and national governments in response to shared policy challenges. Importantly, although local action is essential, its effectiveness will only be fully realised with national support. Therefore, national governments have a key role in promoting a place-based approach to environmental action. They are responsible for establishing the legal and institutional environments that enable subnational governments to implement effective environmental actions. The OECD has developed the Territorial Approach to Climate Action and Resilience (TACAR) framework to support governments in their place-based climate action efforts (Box 2.1).

Box 2.1. The OECD Territorial Approach to Climate Action and Resilience (TACAR) framework

A Territorial Approach to Climate Action and Resilience (TACAR) is a comprehensive policy framework to help policy makers develop effective climate action and resilience policies. It integrates a place-based perspective into national and subnational climate policies, while mainstreaming climate objectives into urban, rural and regional development (OECD, 2023[4]). The TACAR framework recommends tailoring climate policies to the specific needs and strengths of different cities and regions, moving away from one-size-fits-all measures. There are three key components to the TACAR framework: i) 45 territorial climate indicators intended to facilitate internationally comparable monitoring of climate action and resilience at a range of territorial scales; ii) 9 recommended actions that national and subnational governments can use as a checklist to assess policies; and iii) a compendium of 36 leading practices.

Source: (OECD, 2023[4]).

Given the urgency of addressing the planetary triple crisis, Japan must accelerate efforts to leverage regional and local strengths, minimise trade-offs, and maximise synergies across environmental strategies and plans in an effective manner.

2.1.3. Japan's geographical, climatic and socio-economic landscape requires tailored environmental policies

Japan's diverse geographical and climatic landscape features a long archipelago with distinct climate zones, ranging from the snowy, mountainous regions of Hokkaido in the north to the subtropical climates of Okinawa in the south. This diversity is further complicated by the country's varied topography, which includes extensive coastlines, fertile plains and high mountain ranges.

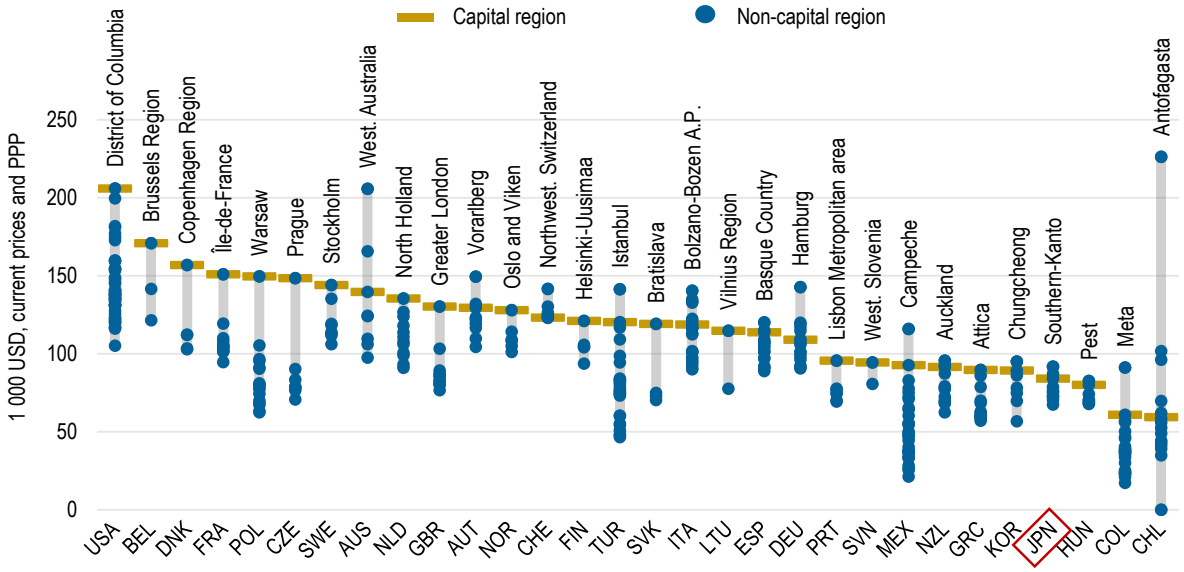
Japan's regional disparities in social and economic performance are less pronounced than in many other OECD countries. For instance, the labour productivity gaps across large regions[1] in Japan are relatively narrow, with only a difference of USD 24 000 per worker between the most and least productive regions. By comparison, the United States has significantly greater regional inequality, with a difference of about USD 100 000 per worker between its most and least productive regions (OECD, 2024[3]) (Figure 2.1).

Japan presents remarkable diversities in environmental performance (e.g. climate mitigation potential, climate risks, green spaces, municipal waste) across its cities and regions. This highlights the need for tailored environmental policies as this section will explore.

Social, economic and environmental disparities are particularly pronounced between urban and rural regions.[2] Rural regions, such as the Tohoku and Chugoku regions, are grappling with significant depopulation (Tsutsumi, 2020[5]). Rural demographic and economic decline is intertwined with environmental challenges, such as land abandonment and decreased agricultural productivity. Rural areas often lack resources and the capacity to implement environmental policies, making them more vulnerable to climate risks like extreme weather events and resource scarcity.

Figure 2.1. Japan's labour productivity levels show less regional variation

Labour productivity (GVA per worker) in large regions (TL2), 2022



Note: 2022 or latest available year: 2021 for Japan, Norway, New Zealand, Switzerland and United Kingdom; 2020 for Australia. For Norway, the regional productivity does not consider the gross value added (GVA) generated from the continental shelf. Regional labour productivity: GVA per worker, based on place of work.
Source: OECD (2024), *OECD Database on Regions, Cities and Local Areas*.

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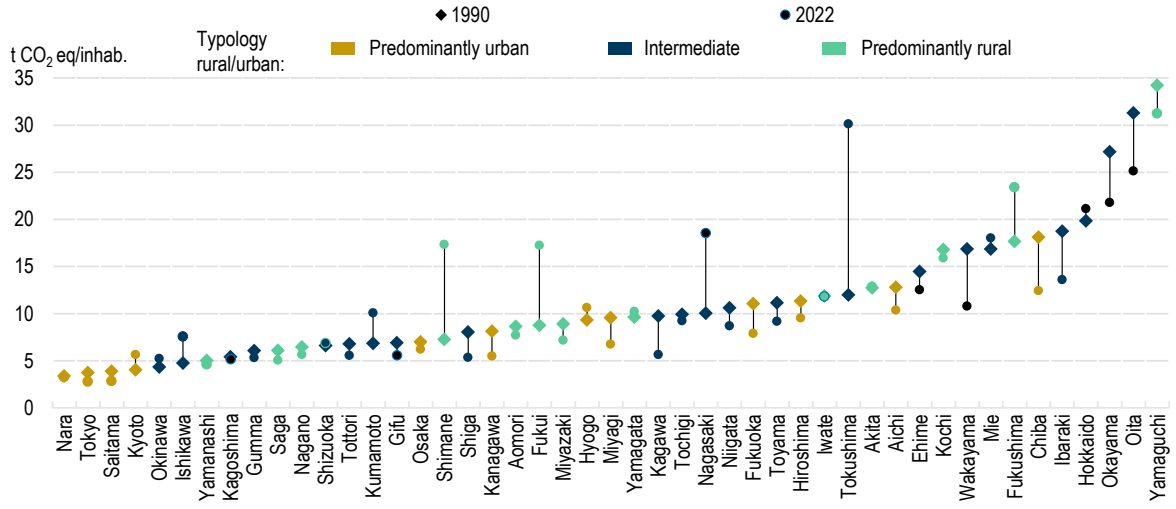
Japan's climate mitigation potential varies across regions

GHG emissions per capita differ widely across prefectures (TL3 regions). While some prefectures have achieved significant emissions reductions since 1990, only three (Nara, Tokyo and Saitama) have already reached emission levels below 4.7 t CO_2-eq per capita, which is the 2030 emission per-capita benchmark consistent with the International Energy Agency's Net Zero Emissions scenario for advanced economies (IEA, 2021[6]; OECD, 2023[4]). Emissions per capita can differ by a factor of ten between the least emitting prefecture (Nara) and the highest (Yamaguchi). Urban prefectures like Tokyo and Osaka tend to have lower emissions per capita than rural ones. Of the 47 prefectures, 32 (68%) achieved reductions in emissions between 1990 and 2022, including most urban regions. However, several regions – notably Shimane, Nagasaki, Fukui and Tokushima – have seen significant increases in emissions (Figure 2.2).

The sectoral profile of emissions also varies significantly between regions. For instance, Chiba Prefecture exhibits the highest emissions per capita among Japan's urban regions due to its steel and petrochemicals industries and extensive port activities (Figure 2.3). Further, electricity production in this region relies almost entirely on fossil fuels.

Figure 2.2. Urban prefectures in Japan have made steady progress in reducing GHG emissions

GHG emissions per capita in 1990 and 2022 by type of TL3 regions (prefectures) in Japan



Note: The analysis in this figure is based on the OECD regional typology as outlined in OECD (2024), *OECD Regions and Cities at a Glance 2024*.
Source: OECD (2024), *OECD Database on Regions, Cities and Local Areas*; Crippa et al. (2023), "EDGAR v8.0 Greenhouse Gas Emissions", European Commission, Joint Research Centre (dataset).

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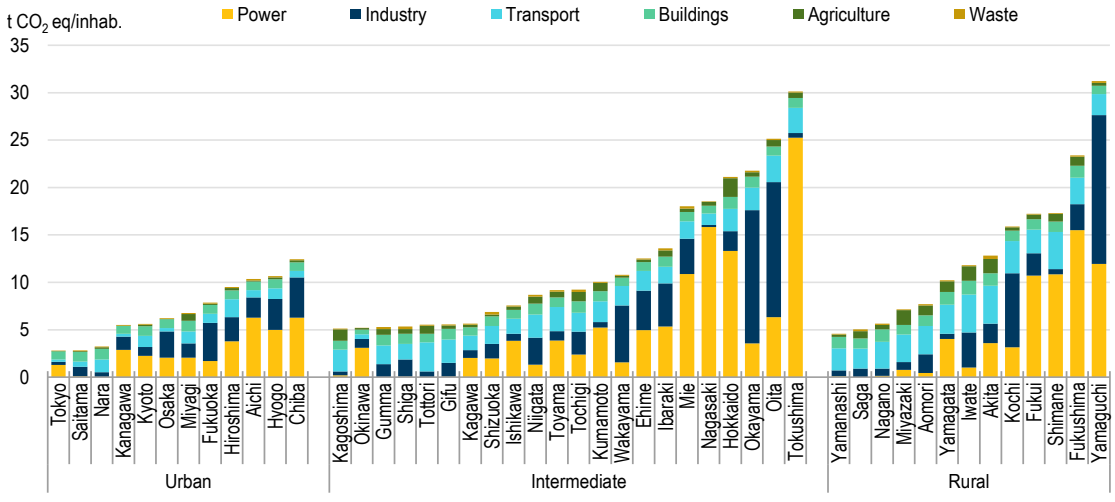
Figure 2.3. There is significant regional variation in GHG emission by sector

GHG emissions by selected sector per capita, TL3 regions in Japan (prefecture), 2022



Note: The 47 TL3 regions (prefectures) are grouped according to the typology: predominantly urban, intermediate and predominantly rural.
Source: OECD (2024), *OECD Database on Regions, Cities and Local Areas*; Crippa et al. (2023), "EDGAR v8.0 Greenhouse Gas Emissions", European Commission, Joint Research Centre (dataset).

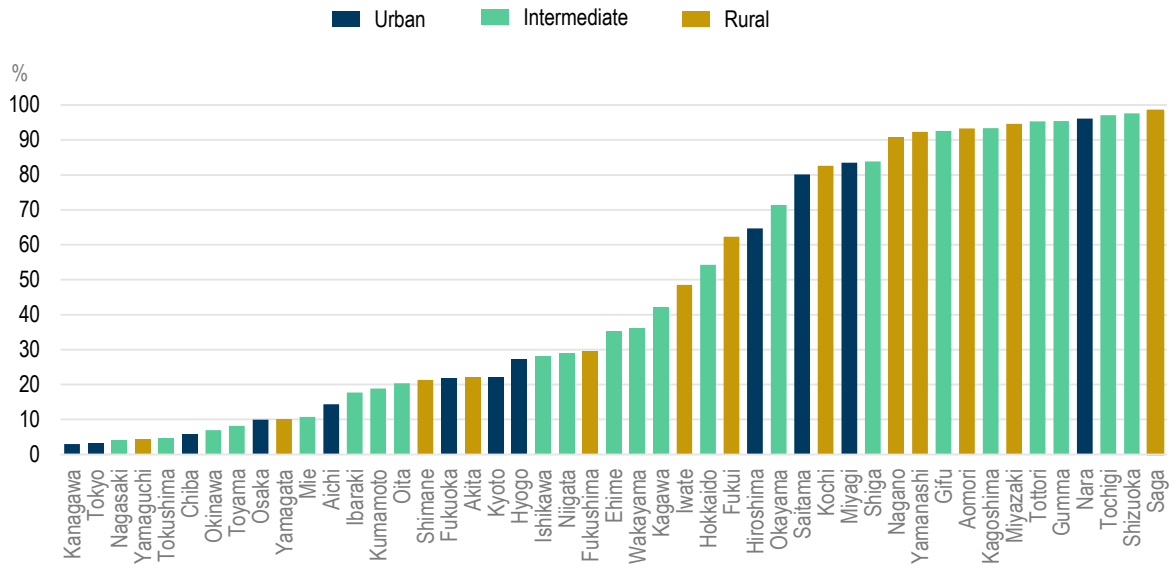
StatLink https://stat.link/aulyfz

Decarbonising buildings is a key opportunity for Japanese cities to achieve the green transition (see Section 2.4.). Emissions from buildings in Japan, on average, accounted for 1 t CO_2-eq per capita in 2022. It is a major source of emissions in urban regions such as Tokyo and Saitama, where the share of emissions from buildings is around 40% for both (Figure 2.3).

The share of electricity generated from renewable sources varies significantly among regions. Urban regions generate less electricity from renewable sources (36%) than intermediate regions (47%) or rural regions (58%). However, the share also varies within urban or rural regions, a disparity likely attributable to availability of space for solar farms and wind turbines, and the presence of natural resources conducive to renewable energy production. Areas like Nagano, Oita and Yamanashi prefectures have seen higher concentrations of solar power installations, partly due to their large areas of undeveloped land (Yamashita, 2016[7]). Yamanashi Prefecture is a leading region for solar power generation (Figure 2.4), achieving 92% renewable electricity generation. This is the lowest rate of GHG emissions of all the rural regions in Japan (Figure 2.3) (Yamanashi Prefecture Government, 2024[8]).

Figure 2.4. The share of electricity produced by low-carbon sources varies significantly

Share of electricity produced by low-carbon sources in TL3 regions in Japan (prefecture) in 2022



Note: Low-carbon sources refer to nuclear or renewables.
Source: OECD (2024), *OECD Regions and Cities Data Visualisation*, https://regions-cities-atlas.oecd.org/.

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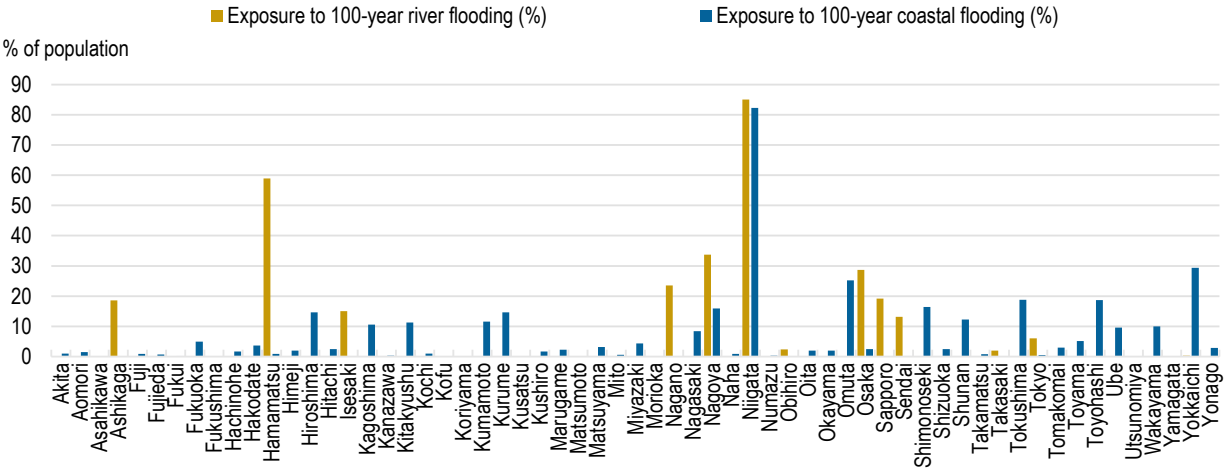
Exposure to climate risks and impacts varies across cities and regions in Japan

In 2020, 10.6% of the population of Japan was found to be at risk of river flooding compared to the OECD average of 12.9%. Japan is an island nation with an extensive coastline, and 4.3% of its population is at risk of coastal flooding, almost double the OECD average of 2.3%. Nonetheless, this share is lower than in the United Kingdom (4.9%) and Iceland (12.5%), two other island nations of similar size. Globally, exposure to flooding risk tends to be a particular challenge for metropolitan areas due to high population densities. In Japan, exposure to the risk of flooding varies significantly between different metropolitan areas (Figure 2.5). Japan has made good progress in the areas of water-related risk assessment. As of 2024,

98% of municipalities had prepared and disclosed flood hazard maps, which can be an effective tool to prepare for floods and minimise damage (Huang, 2024[9]).

Figure 2.5. Some metropolitan areas are particularly exposed to flooding

Share of population exposed to 100-year river flooding and coastal flooding in FUAs, 2020 (%)



Note: A functional urban area (FUA) comprises a city and its commuting zone. It consists of a densely inhabited city and a less densely populated commuting zone whose labour market is highly integrated with the city. A return period is the average or estimated time in which a specific climate-related hazard is likely to recur.
Source: OECD (2024), *OECD Regions and Cities Data Visualisation*, https://regions-cities-atlas.oecd.org/.

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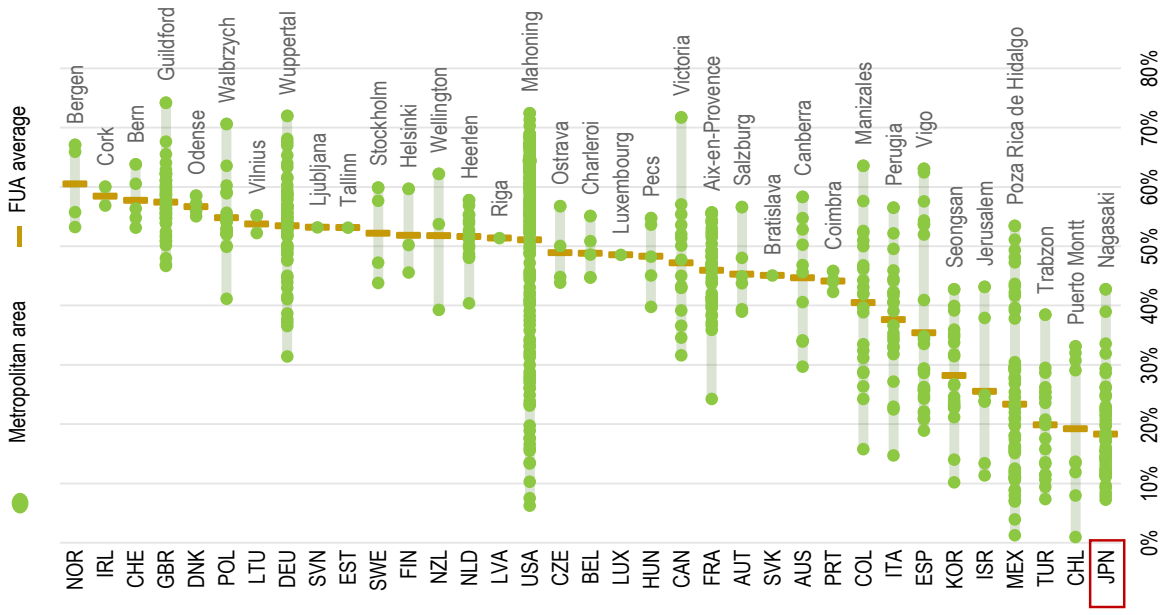
Cities in Japan are also increasingly exposed to heat stress due to the urban heat island effect. From 2018 to 2023, the population was exposed to an average of 60.1 days per year of strong heat stress.[3] This is lower than the OECD average of approximately 64.6 days but still 11 days more than the baseline period of 1981-2010. Japan recorded the highest OECD average for summer daytime urban heat island intensity[4] from 2018 to 2022, with a value of 4.5°C compared to the OECD average of 2.4°C. All Japanese cities registered an annual urban heat island intensity above 1°C, and two-thirds experienced a summer daytime heat island effect exceeding 4°C. This challenge is particularly significant for large cities due to reduced ventilation, the proximity of tall buildings, heat generated from human activities, the properties of urban building materials and the limited amount of vegetation. In Tokyo and Osaka, temperatures in urban centres are often six degrees higher than in their surroundings. High temperatures affect public health, energy demand and overall quality of life.

Urban residents have limited access to green areas

On average, green areas cover only 18% of land in the urban centres of Japanese cities, compared to the OECD average of 42% (Figure 2.6). Although tree cover has increased in 22 of 61 (36%) functional urban areas (FUAs)[5] between 2000 and 2022 – including Osaka – it has decreased in 37 FUAs (61%)[6] (Figure 2.7). Lack of green space has significant implications for quality of life in cities, and for climate resilience; green space is important for attenuating the urban heat island effect, and for the absorption and retention of water to reduce flood risk.

Figure 2.6. Japanese cities have less green space coverage than other OECD cities

Green areas (trees, grass and shrublands) as percentage of the total areas in the urban centres of FUA, 2021



Source: OECD calculation based on *ESA WorldCover 2021 v200 data*.

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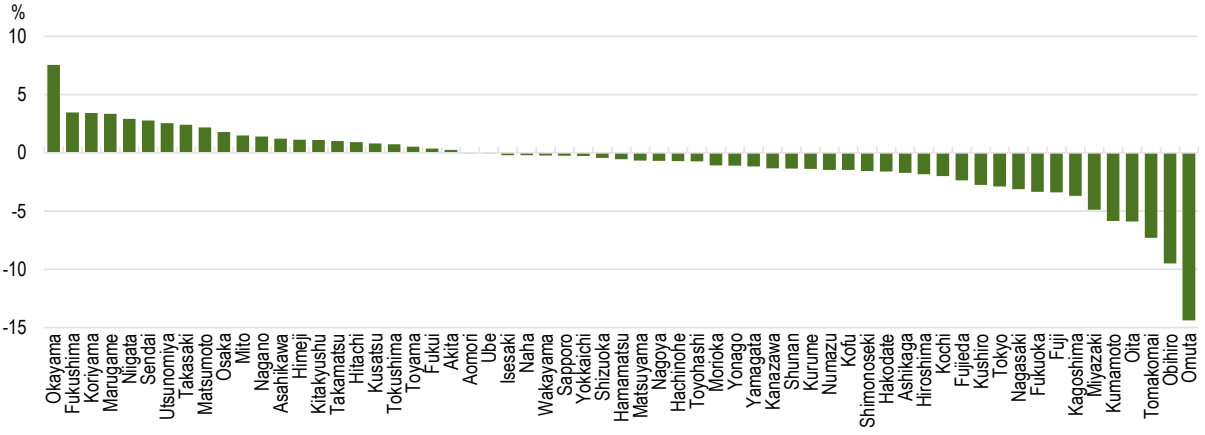
Figure 2.7. Tree cover has declined in two-thirds of Japanese FUAs

Change in tree cover in FUAs, 2000-22



Source: OECD calculations based on *ESA Climate Change Initiative Land Cover data (CCI-LC)*.

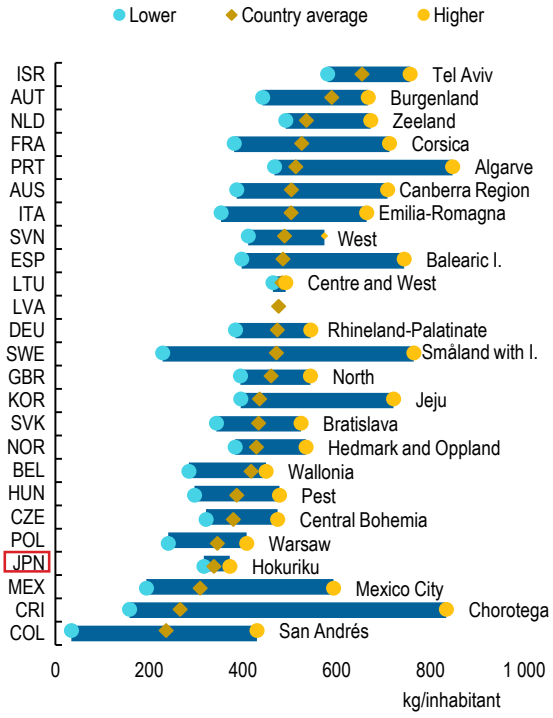
StatLink https://stat.link/zat5dr

Large regions in Japan achieve relatively low rates of municipal waste generation

On average, Japan achieves a relatively low level of municipal waste, at about 330 kg per capita in 2021, compared to the OECD average of 531 kg per capita (OECD, 2024[10]). There is little variation in municipal waste generation rates between regions, which suggests efforts to prevent waste are being applied consistently across the country (Figure 2.8). However, on average, only about 20% of municipal waste is recycled compared to the OECD average of 24%, which suggests that Japan has room for improvement (Chapter 1).

Figure 2.8. Japan achieves lower rates of municipal waste generation than many other OECD countries, with little regional variation

Municipal waste volume per capita, OECD large regions (TL2), 2020



Note: 2018 for Japan; 2019 for Austria, Colombia, Spain, France, Hungary, Israel and Italy.
Source: OECD (2022), *OECD Regions and Cities at a Glance 2022*.

StatLink https://stat.link/cjuohg

Localised data enable policy makers to develop locally tailored solutions

Compared with other OECD countries, Japan has one of the most comprehensive datasets of statistical information at the subnational level. This database could be expanded further by, for instance, producing and collecting data and statistics at the functional geographical scale (e.g. metropolitan areas, water basins), and at the more granular scale in targeted environmental policy areas (e.g. GHG emissions by sector, energy consumption, biodiversity). Having data and statistics available at a range of subnational territorial scales supports policy makers to develop solutions targeted at the right scale. Tools like the OECD's Territorial Climate Indicators (Box 2.1) and the PLATEAU (Box 2.2) can help bridge capacity gaps at the subnational level.

Box 2.2. PLATEAU, an innovative tool for building climate resilience

PLATEAU is an open data platform that provides localised geospatial data, enabling Japanese cities to simulate flooding and assess risk. Led by the Ministry of Land, Infrastructure, Transport and Tourism, PLATEAU is a digital representation of physical objects (digital twin). Users can visit the site virtually, visualise proposed infrastructure and interact with others. Cities are using PLATEAU to support a range of resilience-building actions. For example, Tottori City has used PLATEAU to simulate flooding scenarios and improve evacuation routes, and Nagoya has used it to model the urban heat island effect and assess the risk of heat stress. Local governments have also used PLATEAU to enhance citizen engagement in infrastructure planning decisions.

Source: OECD (2024), *Infrastructure for a Climate-Resilient Future*.

2.2. Integrating local environmental action into national plans and strategies

2.2.1. Japan increasingly recognises the role of local governments in achieving national environmental goals and targets

Japan's major national environmental plans and strategies illustrate that the national government recognises the role of subnational governments in achieving national environmental goals and targets, although with some variation (Table 2.1).[7]

Development process: While Japan has made some efforts to engage local governments in the development of its environmental plans and strategies, more targeted engagement would be beneficial. While local governments are able to participate in the development of national plans and strategies by submitting comments during public consultations, they are not often subject to targeted engagement.

- The development of the 6th Basic Environment Plan, Japan's 5th Fundamental Plan for Establishing a Sound Material-Cycle Society, the Plan for Global Warming Countermeasures and the Climate Change Adaptation Plan all involved gathering comprehensive public comments from a wide range of stakeholders, including local governments.
- The National Biodiversity Strategy and Action Plan (NBSAP) of Japan 2023-2030 emphasises the importance of regional biodiversity and encourages local governments to contribute by developing their own local plans (LBSAPs), ensuring that local conditions are considered in the national framework. This localised approach allows for tailored actions that address the unique ecological conditions, cultural practices and economic activities of different regions.
- Japan has an opportunity to strengthen local government engagement in the development of national plans and strategies with the forthcoming GX2040 Vision (under development) and updated Nationally Determined Contribution (NDC) (due 2025). It is welcome that Japan's council for discussing the forthcoming NDC includes the president of the National Governors' Association, and that discussions incorporate opinions from local areas.

Table 2.1. National environmental plans and strategies are increasingly integrating local perspectives

Strong attention Moderate attention No or limited attention

National environmental plans and strategies	Development process	Targets and goals	Implementation
6th Basic Environment Plan (2024)	Local governments, organisations and experts were consulted extensively, and opinion exchange meetings were held. The plan was revised based on 386 public comments before final adoption.	The Plan expects local governments to contribute to achieving the goals and targets, including through specific initiatives like the Decarbonization Leading Areas.	Local governments are actively involved in the implementation of regional environment measures with national support.
GX Basic Policy (2023)	Local governments had the opportunity to submit comments during consultation but had no active engagement.	Local governments are not explicitly included in targets and goals, but their role in accelerating business- and resident-driven initiatives, and in implementing priority measures to drive regional decarbonisation of energy, is acknowledged.	Local governments are expected to support implementation, e.g. through Decarbonization Leading Areas and supporting the development of renewable energy facilities, but their overall direct involvement is limited.
Nationally Determined Contribution (NDC) (2021)	The president of the National Governors' Association is a member of the council discussing the NDC.	National targets include a 46% GHG reduction from the levels in financial year (FY) 2013 by FY2030 and net zero by 2050. In addition, 60% of subnational governments have committed to net zero by 2050. The NDC does not reflect those commitments, which are mentioned in the Plan for Global Warming Countermeasures.	The NDC is largely implemented through other environmental plans and strategies, e.g. Plan for Global Warming Countermeasures, which include roles for local government. The NDC itself refers to implementation initiative “Green Challenge”, undertaken at the local level.
Plan for Global Warming Countermeasures (2021)	Subnational governments were consulted and enabled to actively participate in the Plan’s development, to an extent.	The Plan aims to reduce GHG emissions by 46% by FY2030 from FY2013 level, in line with the NDC. It encourages subnational governments to set GHG emissions reduction goals that consider each region’s unique energy and environmental needs, promoting tailored strategies to achieve national and local targets.	The Plan supports local-level initiatives, emphasising the role of regional entities in executing decarbonisation strategies and enhancing resilience through local renewable resources and sustainable practices. The Plan requires local governments (alone or jointly) to adopt action plans to reduce GHG emissions arising from their own activities and projects.
Climate Change Adaptation Plan (2021)	The development process involved public comments from various stakeholders, including subnational governments.	The plan addresses climate adaptation across sectors and acknowledges the need for local strategies but gives no emphasis to local targets or goals.	Subnational governments play an active role in implementation.
National Biodiversity Strategy and Action Plan (NBSAP) of Japan 2023-2030	The NBSAP is reviewed every two years, creating regular opportunities for lessons learnt by local governments in implementing their LBSAPs to be reflected in the national plan.	The NBSAP incorporates local perspectives by encouraging active participation from local governments, communities and stakeholders, with tailored conservation measures for specific regions. It also encourages local governments to develop their LBSAPs.	Local governments and communities are called to implement LBSAPs that address local needs and support sustainable management of Japan’s ecosystems, grounding efforts in regional contexts and enhancing the NBSAP's impact.

National environmental plans and strategies	Development process	Targets and goals	Implementation
5th Fundamental Plan for Establishing a Sound Material-Cycle Society (2024)		The plan emphasises regional needs, promoting tailored local initiatives aimed at net zero, a nature-positive economy and stronger local resource circulation. Local governments are tasked with long-term waste management plans (100% of prefectures and 60% of municipalities conduct disaster waste education training), reducing municipal waste, establishing waste-to-energy centres (46% of waste treatment facilities must be able to supply waste-derived energy to local energy centres), and ensuring disaster waste management preparedness through comprehensive planning by 2030.	Local governments are key to implementing the strategy by co-ordinating regional recycling systems, managing waste effectively and fostering localised waste-to-energy initiatives. They collaborate with communities, ensuring disaster waste preparedness and sustainable practices to meet national goals.

Note: The assessment was made according to the degree of attention given to three criteria: *development* considers how local governments were involved in the development of the plan or strategy, and how their perspectives are integrated; *targets and goals* considers how the plan or strategy incorporates local governments in its targets and goals; and *implementation* considers the role of local governments in implementing the plan or strategy, and how the national government supports their efforts. "Strong attention" means active engagement and incorporation of local perspectives; "moderate attention" means some recognition of local perspectives but with limited integration; and "no attention" means no consideration of local perspectives.
Source: OECD Secretariat's elaboration.

Targets and goals: Japan's environmental plans and strategies increasingly integrate targets and goals set at the local level.

- The 6th Basic Environment Plan prioritises regional decarbonisation, including through specific local initiatives like the 100 Decarbonization Leading Areas (DLAs), which target zero GHG emissions in specific neighbourhoods by 2030. Similarly, the NBSAP tailors biodiversity conservation measures to the ecological and socio-economic contexts of different regions.
- The 5th Fundamental Plan for Establishing a Sound Material-Cycle Society sets numerical targets for key indicators to promote a circular economy. The strategy recognises local perspectives and regional variations and promotes local-level initiatives tailored to the specific needs and resources of different areas.
- While Japan's current NDC does not set GHG emissions reduction goals for local governments, 60% of subnational governments have committed to achieving net-zero carbon emissions by 2050, either voluntarily or with national support (MOE, 2024[11]). Japan's updated NDC (due 2025) could reflect these subnational goals. Local governments are not "parties" formally involved in global climate negotiations under the United Nations Framework Convention on Climate Change (UNFCCC). As such, they are not bound by the resulting agreements. However, many national governments do incorporate local climate action in their national pledges and policies, including NDCs (OECD, 2023[4]).
- While the 2023 Basic Policy for the Realization of the Green Transformation (GX) (hereafter GX Basic Policy) focuses on national targets and goals, Japan's forthcoming GX2040 Vision (under development) presents an opportunity to integrate targets and goals for local governments as well.

Implementation: Local governments are already heavily involved in the implementation of national plans and strategies, although not always directly.

- Subnational governments are expected to play a major role in the implementation of the 6th Basic Environment Plan. One of the plan's core principles is "participation", aiming to involve all societal actors in environmental conservation efforts, including local governments. Local governments are responsible for executing priority measures for regional decarbonisation and developing local

decarbonisation plans. The national government provides financial, technical and informational support to local governments to facilitate these efforts. The plan recognises the role of local governments in promoting structural transformations within their regions and encourages the creation of sustainable communities through interaction and co-operation between governments, markets and citizens.

- The Plan for Global Warming Countermeasures requires local governments (alone or jointly) to adopt action plans to reduce GHG emissions arising from their own activities and projects.
- The NBSAP of Japan 2023-2030 entrusts local governments with implementing biodiversity conservation plans tailored to their specific regional contexts. The national government provides tools and guidelines to support the process, such as the "Potential Map of Ecosystem Conservation/Restoration" for implementing nature-based solutions for disaster risk management at the local level. All 47 prefectures (TL3) in Japan have now developed and implemented their LBSAPs based on the NBSAP. Additionally, 177 municipalities within these prefectures, representing about 10% of the total number of municipalities in Japan, have also developed and have been implementing their own LBSAPs.
- Under the Climate Change Adaptation Plan, regional councils on climate change adaptation have been formed as regional collaboration spheres among various local actors for implementing adaptation measures. The Climate Change Adaptation Information Platform (A-PLAT) was also established to collect, organise, analyse and provide information on climate change impacts and adaptation, as well as to offer technical advice and support to local governments and Local Climate Change Adaptation Centers.
- Local governments are key to implementing the 5th Fundamental Plan for Establishing a Sound Material-Cycle Society by co-ordinating regional recycling systems, managing waste effectively and fostering localised waste-to-energy initiatives. They collaborate with communities, ensuring disaster waste preparedness measures and sustainable practices to meet national goals. Local governments act as key co-ordinators, assessing local resource conditions and forming alliances with residents, businesses, non-governmental organisations and experts to create tailored, regionally scaled recycling and waste reduction initiatives.
- Implementation initiatives in the GX Basic Policy focus on sectoral and industry actors, with limited direct involvement of local governments. However, local governments play a key role, if indirectly, in driving regional decarbonisation measures and supporting renewable energy projects through, for instance, local regulatory measures. The forthcoming GX2040 Vision could seek to include local governments in its implementation measures more directly.

Ideally, subnational stakeholders should be systematically involved in the development process of national plans and strategies as this helps ensure they reflect local perspectives. The 6th Basic Environment Plan and the NBSAP stand out for their strong integration of local perspectives across targets, development processes and implementation. Implementing regional roundtables could facilitate dialogue between national and local stakeholders by providing a platform for involvement and feedback, allowing for adaptive management and policy adjustments at the national level. For instance, Germany designed the Climate Action Planning framework that engages federal states and municipalities in a collaborative process to set emissions reduction targets. Strong public engagement efforts are also important for keeping community members informed and involved in sustainability initiatives, fostering a sense of ownership and responsibility.

Japan has made impressive progress to incorporate cities and regions in setting specific targets, in line with leading practice in other OECD countries. In France, for example, the Île-de-France region (which includes Paris) has set specific targets to reduce emissions by 40% by 2030 and achieve carbon neutrality by 2050. These targets are part of the region’s comprehensive Plan Climat-Air-Énergie, which aligns with

national objectives while addressing the unique urban challenges of France's most densely populated area (Région Île-de-France, 2022[12]).

Japan should continue to invest in capacity building for local governments. Providing the necessary tools, knowledge and resources will enable local governments to implement sustainability initiatives effectively. For instance, the government can offer training workshops focused on best practices and new technologies in sustainability. It could also facilitate partnerships between local governments, the private sector and civil society. For example, providing platforms for stakeholders to share ideas and collaborate on sustainability projects could leverage resources, expertise and innovation. To facilitate these partnerships, the government could provide a platform for stakeholders to share ideas and collaborate on sustainability projects.

2.2.2. National plans and strategies could place greater emphasis on generating co-benefits and synergies within the environmental domain, as well as across social and economic domains

Some national plans and strategies discuss co-benefits and synergies in environmental and economic fields but often only implicitly. Opportunities for co-benefits and synergies could be more systematically and explicitly highlighted (Table 2.2).

Table 2.2. Opportunities for co-benefits and synergies in the major national environmental plans and strategies

Policy instrument (year)	Key elements of the plan	Synergies between environmental objectives	Broader synergies (with social and economic objectives)
6th Basic Environment Plan (2024)	- Aims to support sustainable development, environmental conservation, sustainable resource use, biodiversity conservation, climate change mitigation, pollution reduction and local engagement.	- Biodiversity: Supports conservation and restoration efforts through nature-based solutions and promotes biodiversity within supply chains. - Climate mitigation: Aims to decarbonise industries and promote a circular economy. - Material production and consumption: Promotes resource circulation.	- Economic welfare: Purchases goods and services with high environmental value by citizens as consumers having high awareness of environmental issues, promotion of green innovation. - Community development: Supports the creation of communities that are economically, environmentally, socially and culturally sustainable.
GX Basic Policy (2023)	- Leverages energy policy to drive emission reductions alongside economic growth. - Introduces carbon pricing. - Develops renewable energy, hydrogen and recycling technologies. - Invests 150 trillion yen over ten years. - Supports industries and workers through a "just transition".	- Circular economy: Supports chemical recycling, biochemicals and CO2 reuse initiatives to improve resource efficiency, reduce waste and lower carbon emissions.	- Economic growth and competitiveness: Supports industrial competitiveness and economic growth while transitioning to carbon neutrality. - Employment and social stability: Adopts innovation in renewable energy, hydrogen and ammonia sectors to create jobs, with transition finance supporting a low-carbon shift.
Plan for Global Warming Countermeasures (2016)	- Targets a 46% reduction in GHG emissions by financial year (FY) 2030 from FY2013 levels, in line with the 2021 Nationally Determined Contribution, and aims for net-zero emissions by 2050. - Promotes renewable energy, energy efficiency, green technology innovation and carbon pricing mechanisms.	- Circular economy: Aims to reduce waste and improve resource efficiency. - Material production and consumption: Promotes the decarbonisation of industrial sectors to reduce the environmental impact of material production. - Biodiversity: Supports nature-based solutions and decarbonisation. - Sustainable agriculture and fisheries:	- Stimulates economic growth: Makes green investments, creates jobs in renewable sectors, improves public health by reducing pollution and fosters energy security. - Regional revitalisation: Uses renewable energy and decarbonisation projects to stimulate local economies. - Gender equality: Incorporates

Policy instrument (year)	Key elements of the plan	Synergies between environmental objectives	Broader synergies (with social and economic objectives)
		Supports initiatives like the "MIDORI Strategy for Sustainable Food Systems".	gender perspectives and participation in climate actions.
Climate Change Adaptation Plan (2021)	- Promotes resilience, a reduction of climate change impacts through cross-sectoral approaches, and the support of national security and sustainability. - Promotes integrating scientific findings, enhancing information platforms, and co-ordinating efforts among governments, businesses and citizens.	- Biodiversity: Integrates biodiversity conservation into climate adaptation boosts ecosystem resilience. - Climate mitigation: Ensures adaptation measures support net-zero goals by preserving carbon sinks like forests. - Material production and consumption: Promotes sustainable resource use in agriculture cuts emissions and enhances resilience. - Sustainable agriculture: Aligns with the "MIDORI Strategy", which aims to build a sustainable food system resilient to climate change and disasters.	- Economic resilience: Aims to increase natural disaster resilience to avoid casualties, minimise financial damage and allow for rapid recovery. - Public health: Addresses heat stress and rising infectious diseases, among others, with prevention and awareness campaigns.
National Biodiversity Strategy and Action Plan (NBSAP) of Japan 2023-2030	- Aims to conserve at least 30% of Japan's land and sea by 2030. - Includes basic strategies to restore ecosystems, promote nature-based solutions, promote nature-positive economies and enhance public awareness of biodiversity. - Supports creation of LBSAPs with broad participation. - Embeds biodiversity in daily life and consumption.	- Climate change: Emphasises nature-based solutions and ecosystem restoration and conservation to enhance carbon sinks and reduce GHG emissions, and address climate change adaptation. - Sustainable agriculture, forestry and fisheries: Promotes environmentally friendly practices aligned with sustainable production goals, focusing on reduced risk-weighted use of pesticides and promotion of organic farming. - Circular economy: Supports sustainable production and consumption patterns, including in business and industry.	- Economic growth: Promotes leveraging natural resources and culture to support local economies and enhance resilience. - Sustainable business practices: Advocates for environmental, social and governance (ESG) investing to reduce biodiversity risks and promote sustainable production. - Social well-being: Encourages the use of nature-based solutions to tackle societal challenges (e.g. disaster risk reduction), to enhance resilience and quality of life.
5th Fundamental Plan for Establishing a Sound Material-Cycle Society (2024)	- Establishes a sound material-cycle society that minimises resource consumption, manages waste efficiently, reduces environmental impact and promotes sustainable development through the 3Rs and low-carbon, biodiversity-friendly practices. - Adopts several targets on waste management and resources circularity, including 46% of waste treatment facilities to supply waste-derived energy to local energy centres by 2027. - Aims to decrease municipal waste incineration to about 580 grammes per person per day by 2030.	- Climate mitigation: Promotes the 3Rs for low-carbon systems, encourages energy recovery from waste (e.g. thermal recycling, methane production waste-to-energy), and aims to increase biomass use to replace fossil fuels. - Biodiversity: Minimises environmental pollution and habitat destruction by decreasing waste disposal and promoting recycling. - Resource conservation: Encourages efficient use of materials and energy, leading to reduced extraction of natural resources.	- Regional revitalisation: Promotes regional ecological circles to combat depopulation and declining birth rates, supporting local economies through resource management and job creation. **- Energy security**: Enhances local energy resilience through waste-to-energy initiatives, reducing reliance on external energy sources. - Economic growth: Encourages innovation, productivity and technology to drive sustainable development while addressing resource circulation and environmental conservation.

Source: OECD Secretariat's elaboration.

Japan's Regional Environment Offices (REOs) could play a more central role in engaging subnational governments and aligning environmental policies across different levels of government to better identify and exploit synergies across environmental, social and economic policy objectives. REOs are decentralised branches of the Ministry for the Environment that co-ordinate and implement national environmental policies at the local level to ensure alignment between national goals and regional needs. By co-ordinating between national ministries and local governments, REOs can help tailor technical and financial support to meet the needs of cities and regions, particularly small local governments with limited capacity. Strengthening the role of these offices would ensure that national environmental plans and strategies are implemented more effectively, with local governments having the resources and guidance needed.

An illustrative example of this approach is found in Ireland, where four Climate Action Regional Offices (CAROs) were established to support local authorities in developing and implementing climate action plans aligned with national climate goals. CAROs play a vital role in co-ordinating adaptation and mitigation strategies across regions, providing technical assistance and fostering knowledge-sharing among local governments. They work closely with municipalities to tailor climate initiatives to regional needs, helping to build capacity and strengthen resilience (OECD, 2023[4]).

2.3. Enabling and scaling up place-based environmental action

2.3.1. Pilot initiatives have catalysed place-based environmental action effectively

Japan has made significant strides in fostering place-based environmental action that simultaneously supports environmental, economic and social resilience at the local level. The most notable examples of this are the two pilot initiatives: DLAs and the Circular and Ecological Economy (CEE) framework. Both initiatives provide a comprehensive framework for place-based environmental action, aiming to leverage local strengths and overcome context-specific challenges.

Decarbonization Leading Areas (DLAs)

In 2022, Japan started the DLAs initiative to demonstrate how the country can achieve the 2050 carbon neutrality target through neighbourhood-scale pilot projects, in line with its commitments under the Paris Agreement (MOE, 2021[13]). To date, 82 projects have been selected in five rounds to advance regional decarbonisation efforts (Annex Table 2.A.1), with plans to extend this to 100 regions. Specifically, local governments and stakeholders receive national grants and technical assistance aimed at fostering innovation in climate mitigation strategies. The DLA addresses specific needs and challenges of diverse regions, including agricultural areas, mountainous regions, fishing villages, remote islands and urban centres.

Prior to the DLAs, Japan developed a Regional Decarbonisation Roadmap in 2021, which presented a robust framework for generating place-based environmental action. The need for the Roadmap stemmed from the fact that subnational governments often face significant barriers to implementing climate action on their own. These barriers include limited financial resources, inadequate technical expertise and a lack of co-ordination across regions and sectors. Without national support, smaller or less economically developed areas may struggle to invest in large-scale decarbonisation projects. The Roadmap addresses these challenges by providing the necessary funding, expertise and a co-ordinated framework, enabling regions to pursue decarbonisation in a way that advances national goals while reflecting local conditions. The Roadmap promotes localised strategies tailored to specific needs and strengths. DLAs are integral to the broader Roadmap, as they embody its strategy of tailoring decarbonisation efforts to the unique characteristics of each region.

The 82 DLAs include agricultural areas, mountainous regions, fishing villages, remote islands and urban areas (Annex Table 2.A.1). This diversity illustrates the initiative's intention to showcase a variety of regional decarbonisation pathways at all territorial levels. While the list includes some of the most dynamic and industrialised urban centres, the largest share of areas skew towards smaller cities and towns, many of which are in rural or semi-urban settings (MOE, 2024[14]).

The DLAs have been chosen based on criteria aligned with the Roadmap's objectives, such as existing renewable energy capacity, innovative technological developments, and strong local government and industry commitment to sustainability. Each project combines efforts in climate mitigation with other regional challenges, showcasing the potential for regional actions to drive national environmental progress alongside other social, economic and environmental goals. The greatest number of DLA initiatives address disaster prevention and resilience; agriculture, forestry and fisheries; and resource circulation (Annex Table 2.A.1):

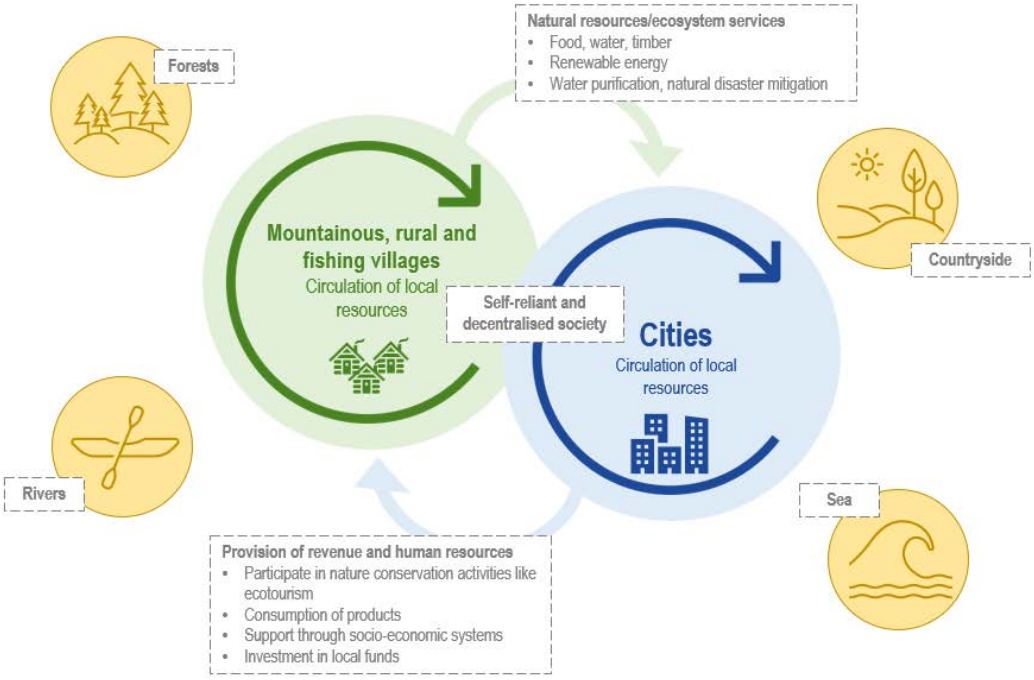
- Disaster prevention and resilience are top priorities, with 29 areas concentrating on interventions that will strengthen institutions and infrastructure in the face of climate risks. This includes efforts to build microgrids, establish disaster prevention agreements with private businesses and use existing infrastructure such as heat pipes.
- Agriculture, forestry and fisheries are also priorities in 28 areas, indicating a strong emphasis on supporting rural economies through, for instance, building new supply chains and improving management bases through the use of solar sharing and fuel conversion.
- Resource circulation initiatives, which cover regional efforts to use unused resources, by-products and discarded technologies, are important in 23 areas.

While many regions focus on pursuing synergies between climate mitigation and circular economy enhancement, synergies between biodiversity and climate mitigation, as well as biodiversity and circular economy enhancement, are underexploited. For instance, few DLAs include biodiversity as part of their decarbonisation efforts (Annex Table 2.A.1). An exception is the *Ukiha* initiative, which centres on local resources like fruit and tourist farms (MOE, 2024[14]). Through innovative measures such as producing biochar from pruned branches and reinvesting in conservation efforts, *Ukiha* creates a model for decarbonising agriculture while promoting biodiversity conservation. This approach shows potential to be scaled up or replicated across other regions.

Japan's Circulating and Ecological Economy (CEE) framework integrates circular economy principles into local strategies effectively

Introduced in 2018, the CEE framework aims to revitalise regions and make the most of local resources. By strengthening mutual support between urban and rural areas, and promoting circularity and self-reliance, it addresses social, economic and environmental challenges concurrently (Ortiz-Moya et al., 2021[15]; MOE, 2024[16]) (Figure 2.9). This framework is implemented through localised Regional Circulating and Ecological Spheres (Regional CEEs) (MOE, 2018[17]). The CEE framework demonstrates Japan's commitment to a place-based, territorial approach that leverages local characteristics and assets. Through this framework, the central government provides guidance to subnational governments, which often lack the financial resources, technical expertise and regulatory frameworks to implement effective circular economy practices on their own.

Figure 2.9. Conceptual illustration of the Circulating and Ecological Economy (CEE) framework



Source: Adapted from (MOE, 2021[36]).

According to a survey by the Ministry of the Environment, 146 subnational governments (in both rural and urban areas) have implemented CEE initiatives to date, including the examples below:

- Nagano Prefecture, renowned for its mountain landscapes, is advancing sustainability through its ambitious “Nagano Comprehensive Five-Year Plan” (IGES, 2019[18]). The prefecture aims for 100% renewable energy and a self-sufficient society by focusing on community engagement and education, local resource use, sustainable and inclusive city planning, and community-centred renewable energy. This approach seeks to maximise synergies between social, economic and environmental objectives. For instance, the renewable energy and sustainable city planning goals contribute to educational and economic objectives. Initiatives include solar mapping and community-based energy projects, as well as exporting hydropower to urban centres. Within the prefecture, the Ina City municipality applies a forest-based bioeconomy model, with a 50-year forest vision to integrate sustainable timber use and biomass heating, coupled with environmental education.
- Hamamatsu City, host to major industries like textiles and musical instruments, promotes local energy production for local consumption, capitalising on its abundant sunlight and renewable energy potential (IGES, 2019[18]). In response to energy security needs after the 2011 earthquake, Hamamatsu established its "New Energy Promotion Department" and launched the “Hamamatsu Energy Vision 3”. This focuses on increasing energy self-sufficiency from 4.3% in 2011 to 20.3% by 2030. To further this goal, Hamamatsu Energy Co. Ltd. was founded in 2015 with local investment to manage solar and biomass energy production, aiming for at least 80% of energy to be generated locally. Hamamatsu City’s model enhances resilience by securing local energy independence. This supports local industries while mitigating risks from national energy crises, generating synergies between environmental and economic objectives.

- In Owase City, a decommissioned thermal power plant has been transformed into a hub for sustainable projects. This initiative has catalysed a shift towards a circular economy, leading to projects that promote land-based aquaculture, mega solar power installations and sustainable lumber production. By leveraging these projects, the city is revitalising its local economy, supporting biodiversity and promoting sustainable resource use. A multi-stakeholder council has been established to enhance co-ordination, ensuring that efforts are scaled appropriately across sectors.
- Shimokawa Town, a rural area known for its rugged winters, has embraced the CEE framework to counteract the challenges of economic decline, depopulation and extreme climate (IGES, 2019[18]). Shimokawa's economy once relied heavily on agriculture, forestry and mining. However, as these industries declined and the population fell rapidly, Shimokawa gathered local stakeholders in 1998 to explore sustainable pathways for growth. The 2004 "Grand Design for Forestry Symbiosis" set the foundation for an economy rooted in sustainable forestry, with initiatives focusing on economic resilience, climate resilience and preservation of environmental assets. Alongside these goals, Shimokawa has aimed to foster community well-being through initiatives like the Ichinohashi Bio-Village. This innovative hub combines housing, social services and a low-carbon energy model based on forest biomass to support both the elderly population and foster sustainability (Shimokawa Town, 2018[19]). The Japanese government has designated Shimokawa Town as an SDGs Future City (Japan Up Close, 2022[20]).
- Suzu City, a small rural municipality, demonstrates how the CEE approach can revitalise communities facing population decline and isolation (Ortiz-Moya et al., 2021[15]). Following a population decline from over 38 000 in 1950 to around 14 600 in 2015, Suzu City launched the "Population Vision for Suzu City" in 2016. This aims to stabilise population through sustainable growth that integrates local landscapes into industry to support community resilience and attract younger populations. Central to this effort are Suzu's *Satoyama* landscapes and seascapes, which integrate agriculture, forestry and fishing as sustainable assets to foster industry, biodiversity and rural-urban connections. Renewable energy and resource-circulation projects, including wind and solar installations, a biomass plant and community recycling, have contributed emissions reductions alongside community and economic revitalisation. Suzu's 2018 designation as an SDGs Future City has enabled new partnerships (e.g. with Kanazawa University) and initiatives such as the Noto Satoyama-Satoumi Meister Programme to train younger generations in sustainability.

2.3.2. The national government plays a key role in enabling and scaling up successful local initiatives

The DLA and CEE initiatives demonstrate that a place-based approach holds great potential for delivering effective environmental action. Efforts to scale these initiatives should focus on expanding their geographical reach, deepening impact and targeting municipalities with limited financial and technical resources but strong decarbonisation potential.

Raising awareness, building capacity and establishing a support network at the local level

Implementing awareness campaigns, developing training programmes and establishing a regional support network could enable a larger number of Japanese municipalities to participate in the DLA and CEE initiatives.

- Awareness campaigns can be launched to inform all municipalities about the opportunity to participate in these programmes.
- The national government could partner with representatives from successful DLAs and CESs to conduct training sessions to educate municipalities on potential projects, innovative technologies and approaches.
- Creating a regional support network – through a digital platform, for example – would facilitate knowledge exchange among municipalities already involved in the DLA and Regional CES initiatives, national government officials and other municipalities. This network could promote the sharing of effective strategies, identify challenges and facilitate distribution of resources. It would also help the national government gain insights into the specific issues faced by existing and aspiring DLAs and regional CESs, allowing for more effective allocation of resources and support.

The national government of Japan could look to Costa Rica's National Decarbonisation Plan for further inspiration on how to scale local environmental action (Box 2.3). It provides inspiration to enhance local action by employing transformative, rather than incremental, approaches.

Box 2.3. Costa Rica's National Decarbonisation Plan: Local implementation and scalability

Costa Rica's National Decarbonisation Plan (NDP) commits to achieving net-zero emissions by 2050, aiming to eliminate fossil fuel dependency and build resilience across sectors like transport, energy and industry. The Plan incorporates scalable local initiatives and emphasises municipality engagement to ensure a transition towards low-emission development models that are transformative rather than incremental. Key aspects include project scalability, local carbon neutrality and sustainable mobility promotion.

The NDP does not have direct binding power on local actions. Instead, it "encourages" municipalities with the tools, frameworks and incentives to act. The scalability of these local initiatives is encouraged by replicating best practices across cantons, allowing for national impact. The Plan's success in ensuring local implementation and scalability depends on the commitment of local governments and the continued development of supportive policies at both the local and national levels. The NDP promotes programmes like the National Cantonal Carbon Neutrality Programme 2.0, the cantonal category and the development of strategies and pilot projects for mitigation at the local level in key sectors such as sustainable mobility, electric mobility and waste management. By setting clear, phased milestones up to 2050, Costa Rica encourages immediate local actions while maintaining a sustainable vision.

Source: (Gobierno de Costa Rica, 2018[21]).

It is essential for the national government to ensure sufficient human and financial resources to support the DLA and CEE initiatives. For instance, DLAs already receive prioritised support from the national government, including access to specialised funding, technical expertise and regulatory leeway to implement advanced decarbonisation projects. This includes subsidies for local decarbonisation actions, with a budget of JPY 35 billion in 2023. It also includes funding from the Japan Green Investment Corporation for Carbon Neutrality. The latter had a budget of JPY 40 billion in 2022 for corporations that implement decarbonisation projects in addition to the government guarantee for less than five years of JPY 20 billion (MOE, 2024[22]). Continued financial support in lagging regions where municipalities tend to struggle for financial resources would help ensure these DLAs continue to generate positive impacts.

Monitoring and evaluating the impact of local environmental action

The efficiency and effectiveness of DLA and CEE initiatives could be improved by developing a more comprehensive framework to monitor and evaluate the impact of local environmental actions they generate. This would involve first taking stock of existing measuring and monitoring frameworks, then assessing data and information gaps. The government could then implement more standardised mechanisms for measuring, monitoring and reporting various indicators at the local scale. This, in turn, would enable the national government to make more informed decisions on how to best direct funding and support to regions.

Identifying and addressing synergy gaps

To fully harness the potential of synergies between the economic, social and environmental objectives (and avoid any associated trade-offs), Japan should carefully examine where synergy-potential remains underdeveloped.

For instance, biodiversity is not well considered in the DLA initiative. Biodiversity conservation can be integrated with climate mitigation and adaptation according to the "nature-positive city" model. "Nature-positive cities" is an emerging concept that takes a holistic approach to integrating nature-based solutions into the design of cities at the metropolitan scale, achieving multiple co-benefits across the environmental, social and economic objectives (WEF, 2024[23]). Urban parks, for instance, capture carbon in trees and vegetation while helping cities adapt to climate change by providing a cooling effect and absorbing stormwater. At the same time, they can enhance urban biodiversity and improve the well-being of local residents.

Similarly, investing in solar panel recycling technologies can provide opportunities for Japan to embed circular economy principles into its renewable energy strategy. By prioritising infrastructure that facilitates the recycling and repurposing of solar panels and encouraging the design of solar panels with end-of-life considerations, the solar industry can significantly reduce waste and resource consumption. In so doing, it would contribute to both environmental protection and long-term economic viability.

It is also important to design incentives with synergies in mind. For instance, programmes that offer financial support for community-driven renewable energy initiatives can boost local economies and create local jobs, while supporting the country's climate commitments.

Enhancing the support of Regional Environment Offices and fostering collaboration with prefectures

An enhanced role for REOs could also help scale DLA and CEE initiatives. Japan's REOs could do more to engage with subnational governments and ensure alignment of environmental policies across various government levels. By acting as intermediaries between the national and local governments, these offices could deliver the tailored support needed for smaller prefectures and municipalities to initiate local environmental action, and participate in the DLA and CEE initiatives.

Prefectures could also play a more active role in co-ordinating between the national and municipal governments, leveraging their place-based knowledge and human, technical and financial capacity. For example, in France, the Regional Conference of the Parties ("Regional COP") employs a co-ordinated environmental planning process. Prefectures act as a link between the national government and local municipalities, facilitating the implementation of environmental objectives at the local level (Box 2.4).

Box 2.4. National and subnational co-ordination: "Regional COP" in France

National and local co-ordination

The Regional Conference of the Parties ("Regional COP") – inspired by the UNFCCC Conference of the Parties – is an environmental planning process. It convenes all levels of government alongside economic and civil society actors, co-ordinated by the Secrétariat Général à la Planification Écologique (General Secretariat for Ecological Planning). This approach seeks to identify leading areas in decarbonisation and emphasises the need to scale up and replicate these models across more local governments. Active participation from all French regions is crucial in achieving the established environmental targets.

"Regional COP" events, chaired by the Prefect (central government representative) and the President of the Regional Council, engage all French regions in a discussion to identify the levers for action needed to achieve environmental targets at the local level. This collaborative approach is essential to ensure that the proposed strategies and actions are inclusive and effective, encompassing a wide range of local perspectives and expertise.

Source: (Government of France, 2024[24]).

2.3.3. Japan should keep improving the legislative and institutional environment to maximise synergies and minimise trade-offs at the local level

National-scale regulatory, institutional and financial frameworks can be leveraged to advance local environmental action in a manner that maximises environmental, social and economic synergies. Japan has already made progress with this in the transition to renewable energies. For instance, the solar-sharing model – implemented, for example, in Sosa City – was made possible by a notice issued by the Ministry of Agriculture, Forestry and Fisheries in 2013 that enabled rural solar expansion through solar sharing. This allows for the simultaneous use of land for agriculture and solar energy production, contributing to both environmental and economic objectives (Magami, 2014[25]).

Another good example is the Renewable Energy Promotion Areas (REPAs), established under the Act on Promotion of Global Warming Countermeasures. Designated by municipalities, REPAs streamline regulatory processes, allowing subnational governments to align projects with both national and local standards, thus accelerating the deployment of solar, wind and other renewables (MOE, 2021[26]; Kohsaka and Kohyama, 2022[27]). REPAs help minimise land-use conflicts and community opposition by being attuned to local social conditions. Approval involves councils and stakeholder bodies to ensure regional consensus (MOE, 2021[26]). Additionally, the national framework for REPAs supports infrastructure investments that facilitate grid integration, enabling local governments to leverage renewable energy for economic growth and environmental benefits. However, as of May 2024, only 36 of the 1 718 municipalities in Japan had established renewable energy promotion zones (MOE, 2024[28]) due to the local authorities' shortage of personnel and information. To address this challenge, the 2024 revision of the Act on Promotion of Global Warming Countermeasures introduced a framework for joint designation of REPAs between prefectures and municipalities. Prefectural involvement is expected to support small municipalities and simplify the designation of zones across multiple areas, especially for large-scale installations like onshore wind facilities.

Prefectures have leveraged local ordinances to manage the trade-offs between renewable energy development and local environmental and social concerns (RILG, 2024[29]). Hyogo Prefecture's "Ordinance on Harmony between Solar Power Generation Facilities and the Local Environment" 2024 guides solar energy projects to be aligned with the local context rather than simply restricting their installation (Hyogo Prefecture, 2024[30]). The ordinance requires solar installations to preserve local landscapes, prevent environmental degradation and include disaster prevention measures like ensuring ground stability and proper drainage. The ordinance also requires notification and co-ordination with neighbours to mitigate negative impacts on the community.

2.3.4. Stakeholder engagement could significantly increase local acceptance of environmental action

Community opposition can often be a barrier to scaling up place-based environmental action, particularly in the case of renewable energy projects. The solar energy sector's rapid expansion in Japan has led to substantial public resistance, primarily due to concerns over impacts on landscapes, increased landslide risks and other environmental disruptions. Consequently, municipalities have introduced zoning and environmental regulations targeting solar power sites, requiring environmental impact assessments and establishing land-use restrictions to protect cultural and ecological sites (Yamashita, 2016[7]; Kohsaka and Kohyama, 2023[31]). As of June 2024, these ordinances total 289. While well intentioned, some ordinances have inadvertently limited suitable land for solar projects, potentially slowing Japan's transition to renewable energy (RILG, 2024[29]).

Improving stakeholder engagement could be a pathway to significantly increase local acceptance of environmental actions like solar power installations. In Germany, for instance, agrivoltaics initiatives prioritise sustainable land use and biodiversity while generating renewable energy. They have shown that involving local communities in the decision-making process can improve acceptance and support for solar installations (Rösch and Fakharizadehshirazi, 2024[32]). In Korea, the government's support for agrivoltaics, which aims to assist low-income farmers while advancing renewable energy goals, illustrates how public policy can foster community acceptance and participation in renewable energy projects (Tajima, Doedt and Lida, 2022[33]). France has also implemented agrivoltaics projects that emphasise environmental stewardship and community benefits, thereby showcasing the potential for successful local consensus-building around solar facilities (Tajima, Doedt and Lida, 2022[33]). The 100 Climate-Neutral and Smart Cities programme, developed by the European Union, engages local communities and stakeholders as a key tool for scaling up (Box 2.5).

2.3.5. Japan needs to diversify sources of funding and financing for environmental action at the local level

Although the national government has provided substantial financial support for environmental action at the local level, the uneven distribution of resources has placed regions with limited fiscal capacity at a disadvantage. This challenge stems, in part, from their dependency on subsidies, which are an uncertain revenue stream, making it difficult to leverage the available financing tools. To address this, Japan could diversify the funding and financing instruments accessible to cities and regions, particularly revenue-raising tools. Mechanisms such as land value capture, biodiversity offsetting, payments for ecosystem services and environmental bonds could help cities and regions mobilise private investment in environmental initiatives. It is essential to embed safeguards to ensure revenue raising is equitable, and that vulnerable and marginalised communities are protected from potential adverse impacts (G20/OECD, 2023[35]).

Box 2.5. The 100 Climate-Neutral and Smart Cities programme

The 100 Climate-Neutral and Smart Cities programme, developed by the European Union, aims to achieve climate neutrality in 100 cities by 2030. This programme seeks to establish these selected cities as models of sustainability, innovation and decarbonisation. Its mission aligns with the goal of making all European cities climate neutral by 2050 as part of the Horizon Europe framework. Key tools for scaling up are as follows:

- Objectives and implementation: The programme aims to make cities hubs for experimentation and innovation in urban sustainability. It promotes cross-sectoral planning, tailored guidance and active local stakeholder involvement, fostering collaboration among cities, national governments, citizens and private investors. These partnerships provide cities with extensive funding from the European Union, national programmes and private sources, with targeted support for research and innovation.
- Climate City Contracts: The programme's framework centres on Climate City Contracts (CCC) as strategic planning tools, outlining cities' commitments and actions towards climate neutrality, engaging local communities and stakeholders throughout. Cities with exemplary CCCs receive the EU Mission label, enhancing recognition and access to additional funding and support.
- Benefits of participation: Participating cities gain visibility and a stronger political profile, and attract skilled workers. They can learn from peers and amplify local climate initiatives, promoting immediate environmental benefits and long-term socio-economic improvements, making these urban centres more attractive, sustainable and resilient.

Source: (European Union, 2024[34]).

Expanding the revenue sources available to subnational governments would help make their projects – including environmental action projects – more attractive and less risky to private investors, and therefore easier to finance. For instance, to address deteriorating water quality, Kanagawa prefecture initiated the "Basic Policy for Water Source Environment Conservation and Restoration" (2005-2025) and launched a funding plan in 2018 through a special water conservation tax. This tax, averaging JPY 890 per taxpayer, funds actions such as water monitoring, river conservation in neighbouring prefectures and public awareness. Support for this plan was high, with 77% of citizens favouring budget spending beyond prefectural limits. This initiative showcases Kanagawa's commitment to sustainable resource management (IGES, 2019[18]), including through an innovative funding instrument.

Given the tight public budget, leveraging private investment in local environmental action will be more and more crucial. The growing availability of sustainable finance presents an opportunity for local governments to better meet their investment needs. To enhance local governments' access to sustainable finance, G20/OECD (2023[35]) highlighted the need for establishing effective fiscal and regulatory frameworks to facilitate affordable and sustainable finance while ensuring fiscal responsibility. Green financing and transition finance have emerged as a central mechanism for Japan to scale projects that foster environmental and social benefits while delivering economic value (Chapter 1). Green bonds, sustainability-linked loans and impact investing are tools that can attract private capital to sustainable projects. By supporting infrastructure for renewable energy, low-carbon transport systems and sustainable urban development, green financing can contribute to emissions reductions and positive environmental outcomes, while generating employment opportunities and fostering technological innovation.

2.4. Leveraging synergies through urban and rural development

Japanese urban and rural regions offer distinct opportunities to create synergies between environmental, social and economic objectives, including through climate mitigation and adaptation projects, biodiversity conservation and the circular economy.

2.4.1. Urban areas have been advancing environmental action alongside addressing economic and social challenges

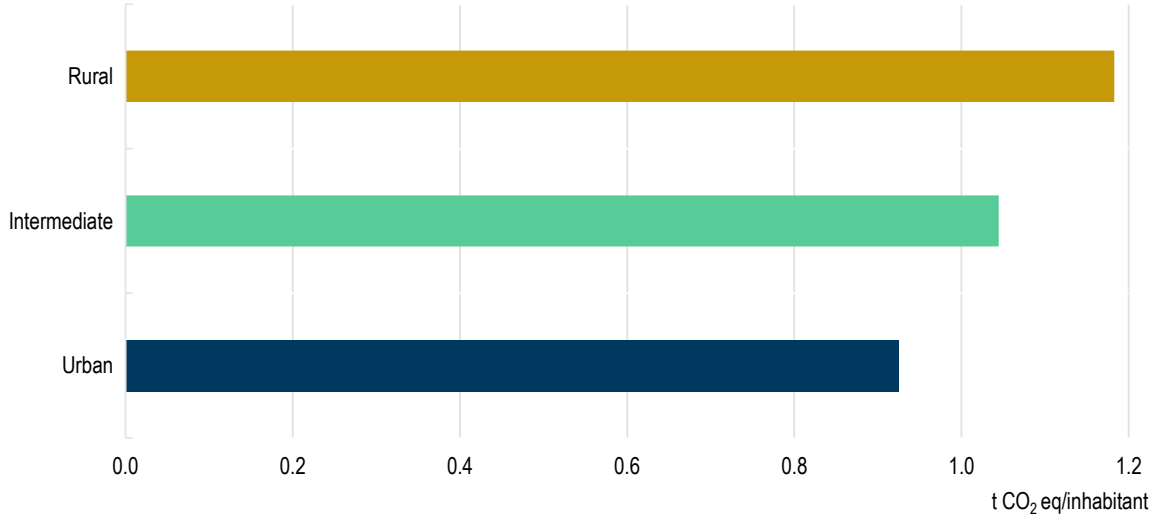
Japan's urban areas play an essential role in advancing environmental policies, while facing specific social, economic and environmental challenges that require tailored responses. High population density and industrial activity require that cities balance climate mitigation with biodiversity conservation and circular economy goals.

Decarbonising buildings remains a challenge in urban areas

GHG emissions from buildings tend to be lower per capita in dense, urban areas because apartments tend to have smaller floor areas and fewer external walls than standalone homes, which makes them more energy efficient. However, GHG emissions from buildings remain a challenge in urban areas. Meanwhile, on a per capita basis, emissions from buildings are higher in rural regions (Figure 2.10), urban areas still account for the absolute majority (54.5%) of total emissions from buildings in Japan (OECD, 2023[4]).

Figure 2.10. Building emissions per capita tend to be higher in rural regions

Building emissions per capita in urban, rural and intermediate TL3s, 2022



Note: Estimates based on OECD computations.
Source: OECD (2024), *OECD Database on Regions, Cities and Local Areas*; Crippa et al. (2023), "EDGAR v8.0 Greenhouse Gas Emissions", European Commission, Joint Research Centre (dataset).

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Across Japanese cities, sustainable building initiatives are integrating innovative energy management and decarbonisation measures that can generate environmental, economic and social co-benefits.

- In Saitama City, the development of digital technology in energy management systems has significantly reduced carbon emissions, while enhancing local economies and improving residents' quality of life (MOE, 2024[14]). This approach demonstrates effective mainstreaming of climate objectives within urban policies and showcases synergies between technological innovation, community engagement and sustainable urban development through the integration of renewable energy sources, smart grid technology and Community Energy Management Systems powered by solar and waste energy. Nevertheless, scaling these innovations nationwide poses challenges, particularly in areas with underdeveloped digital infrastructure. Additionally, the up-front costs of advanced systems can be prohibitive for smaller municipalities, limiting widespread implementation and the overall impact of these initiatives. To better inform decarbonisation strategies, Saitama could conduct detailed assessments of building stock and local heating sources to tailor policies effectively to community needs.
- In Ishikari City, the development of a smart industrial space powered entirely by renewable energy – including wind, solar and biomass – aims to decarbonise the industrial area around Ishikari Bay New Port (MOE, 2021[36]). This initiative not only reduces carbon emissions but also attracts green businesses, such as Kyocera's zero-emissions data centre, while promoting local energy consumption to revitalise the economy. Additionally, in response to the 2018 Hokkaido earthquake, Ishikari is building a microgrid for autonomous energy supply, further enhancing regional resilience (MOE, 2021[36]). This dual focus on sustainability and economic revitalisation illustrates how Japan has mainstreamed environment objectives within economic development goals, with the local industrial scale promoting resilience and sustainability. Expanding similar projects to other regions could foster economic revitalisation and promote net-zero transitions on a larger scale.

Innovative solutions are needed to increase the supply of renewable energy in urban areas to decarbonise energy use in buildings. This could include introducing storage batteries and new technology such as perovskite solar cells, and transmitting electricity from other regions where renewable energy generation exceeds their energy demand.

District-scale decarbonisation can yield strong synergies across environmental objectives

Yokohama's Minato Mirai 21 District exemplifies collaboration between local government and businesses to achieve carbon neutrality in the commercial sector by 2030. This initiative includes a framework for climate mitigation and adaptation objectives within urban master plans, ensuring strategic alignment with national climate goals. Designated as a DLA by the Ministry of the Environment, Minato Mirai 21 is implementing renewable energy solutions and energy management technologies (City of Yokohama, 2024[37]). The city's initiative to recycle plastic waste into new products reduces CO_2 emissions by minimising waste incineration, while supporting a circular economy. This focus on multi-sectoral co-benefits through circular economy projects promotes neighbourhood-level action in an effective manner with benefits beyond climate. Currently, 35 of the 64 eligible businesses in the area have endorsed the decarbonisation initiative. However, reliance on voluntary commitments limits potential impact; more robust regulatory frameworks and economic incentives could sustain and scale up business participation, reinforcing regional and national decarbonisation goals (City of Yokohama, 2024[37]).

Decarbonising the industrial sector in urban areas

Cities have implemented innovative industrial initiatives that integrate environmental action with economic and social development. For instance, Kitakyushu City's Eco-Recycling Enterprise Cluster has mainstreamed environmental initiatives, contributing to a reduction of approximately 430 000 tonnes of CO_2 emissions annually while fostering industrial symbiosis (MOE, 2019[38]). This cluster brings together industries, research institutions and local governments to promote sustainable practices and environmental

conservation. It has generated over 1 000 jobs and supported local economic growth, illustrating a strong synergy between sustainability and economic progress (MOE, 2019[38]). This initiative mainstreams climate objectives into urban policy effectively by linking environmental conservation with economic growth. However, ongoing assessments of local resources could enhance its resilience and identify new areas to support net-zero transitions within industrial sectors.

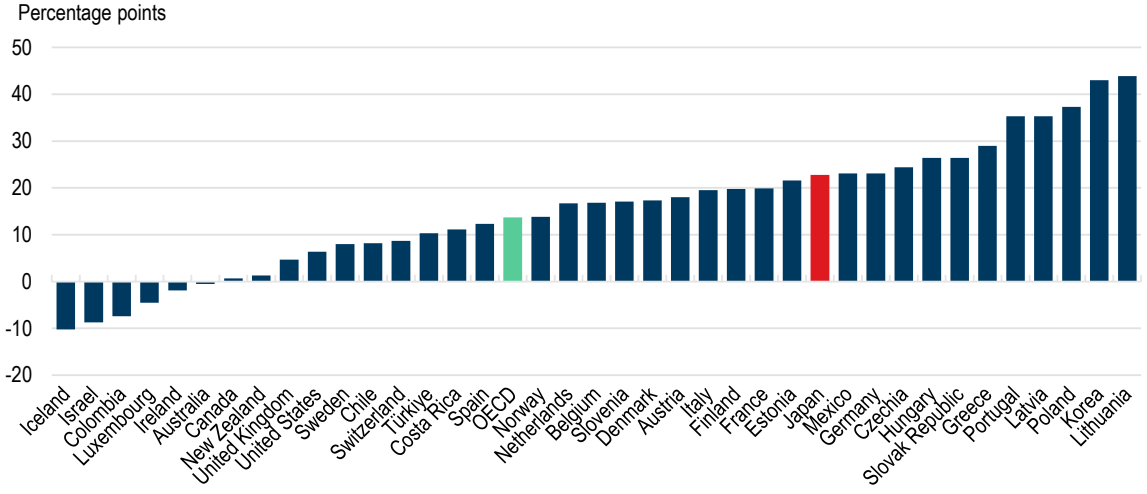
Promoting compact and connected urban development

Japan will need to double down its efforts to minimise the conversion of natural land to urban uses (land artificialisation) and promote mixed-use, high-density and nature-positive urban development, as these are effective policy instruments to generate synergies between climate action, biodiversity and material circularity objectives.

In 80% of OECD FUAs, built-up areas grew faster than the population between 2000 and 2020 (OECD, 2023[4]) – including every FUA in Japan (Figure 2.11; Figure 2.12). Increasing built-up area per capita tends to be associated with low-density housing and urban sprawl, which leads to higher energy demand and increased transport-related GHG emissions (Burgalassi and Luzzati, 2015[39]; Hardelin and Lankoski, 2018[40]). The conversion of natural land to urban uses can contribute to shrinking carbon sinks and higher agriculture, forestry and other land-use emissions. The speed of increase in Japan is among the fastest among OECD countries, despite the country's population decline (Figure 2.11). In Japan's three largest FUAs (Tokyo, Osaka and Nagoya), built-up area outpaced population growth by 4.3 percentage points (p.p), 19.6 p.p. and 8.8 p.p., respectively (Figure 2.12). In the Matsumoto FUA, this difference in growth rates exceeded 60 p.p. This means that built-up area grew by 158%, while population decreased by 2% in 2000-20 (Figure 2.12).

Figure 2.11. Built-up areas grew faster than the population between 2000 and 2020 in 80% of OECD FUAs

Differences between built-up surface growth and population growth 2000-20 in OECD FUAs



Note: FUA = Functional Urban Area.
Source: OECD (2024), *OECD Regions and Cities Data Visualisation*, https://regions-cities-atlas.oecd.org/.

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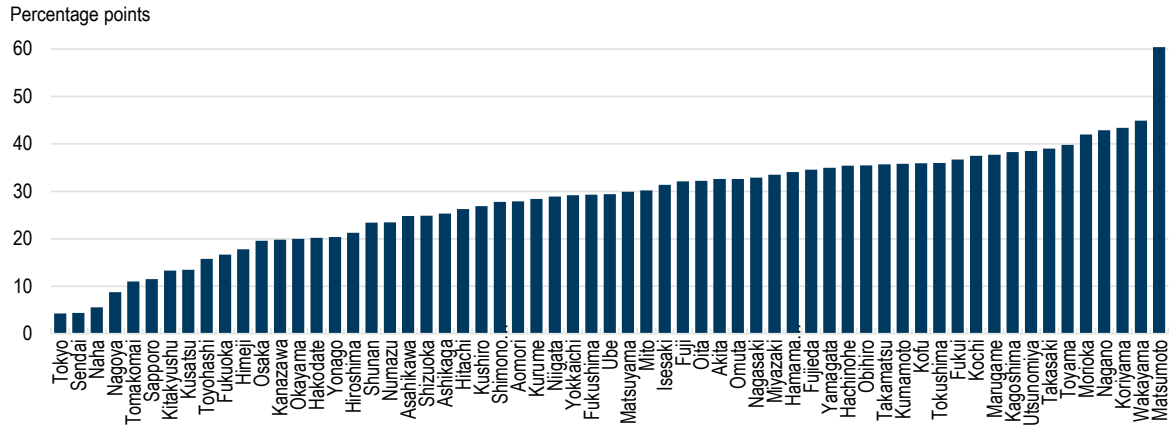
Figure 2.12. Built-up areas grew faster than the population between 2000 and 2020 in all FUAs in Japan

Difference between built-up surface growth and population growth 2000-20 in Japan FUAs



Note: FUA = Functional Urban Area. Although some FUAs experienced population decline during this period, built-up area expanded in *all* FUAs. Hence, the difference between built-up surface growth and population growth between 2000-20 is positive for every FUA in Japan.
Source: OECD (2024), *OECD Regions and Cities Data Visualisation,* https://regions-cities-atlas.oecd.org/.

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In addition to promoting compact urban development, enhancing urban transport connectivity is essential for reducing transport-related emissions, commute times and travel costs while providing inclusive transport options, such as public transit and active mobility. Many urban areas in Japan have advanced sustainable transport initiatives that integrate environmental action with urban mobility, creating effective synergies across multiple goals and offering valuable inspiration for other cities:

- Toyama City is positioning itself as a leader in sustainable urban development with the goal of becoming a Zero-Carbon City. Its comprehensive energy policies focus on promoting renewable energy and conservation. The city's "Compact City" model, introduced in 2005, concentrates development around transit hubs, reducing GHG emissions and boosting train ridership, which doubled from 2005 to 2019 (Kazuya, 2024[41]). Toyama aims to double its renewable energy capacity by 2030 and quintuple it by 2050, while also improving energy efficiency through initiatives like Net-Zero Energy Buildings. By the end of fiscal year 2021, the city had reduced CO_2 emissions by 21% compared to 2013 levels. While the Compact City model drives climate action by enhancing transportation connectivity and minimising emissions effectively, integrating biodiversity considerations into urban planning could further strengthen its sustainability efforts. Assessing climate impacts and risks from urban expansion would help Toyama better align its strategies with resilience and adaptation goals (Kazuya, 2024[41]).
- Utsunomiya City is leading in zero-carbon transportation by developing light rail transit systems and electric buses powered entirely by renewable energy (MOE, 2024[14]). This initiative aims to improve connectivity within the city and surrounding areas, reduce traffic congestion and lower GHG emissions. The city is also integrating advanced electric mobility systems that use consumer-side control batteries and large-scale storage to enhance sustainable mobility. By prioritising functional urban connectivity and emissions reduction, Utsunomiya demonstrates effective promotion of climate action at the right scale. Assessing community impacts and emission trends could help ensure the ongoing relevance and success of this transit system.

- Kyoto City is actively promoting electric taxis (e-taxis) as a significant step towards decarbonisation and sustainable urban mobility. This initiative aims to improve air quality and reduce GHG emissions, benefiting both public health and the environment (MOE, 2024[14]). To support this transition, Kyoto has implemented incentives for taxi operators to switch from petrol vehicles, including subsidies for electric vehicles, charging infrastructure and preferential access to dedicated lanes and reduced parking fees for e-taxis (MOE, 2024[14]). This initiative exemplifies effective neighbourhood-scale co-benefits, with public health and air quality improvements. Assessing the impact on travel patterns and emissions could further optimise and refine the programme by allowing policies to be adapted as needed.

Encourage decarbonisation initiatives through a metropolitan-scale approach

To maximise the impacts of such urban initiatives, it is recommended that they be co-ordinated with land use and housing policies at the metropolitan (FUA) scale. A metropolitan-scale approach allows for joint action plans whereby groups of neighbouring local authorities can co-ordinate their actions to achieve more effective results than if they carried out their initiatives in isolation.

This approach has been successfully applied in numerous metropolitan areas globally, with transit-oriented development (TOD) serving as a model that ties climate and energy objectives with urban planning. TOD-based development typically centres around high-density, mixed-used hubs anchored by public transit stations, with density decreasing as development extends outward. A notable example is the “Metro Vancouver 2040: Shaping Our Future” strategy in Canada, a regional growth strategy aimed at reducing GHG emissions by 33% from 2007 levels by 2020, and by 80% by 2050 at the metropolitan scale (OECD, 2023[4]). This ambitious strategy focuses on stimulating development in urban centres and transit corridors, promoting local employment, recreational opportunities and green infrastructure, and fostering mixed-use, transit-oriented communities to reduce vehicle kilometres travelled (OECD, 2023[4]). In taking a metropolitan-scale approach, the Metro Vancouver Region demonstrates how co-ordinated urban planning and transportation investments can enhance both environmental sustainability and quality of life.

Support small and medium-sized cities through a dedicated decarbonisation strategy

While larger, resource-rich cities align their development with climate goals, smaller cities face challenges in implementing similar measures. These disparities create uneven progress towards urban sustainability across Japan. Tailored policy measures are essential for smaller cities to catch up with larger metropolitan areas. One approach is to develop a dedicated decarbonisation strategy for small and medium-sized cities, addressing their unique sustainability challenges with customised solutions. The national government should also provide targeted technical and financial assistance to support renewable energy projects, waste management improvements and enhanced public transportation in these cities.

2.4.2. Rural regions are leveraging local resources for sustainable energy and economic development

Compared with urban regions, rural regions are sparsely populated with more available land and natural environment, which creates their unique opportunities and challenges towards the green transition.

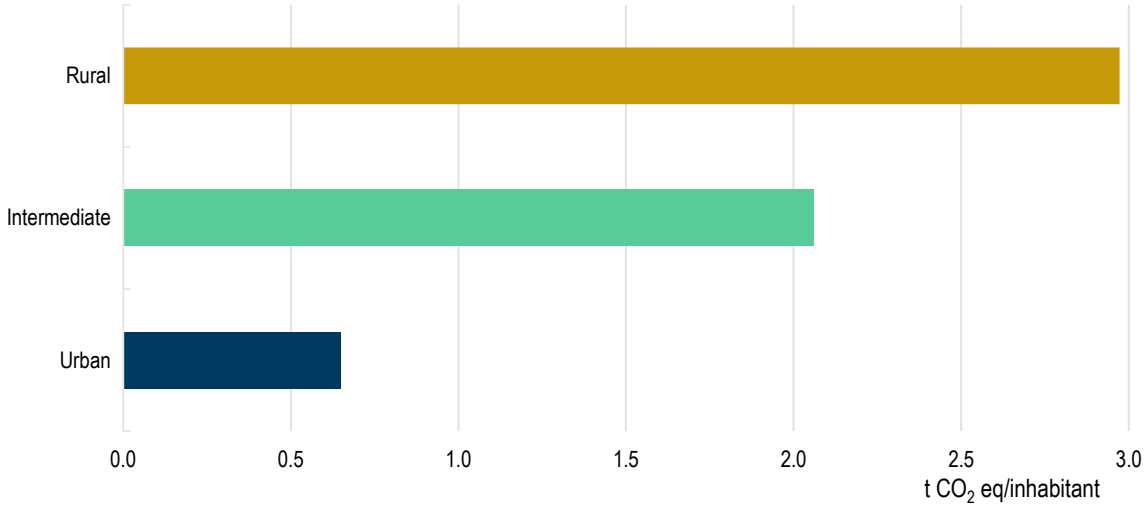
Promoting low-carbon transport solutions is a persistent challenge in rural areas

As is common in most OECD countries, rural regions in Japan have higher ground transport emissions per capita. GHG emissions from transport decreased by 9% from 1990 to 2022 in Japan, in comparison to a 22% increase on average in the OECD. The achievement can be attributed to Japan's extensive rail infrastructure and improvements in vehicle fuel efficiency. However, per capita emissions from ground transport in rural regions, on average, are 0.8 t CO_2-eq/capita, which is three times higher than in urban

regions (2.8 t CO_2-eq/capita) (Figure 2.13). This is likely due to higher rates of vehicle usage and longer travel distances in rural areas. Low population density, together with smaller administrations and lower technical and financial capacity, makes it difficult to provide low-carbon alternatives.

Figure 2.13. Ground transport emissions per capita tend to be higher in rural regions

Ground transport emissions per capita in urban, rural and intermediate TL3 regions, 2022



Note: Ground transport emissions per capita include road, train and off-road transport.
Source: OECD (2024), *OECD Database on Regions, Cities and Local Areas*; Crippa et al. (2023), "EDGAR v8.0 Greenhouse Gas Emissions", European Commission, Joint Research Centre (dataset).

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Japan has been using big data to pioneer demand-responsive transport solutions. Already in 2016, more than 200 municipalities offered demand-responsive transport schemes in some form. In some areas, riders can hail on-demand buses using a mobile application, with computers handling the scheduling, routing and dispatching. Such technology can improve the efficiency and coverage of rural public transport (OECD, 2023[4]). In some places, the local private sector has also been involved in designing routes and financing initiatives in co-operation with local authorities. For example, Hidakagawa-cho (Wakayama Prefecture) has integrated its bus routes with shared taxis. This allows variation in vehicle size depending on demand at different times, as well as enhanced feeder services and greater frequency. Niseko-cho in Hokkaido has integrated the routes of private buses, municipal welfare buses and school buses. The resulting increase in frequency and reliability then led to more use of buses by the general public (OECD, 2023[4]).

In addition to replicating such innovative practices, Japan can also tackle the sustainable mobility challenges in rural areas by reducing emissions from private car use through car- and ride-sharing programmes and deployment of electric vehicles. In the province of Alberta (Canada), for example, civil society groups, local businesses, and local and regional governments collectively invest in electric vehicle charging infrastructure to facilitate emission reductions, economic development and tourism. The project has installed 22 charging stations powered by renewable energy sourced from the region (OECD, 2023[4]).

Renewable energy initiatives in rural Japan presents opportunities for synergies

In response to the energy crisis following the 2011 Great East Japan Earthquake, Japan's 2012 feed-in tariff spurred a "solar rush". This encouraged utilities and rural governments to invest in solar energy to

offset the nuclear power shortage (Akita et al., 2020[42]; IEA, 2021[43]). Rural areas leveraged this growth by offering subsidies and tax incentives to attract projects that would revitalise local economies and use vacant land (Kohsaka and Kohyama, 2022[27]). Since 2000, multiple waves of local ordinances – guided by national policies – have incentivised renewable energy. At least 34 municipalities and 8 prefectures now offer support like subsidies and tax breaks (RILG, 2024[29]).

More recently, the DLAs and CES initiatives have successfully supported several renewable energy projects that also contribute to other environment goals while addressing local specific socio-economic challenges:

- Kamishihoro Town's biogas plant exemplifies the dual benefit of turning waste into valuable energy sources, while contributing to climate mitigation (MOE, 2024[14]). By using livestock manure to produce biogas, the town enhances energy security, reduces GHG emissions and supports biodiversity through sustainable waste management. The local government has undertaken assessments to identify specific potential and opportunities for enhancing climate resilience and promoting the net-zero transition. This project illustrates how economic resilience and environmental preservation can be intertwined when local resources are managed sustainably. It also demonstrates effective mainstreaming of climate objectives by linking waste management with climate goals. Meanwhile, its local scale ensures resilience to energy disruptions. Further co-benefits could be achieved by exploring uses for the biogas by-products beyond energy supply.
- Sosa City's "solar-sharing" model exemplifies how agricultural sustainability, renewable energy production and climate mitigation can align through an agrivoltaics approach. This initiative integrates solar panels with agricultural land use, supporting decarbonisation while revitalising the agricultural sector (MOE, 2024[14]). Concrete targets for the expansion of renewable energy projects have been established and are reflected in the city's strategic plans. By placing solar panels above fields, Sosa City not only produces renewable energy but also protects and supports agriculture, aligning environmental and economic objectives. The solar-sharing approach is a model of neighbourhood projects with co-benefits beyond climate, as it balances energy security with agricultural vitality. Expanding community engagement and shared ownership models could further enhance local buy-in and participation, thereby strengthening resilience.
- Maniwa City's biomass town initiative showcases how circular economy principles and climate mitigation can stimulate local economies while preserving natural ecosystems. Clear climate mitigation and adaptation objectives are outlined in Maniwa's development policies, thereby ensuring alignment with national and international climate goals. By using forest residues for biomass power generation, the city contributes to the decarbonisation of its forestry industry and enhances disaster resilience. In 2006, Maniwa City announced its "biomass town concept" to use forest residues and wood waste effectively (Amanuma, Onoda and Fujino, 2023[44]). Certified as a biomass town by the national government, Maniwa focuses on biomass power generation to boost resilience to natural disasters, revitalise local industries and conserve biodiversity (MOE, 2024[14]). In 2020, Maniwa declared itself a Zero-Carbon City, aiming for 100% self-sufficiency in renewable energy through the sustainable use of forest resources and the development of a timber industry cluster (Amanuma, Onoda and Fujino, 2023[44]). This initiative promotes climate action at the right scale in an effective manner by enhancing local renewable energy sources and fortifying disaster resilience. However, enhanced biodiversity monitoring would strengthen environmental outcomes, ensuring ongoing ecosystem health while supporting economic growth.
- The Ikoma City Civic Power initiative illustrates how local engagement and renewable energy production can foster a socially inclusive energy model that enhances the circular economy and supports climate action. By involving citizens in the production and consumption of renewable energy, Ikoma promotes social cohesion and economic participation alongside environmental objectives. Designated as an Eco-Model City in 2014, Ikoma faces challenges like an ageing population and the revitalisation of industries (MOE, 2021[36]). It has developed innovative energy

management strategies, including the establishment of Ikoma Civic Power Ltd., a citizen-invested power company supplying renewable energy from solar, hydroelectric and biomass sources. These initiatives emphasise social engagement, local energy production and the circular economy, reflecting a thorough understanding of the local energy landscape (MOE, 2021[36]). In this way, it emphasises effective mainstreaming of climate objectives by involving the community in renewable energy and circular economy practices.

- Goto City's floating offshore wind power project illustrates how renewable energy can enhance marine biodiversity. Launched by the Ministry of the Environment in 2010 and taken over by Goto City in 2016, the deployment of a 16.8 MW wind farm off the coast is expected to attract marine life, creating synergy between energy production and ecological (METI, 2022[45]; Energy Tracker Asia, 2024[46]). This project has increased visitor numbers and boosted regional development, fostering industry clusters related to offshore wind turbine construction and maintenance, significantly contributing to local job creation. In December 2019, Goto City became the first promotion zone under the Act on Utilization of Sea Areas for Renewable Energy, with Goto Floating Wind Farm LLC, including Toda Corporation, selected as the power operator in June 2021. By combining renewable energy with ecological benefits, this initiative fosters co-benefits beyond climate, benefiting both tourism and marine conservation. Future assessments of GHG emission reduction and biodiversity impacts could optimise project outcomes and inform further expansions.
- Shikaoi Town's biogas and hydrogen initiatives exemplify the synergy between waste management, decarbonisation and circular economy enhancement. Since 2007, the town has operated a biogas plant that converts livestock manure into biogas for effective waste treatment (Sawaji, 2019[47]). While Shikaoi has made strides in energy transition, further assessments could help identify additional locally available heating sources to ensure effective and sustainable strategies are implemented. In 2015, it established a hydrogen gas station at the plant, producing and selling hydrogen derived from biogas to fuel cell electric vehicles, including those owned by local companies and residents. By promoting climate action at a localised scale, Shikaoi enhances resilience and energy independence, while aligning broader climate goals. The project's co-benefits could be expanded by exploring hydrogen applications beyond transportation and conducting local ecosystem assessments.

To amplify the impact of these renewable energy initiatives and achieve broader community participation, Japan can draw inspiration from successful international models that enhance scalability and inclusivity of renewable projects. One recommendation is to introduce community-based co-operative ownership structures similar to those in Denmark and Germany, where local communities hold partial ownership of renewable energy installations:

- Denmark's Middelgrunden Offshore Wind Farm, partially owned by a co-operative of local citizens, showcases a model that promotes local buy-in and shares economic benefits with the community (Larsen and Sørensen, 2003[48]). This approach has increased public acceptance and facilitated quicker deployment of renewable energy infrastructure.
- Germany's Schönau Power Company (EWS Schönau) provides an excellent example of community-based ownership that could serve as a model for Japan (Hockenos, 2019[49]). EWS Schönau began in the small town of Schönau in the Black Forest region when local residents, motivated by environmental concerns, took over the town's electricity grid in the late 1990s (Hockenos, 2019[49]). Now operating as a co-operative, EWS Schönau supplies clean energy across Germany and allows local communities and individuals to become shareholders (Hockenos, 2019[49]). This model has proven successful in fostering local energy independence, increasing energy use and reinvesting profits into further green initiatives.

Implementing a similar co-operative structure in Japan could support rural areas by distributing economic benefits, fostering stronger local engagement, attracting local investments and improving self-sufficiency, particularly in regions with ageing populations or depopulation concerns.

Place-based, sustainable resource management demonstrates strong synergy potential

Circular economy practices have shown potential for overcoming Japan's challenges related to its ageing and declining population in rural areas. For instance, in Shibushi City, advanced waste separation and recycling processes have significantly reduced landfill waste, showcasing effective local strategies for waste management. Previously lacking incineration facilities, Shibushi has implemented systems that achieve high recycling rates (MOE, 2021[36]). A key initiative involves collaborating with Unicharm Corporation to recycle used disposable diapers, which constitute a significant portion of landfill waste. This collaboration transforms diapers into materials like refuse paper and plastic, aligning with circular economy principles. The project encourages extensive community participation and partnerships, extending landfill lifespans and reducing methane emissions. Overall, this initiative supports environmental sustainability, enhances the region's image, attracts visitors and contributes to the city's economic vitality (MOE, 2021[36]).

Other sustainable resource management initiatives in rural Japan also demonstrate co-benefits across decarbonisation, biodiversity and flood management:

- Minamisanriku Town, which experienced significant damage from the Great East Japan Earthquake, has focused on restoring seaweed beds in Shizugawa Bay to enhance biodiversity and convert blue carbon into CO_2 credits (Amanuma, Onoda and Fujino, 2023[44]). The town also promotes biodiversity-conscious forest management, with 70% forest coverage acting as CO_2 sinks. It received Forest Stewardship Council certification in 2015, and local organisations, like Sakyu Corporation, collaborate with the World Wide Fund for Nature to ensure sustainable wood usage (Amanuma, Onoda and Fujino, 2023[44]). Additionally, the town's oyster farming has gained certification from the Aquaculture Stewardship Council for environmentally friendly practices, improving efficiency and income for farmers. Organic household waste is also processed into biogas for electricity and liquid fertiliser for farms, aligning environmental and economic goals.
- In Lake Inba, restoration efforts focus on green infrastructure to combat flooding and environmental degradation. Initiatives include restoring abandoned rice paddies and wetlands to slow rainwater run-off, reduce nitrogen and phosphorus levels, and improve water quality. These efforts conserve wetland species and engage the local community in environmental stewardship through tasks like clearing waterways and managing vegetation. Moreover, the collaboration between municipalities within the same water basin is vital for developing a common strategy for water resilience. The synergies in Lake Inba include flood control, water purification, ecosystem conservation, community revitalisation and the creation of scenic landscapes (Amanuma, Onoda and Fujino, 2023[44]).

Expanding these projects to include climate adaptation targets and community-led resilience assessments could further enhance local environmental and economic resilience (Amanuma, Onoda and Fujino, 2023[44]; AP-PLAT, 2023[50]).

Minimising trade-offs in rural land use by promoting urban-rural collaboration

The diverse initiatives in rural Japan demonstrate the potential of localised, resource-driven approaches to foster sustainable development that aligns with national climate goals, while revitalising local economies and communities. These efforts showcase how rural areas can lead in advancing circular economy principles, supporting biodiversity and addressing climate adaptation challenges in a way that suits their unique contexts. By mainstreaming climate action, promoting resilience at the local scale, and delivering social and economic co-benefits, rural Japanese communities are proving that sustainable practices can be adapted and scaled to address environmental challenges. As these initiatives continue to evolve, they

offer a valuable blueprint for balancing environmental and economic goals across regions, illustrating the importance of community-driven strategies in achieving Japan's broader sustainability and decarbonisation ambitions.

Japan could consider a strategic approach to promote urban-rural partnerships to minimise trade-offs in rural land use. This approach involves the development of environmental policies at the FUA level aligned with the principles of the Degree of Urbanisation,[8] to enhance complementarities between urban and rural areas through collaborative projects. These could include joint renewable energy initiatives, shared public transportation systems and co-ordinated land-use planning. Such an approach seeks to bridge the urban-rural divide, maximising synergies and equitably distributing the costs and benefits of environmental action.

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Notes

[1] The OECD regional database uses the following territorial classification: Territorial Level (TL) 1: Nation; TL2: Larger administrative regions such as Tohoku in Japan; TL3: Smaller administrative regions within TL2 divisions, such as prefectures in Japan (OECD, 2024[3]).

[2] In this report, “urban”, “intermediate” and “rural” regions stand for, respectively, “predominantly urban”, “intermediate” and “predominantly rural” regions in the OECD regional typology.

[3] Strong heat stress corresponds to Universal Thermal Climate Index (UTCI) values between 32°C and 38°C.

[4] Heat island intensity corresponds to the average difference in the land surface temperature between urban land and non-urban lands within an FUA.

[5] A functional urban area consists of a city and its commuting zone. It consists of a densely inhabited city and a less densely populated commuting zone whose labour market is highly integrated with the city.

[6] In the remaining two FUAs, no change was observed over this period.

[7] Three criteria were used for assessment: i) *development*: have local governments been involved in the development of the environmental policy instrument, and how are their perspectives integrated?; ii) *targets and goals*: how does the environmental policy instrument incorporate local governments in its targets and goals?; and iii) implementation: what roles do local governments play in implementing the environmental policy instrument, and how does the national government support their efforts?

[8] The Degree of Urbanisation methodology enables nuanced international comparisons, recognising Japan's urban-rural continuum beyond a simple dichotomy, capturing semi-dense areas, functional linkages, and interconnected economic and social flows.

Annex 2.A. Decarbonization Leading Areas

Annex Table 2.A.1. Decarbonization Leading Areas aim to resolve diverse local challenges

DLA selection rounds: ■ First round (Apr 2022) ■ Second round (Nov 2022) □ Third round (Apr 2023) □ Fourth round (Nov 2023) □ Fifth round (Sep 2024)

DLA and classification	Type of area	Project description	Disaster resilience	Industrial promotion	Agriculture, forestry and fisheries	Tourism	Urban regeneration	Urban renewable energy	Public transit	Resource circulation	Biodiversity conservation	Profits to locals
1. Ishikari	City (<100 000)	Renewable energy and regional decarbonisation	■	■	■							
2. Kamishihoro	Town	Zero-carbon smart town	■							■		
3.Shikaoi	Town	Regional revitalisation through renewable energy	■		■					■		
4.Higashimatsushima	City (<100 000)	Future-focused, community-driven, decarbonised city										■
5. Akita	Prefecture	Regional microgrid with river-based renewable energy	■							■		
6.Ogata	Village	Village powered 100% by renewable energy			■					■		
7.Saitama	Designated city	Decarbonising sectors						■	■			
8.Yokohama	Designated city	A PPP in the Minato Mirai 21 District to tackle decarbonisation						■				■
9. Kawasaki	Designated city	Reducing transportation-related CO_2 emissions						■				
10. Sado	City (<100 000)	A renewable energy system for remote island sustainability	■									
11. Matsumoto	Core city	Creating the "Zero Carbon				■						

DLA and classification	Type of area	Project description	Disaster resilience	Industrial promotion	Agriculture, forestry and fisheries	Tourism	Urban regeneration	Urban renewable energy	Public transit	Resource circulation	Biodiversity conservation	Profits to locals
		Park" at Norikura Highlands				■						
12. Shizuoka	Designated city	Decarbonising “Port Town Shimizu”	■	■			■					
13. Nagoya	Designated city	A carbon-free compact city in a redevelopment district	■									
14. Maibara	City (<100 000)	Regional revitalisation through decarbonisation and the eco-village concept			■							
15. Sakai	Designated city	Local production and consumption of energy										
16. Himeji	Core city	Decarbonising Himeji Castle				■			■			
17. Amagasaki	Core city	Creating a zero-carbon baseball park through a PPP	■				■		■			
18. Awaji	City (<100 000)	Hybrid decarbonisation (compact city x Satoyama model)		■								
19. Yonago and Sakaiminato	City (≥100 000)	Promoting zero-carbon energy						■				
20. Onan	Town	A renewable energy strategy for regional growth			■							
21. Maniwa	City (<100 000)	A zero-carbon city through forest resource circulation			■					■		
22. Nishiawakura	Village	Village-wide decarbonisation for sustainable living by 2050			■					■		
23. Yusuhara	Town	Starting decarbonisation efforts in the Tosa mountains	■		■					■		
24. Kitakyushu	Designated city	Boosting industry competitiveness with renewable energy								■		
25. Kuma	Village	Developing a zero-carbon village			■							■

DLA and classification	Type of area	Project description	Disaster resilience	Industrial promotion	Agriculture, forestry and fisheries	Tourism	Urban regeneration	Urban renewable energy	Public transit	Resource circulation	Biodiversity conservation	Profits to locals
26. Chiran and Wadomari	Town	Creating a zero-carbon island on Okinoerabu	■									
27. Sapporo	Designated city	Aiming for zero-carbon status as a model for cold regions						■				
28. Okushiri	Town	The “Sustainable Island Okushiri” project	■									
29. Miyako	City (<100 000)	Building a decarbonised community										■
30. Kuji	City (<100 000)	A decarbonisation model for regional revitalisation			■					■		
31. Utsunomiya	Core city	Creating a zero-carbon model city starting with an LRT line							■			
32. Nasu-Shiobara	City (≥100 000)	Building a zero-carbon block in the Aoki District	■		■					■		
33. Ueno	Village	Creating a decarbonised regional community	■		■							
34. Chiba	Designated city	Enhancing the city’s appeal through decarbonisation	■									
35. Odawara	Core city	Revitalising urban areas with renewable energy					■					■
36. Sekikawa	Village	Disaster resilience and decarbonisation through renewables	■		■							
37. Tsuruga	City (<100 000)	Decarbonisation with the Hokuriku Shinkansen project		■								
38. Iida	City (<100 000)	A microgrid for town development and connection	■									
39. Okazaki	Core city	Creating a carbon-free town								■		
40. Konan	City (<100 000)	Implementing a region-wide decarbonisation project			■							

DLA and classification	Type of area	Project description	Disaster resilience	Industrial promotion	Agriculture, forestry and fisheries	Tourism	Urban regeneration	Urban renewable energy	Public transit	Resource circulation	Biodiversity conservation	Profits to locals
41. Kyoto	Designated city	Decarbonising Kyoto's culture and lifestyles				■			■			■
42. Kasai	City (<100 000)	Creating a battery-powered, energy-sharing community	■							■		
43. Yamaguchi	City (≥100 000)	Decarbonisation through local collaborations					■					
44. Nobeoka	City (≥100 000)	Regenerating residential areas with a carbon-neutral model	■				■					
45. Yonabaru	Town	Developing a decarbonised and vibrant community										
46. Sai	Village	Creating a zero-carbon fishing village			■					■		
47. Shiwa	Town	Implementing the Mikumarutto decarbonisation model			■					■		
48. Aizuwakamatsu	City (≥100 000)	The "Aizu-Wakamatsu Model" for zero-carbon cities										
49. Nikko	City (<100 000)	Transforming Oku-Nikko into a sustainable resort				■			■			
50. Kai	City (<100 000)	Building a zero-carbon model around nature and wineries			■	■				■		
51. Komoro	City (<100 000)	Creating a sustainable, low-carbon city	■				■					
52. Ikusaka	Village	Sustainable agricultural and mountain village model	■		■							
53. Ikoma	City (≥100 000)	Building a community-powered decarbonisation model					■					
54. Tottori	Core city	Advancing regional decarbonisation and renewable energy	■				■		■			

DLA and classification	Type of area	Project description	Disaster resilience	Industrial promotion	Agriculture, forestry and fisheries	Tourism	Urban regeneration	Urban renewable energy	Public transit	Resource circulation	Biodiversity conservation	Profits to locals
55. Matsue	Core city	Decarbonising Matsue's cultural tourism	■			■						
56. Setouchi	City (<100 000)	Decarbonisation in traditional fishing and farming areas			■					■		
57. Susaki	City (<100 000)	Decarbonising greenhouse horticulture			■							■
58. Kitagawa	Village	Developing a sustainable village decarbonisation model			■							
59. Kuroshio	Town	Building a zero-carbon disaster prevention town	■									
60. Asagiri	Town	Decarbonising agriculture and livestock			■							
61. Hioki	City (<100 000)	Microgrids and small-scale hydroelectric power generation	■									■
62. Tomakomai	City (≥100 000)	An energy base to decarbonise industry and urban areas		■								■
63. Sendai	Designated city	Decarbonising daily life for residents					■			■		
64. Tsukuba	Core city	City revitalisation and startup growth with decarbonisation		■								
65. Sosa	City (<100 000)	Promoting decarbonisation through solar sharing			■					■		■
66. Takaoka	City (≥100 000)	Decarbonisation and resource circulation in the city centre		■			■			■		
67. Ueda	City (≥100 000)	Developing a zero-carbon transportation system	■						■			
68. Takayama	City (≥100 000)	Addressing local issues with decarbonisation					■					■

DLA and classification	Type of area	Project description	Disaster resilience	Industrial promotion	Agriculture, forestry and fisheries	Tourism	Urban regeneration	Urban renewable energy	Public transit	Resource circulation	Biodiversity conservation	Profits to locals
69. Osaka	Designated city	A people-centred, carbon-neutral urban street in "Midosuji"					■	■				■
70. Ukiha	City (<100 000)	A carbon-free rural economy			■						■	■
71. Nagasaki	Core city	Promoting sustainable, decarbonised tourism				■						■
72. Mashiki	Prefecture	An RE100 industrial area near Aso Kumamoto Airport		■						■		
73. Miyakojima	City (<100 000)	Transforming Miyakojima into a decarbonised eco-island	■									■
74. Atsuta	Town	Wind power generation, local employment and revitalisation		■	■							■
75. Rikuzentakata	City (<100 000)	Decarbonisation and resource circulation			■			■		■	■	
76. Kamaishi	City (<100 000)	The "Kamaishi version of sustainable tourism"	■			■					■	
77. Watarai	Town	Decarbonisation and resource circulation			■	■				■		
78. Kobe	Designated city	Renewable energy production and disaster resilience	■					■				
79.Higashihiroshima	City (≥100 000)	A carbon-neutral academic town for the next generation		■			■	■				
80. Shimonoseki	Core city	Decarbonisation and regional revitalisation		■	■			■				
81. Fukuoka	Designated city	Decarbonisation centred on perovskite solar cells						■		■		
82. Goto	City (<100 000)	Promoting renewable energy in grid-congested areas	■					■			■	
TOTAL:			**29**	**11**	**28**	**9**	**13**	**12**	**8**	**23**	**4**	**17**

Note: The categorisation of DLA 1-73 (in blue) corresponds to the MOE's categorisation available at https://policies.env.go.jp/policy/roadmap/preceding-region/#senshinseimodelsei (in Japanese). The categorisation of DLA 74-82 (in orange) is the OECD Secretariat's elaboration based on MOE's classification criteria available at the same website.

Source: OECD Secretariat's elaboration; MOE (2024), "Leading regions for decarbonisation" (in Japanese), website, https://policies.env.go.jp/policy/roadmap/preceding-region/#senshinseimodelsei.

OECD Environmental Performance Reviews: Japan 2025

Japan has made progress in reducing environmental pressures, including energy use, greenhouse gas emissions, air pollution and waste. It has increasingly invested in the clean energy transition and the circular economy, but its energy mix remains carbon intensive and recycling efforts need strengthening, especially for plastics. Japan raised its climate ambition but must accelerate emission reductions and move away from fossil fuels to reach net zero by mid-century. The country has built robust climate adaptation capacity and has engaged the private sector more actively in biodiversity conservation to alleviate persisting pressures on ecosystems and species. A comprehensive, cost-effective policy package is needed for a successful green transformation. Scaling-up pilot initiatives that help subnational governments address socio-economic and environmental challenges would benefit the entire country.

This report is the fourth OECD Environmental Performance Review of Japan. It provides an evidence-based assessment of the country's environmental performance over the past decade along with 34 recommendations, including a special focus on leveraging synergies and local action for the green transition.

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