Estimating Total Carbon Pricing in Japan toward Carbon Neutrality

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Abstract

To date, there are three well-known carbon pricing mechanisms in Japan: the National Carbon Tax and two regional Emission Trading Systems in the Tokyo and Saitama Prefectures. However, in practice, there are other pricing instruments that can be considered indirect forms of carbon pricing. These instruments include fuel excise taxes, fuel taxes, and fuel subsidies. The latter was introduced during the period of high energy prices in 2023 to help combat rising domestic energy costs resulting from the Russian invasion of Ukraine. However, this subsidy, or negative taxation, has the unintended consequence of making the carbon tax less effective by artificially suppressing energy prices, thereby maintaining the demand level for fossil fuels instead of encouraging the switch to renewables or energy conservation. This paper uses a methodology developed by the World Bank (2023) for calculating a total carbon price, which includes direct and indirect carbon pricing mechanisms. Taken together, this approach helps policymakers understand the overall carbon price signal from their fiscal policies. This paper estimates total carbon pricing in Japan from 2018 to 2023.

1. Introduction

In recent years, the discourse surrounding carbon pricing has gained significant traction as policymakers and stakeholders grapple with the urgent need to mitigate climate change. While much attention has been focused on direct carbon pricing mechanisms such as carbon taxes and emissions trading systems (ETS), there exists a broader and more nuanced perspective when considering the Total Carbon Price (TCP).

The TCP encompasses not only direct carbon pricing instruments but also indirect mechanisms such as fuel excise taxes, subsidies, and deviations in value-added tax rates. This holistic approach provides a comprehensive understanding of the overall price signal for carbon emissions within an economy.

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By incorporating indirect carbon pricing mechanisms, the TCP reveals insights beyond what is visible from direct carbon pricing alone. It sheds light on the complex interplay between various fiscal policies, sectoral emissions contributions, and the effectiveness of carbon pricing incentives.

This paper aims to explore the significance of the TCP in shaping climate policy and decision-making, with a particular focus on Japan's carbon pricing landscape. Through a detailed analysis of Japan's carbon pricing policies, beyond the National Carbon Tax and regional Emission Trading Systems in Tokyo and Saitama Prefectures, we demonstrate how the TCP unveils hidden dynamics and underscores the importance of understanding the overall carbon pricing structure in Japan. By examining both direct and indirect pricing mechanisms in the Japanese context, we uncover a more comprehensive picture of the incentives and challenges associated with decarbonizing the Japanese economy.

The following sections provide a detailed methodology for calculating Japan's Total Carbon Price (Section 2), present the results of both direct and indirect carbon pricing mechanisms (Section 3), discuss the implications of these findings on Japan's carbon pricing strategy (Section 4), address the study's limitations (Section 5), and conclude with final remarks and future outlook (Section 6).

2. Methodology

There are two components of TCP: the direct carbon price and the indirect carbon price. To construct the TCP, all pricing instruments must be converted to a common unit of Japanese Yen per ton of CO_2. To operationalize the concept of a TCP, all elements must reflect the full (direct and indirect) net (positive minus negative) carbon price signal affecting emissions or fuel consumption at a specific level of analysis. In this case, the analysis is conducted at the national level, but it can also be calculated at the sector level.

2.1 Direct carbon price calculation

According to the World Bank definition, direct carbon pricing includes carbon taxes and emission trading systems (ETSs), which may encompass cap-and-trade schemes and certain carbon crediting mechanisms. However, because carbon crediting mechanisms typically involve voluntary transactions and relevant coverage and price data are not available, it is not possible to include them in the total carbon pricing calculation. Incorporating the marginal carbon prices from carbon taxes and ETSs into the TCP is straightforward but depends on coverage. If an ETS or carbon tax covers only a small share of a country's emissions, weighting by coverage translates this nominal price into a lower TCP figure.

The formula for the Weighted Direct Carbon Price at national level is as follows:

$$\text{Weighted Direct Carbon Price (JPY/tCO}_2\text{)} = \text{Carbon Price (JPY/tCO}_2\text{)} \times \text{Emission Coverage} \quad (1)$$

This approach ensures that the TCP accurately reflects the proportion of emissions subject to direct carbon pricing mechanisms.

2.2 Indirect carbon price calculation

Indirect carbon pricing mechanisms include fuel excise taxes, fuel subsidies, and deviations in value-added tax (VAT) rates (when VAT on fuels is lower than the standard rate). These instruments affect fossil fuel prices and can be indirectly considered a form of carbon pricing. The extent to which they are effective as carbon pricing depends on the CO_2 content of the fuels subject to these measures.

The formula for calculating the carbon price rate from fuel excise taxes and subsidies is as follows:

$$\text{Carbon Price Rate from Fuel Excise Taxes and Subsidies (JPY/tCO}_2\text{)} = \text{Tax Rate (JPY/liter)} \times \text{Carbon Content (ton CO}_2\text{/liter)} \quad (2)$$

This approach ensures that the indirect carbon price accurately reflects the carbon content of the fuels impacted by these pricing instruments. It should be noted that fuel subsidies constitute negative carbon pricing. Similar to the direct carbon pricing calculation, the coverage of excise duties and fuel subsidies also needs to be taken into account. For example, to convert an excise duty on electricity consumption by households into an indirect carbon price at the national level, the following calculation is used:

$$\text{Indirect Carbon Price of Electricity Excise Duties (JPY/tCO}_2\text{)} = \text{Excise Duty Rate (JPY/kWh)} \times \text{CO}_2 \text{ Emission Intensity of Japan's Power Sector (tCO}_2\text{/kWh)} \times \text{Household Electricity Consumption Share of Total Electricity Sector} \times \text{Power Sector CO}_2 \text{ Emissions Share in Total CO}_2 \text{ Emissions} \quad (3)$$

In Japan, the standard rate of VAT is applied to energy products and therefore does not create a pricing incentive. As a result, it can be excluded from the TCP calculation.

3. Data

3.1 Direct carbon price

Direct carbon price information for carbon tax and ETS are taken from the latest State and Trends of Carbon Pricing Dashboard by the World Bank (World Bank, 2024). The following Table contains are direct pricing data and information obtained from the World Bank:

Table 1: Overview of the direct carbon price in Japan

Instrument	Covered Fuels	Covered Sectors	Covered Emissions (% of national)	Price
National Carbon tax	Coal; Diesel; Gasoline; Kerosene; Other oil products; LPG; Natural gas	Certain uses of fossil fuels in the industry, power, transport, agriculture and forestry sectors are exempt from the carbon tax.	80% of Japan	JPY 289/tCO_2
Saitama ETS	Diesel; Gasoline; Kerosene; Other oil products; LPG; Natural gas; Non-fuel emissions	It covers about 600 entities in the industrial and commercial buildings sectors	18% of Saitama (0.6% of Japan)	JPY144-650/tCO_2
Tokyo Cap and Trade	Diesel; Gasoline; Kerosene; Other oil products; LPG; Natural gas; Non-fuel emissions	energy-use related CO_2 emissions from the industry, power and buildings sectors.	18%of Tokyo (1% of Japan)	JPY 540-5600/tCO_2

Source(s): State and Trends of Carbon Pricing, World Bank, accessed on 4th June 2024

The time series of the direct tax rates are also available from the dashboard (Table 2). The unit of the following table is JPY per tCO_2.

Table 2: Direct carbon price in Japan, JPY per tCO_2, 2018–2023

	2018	2019	2020	2021	2022	2023
Tokyo CAT (1%)	650	600	540	540	5600	5600
National Carbon Tax (80%)	289	289	289	289	289	289
Saitama ETS (0.6%)	650	600	600	469	144	144

Source(s): State and Trends of Carbon Pricing, World Bank, accessed on 4th June 2024.

3.2 Excise duties

Data on excise duties are taken from the End-use Energy Prices and Taxes for OECD Countries database (IEA, 2024). This dataset includes yearly energy end-use prices and a breakdown of taxation (ex-tax price, excise taxes, value-added tax rates and taxes, total taxes, and total prices including taxes) by three sectors (household, industry, and power sector) and by fuel products. Excise data for Japan's energy products are extracted from this database.

Table 3: Fuel excise duties in Japan, JPY per physical unit, 2018–2023

Fuel (unit)	Sectors	2018	2019	2020	2021	2022	2023
Light fuel oil (JPY/1000 litres)	Industry	2800	2800	2800	2800	2800	2800
Automotive diesel (JPY/litre)	Industry	34.9	34.9	34.9	34.9	34.9	34.9
Liquefied petroleum gas (JPY/litre)	Industry	9.8	9.8	9.8	9.8	9.8	9.8
Steam coal (JPY/tonne)	Industry	1370	1370	1370	1370	1370	1370
Coking coal (JPY/tonne)	Industry	1370	1370	1370	1370	1370	1370
Electricity (JPY/MWh)	Industry	375	375	375	375	375	375
Light fuel oil (JPY/1000 litres)	Household	2800	2800	2800	2800	2800	2800
Automotive diesel (JPY/litre)	Household	34.9	34.9	34.9	34.9	34.9	34.9
Regular unleaded gasoline (JPY/litre)	Household	56.6	56.6	56.6	56.6	56.6	56.6
Liquefied petroleum gas (JPY/litre)	Household	9.8	9.8	9.8	9.8	9.8	9.8
Electricity (JPY/MWh)	Household	375	375	375	375	375	375

Source(s): End-use energy prices and taxes for OECD countries database (IEA, 2024).

3.3 Fuel subsidies

Since January 2022, the Japanese government has announced gasoline subsidies for oil distributors to stabilize rising fuel prices. As a temporary measure, the government subsidizes retail gasoline if the price exceeds the threshold of JPY 170 per liter. According to a Japanese news website, this subsidy amounts to approximately JPY 25 per liter (Nippon com 2023 and The Japan News 2024). Additionally, in 2023, the Japanese government introduced household gas and electricity utility bill subsidies to combat rising energy prices. As of June 2024, these subsidies are still in place but are expected to be phased out by the government. The gasoline subsidy is estimated to be around JPY 25 per liter, while the subsidies for electricity (households only) and gas (households only) are approximately JPY 7 per kWh and JPY 30 per m^3, respectively.

Table 4: Fuel subsidies in Japan, 2018–2023 JPY per physical unit.

	2018	2019	2020	2021	2022	2023
Oil-JPY per litre (all sectors)	0	0	0	0	25	25
Electricity subsidy (households), JPY per kwh	0	0	0	0	0	7
Gas subsidy (households), JPY per m3	0	0	0	0	0	30

Source(s): https://japannews.yomiuri.co.jp/editorial/yomiuri-editorial/20240421-181684/and https://www.nippon.com/en/japan-data/h01550/

3.4 Fuel consumption

Fuel consumption data by source and sector is needed to calculate the weighted average of fuel excise duties and fuel subsidies, which are given per unit of each fuel and vary by sector. In this paper, data for final consumption of fuel by source and sector in Japan (Figure 1) is taken

from the IEA Japan Energy Policy Review (IEA, 2021). Unfortunately, the available data is for 2018 only, but it serves as a good proxy for the weights between 2018–2023.

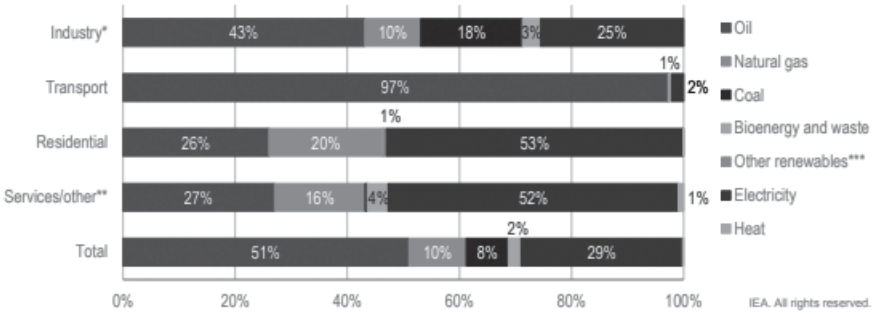

Figure 1: Total final fuel consumption by source and sector, Japan, 2018 (IEA, 2021)
Source(s): IEA (2021).

3.5 Emissions by sectors

Emissions by sector are also needed to calculate the weighted national carbon price rate, as it is important to account for each sector's contribution to overall national emissions. The sectoral emissions shares are taken from the IEA Data Service (2024) and are for the year 2021 (Figure 2).

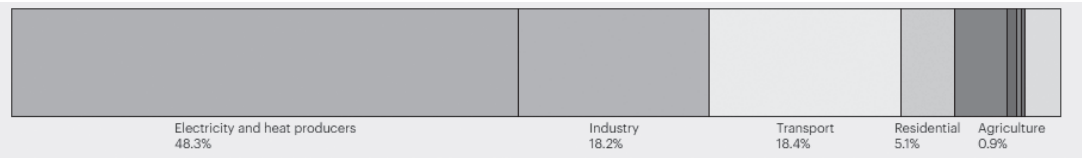

Figure 2: CO_2 emissions by sector share, Japan, 2021 (IEA, 2024).
Source(s) IEA Data Services, 2024

3.6 Emissions factor

Emission factor data are needed to convert fuel taxes and subsidies from the physical fuel unit (e.g., per ton) to emission-based (e.g., per tCO_2). The emissions content of Japan's power sector depends on the power generation mix. According to Climate Transparency, in 2020, the emission factor for Japan's power sector is 465.8 g of CO_2 per kWh. Emission factors for other fuel types are taken from the EIA website (Table 5). It should be noted that these emissions factors are not specific to Japan.

Table 5: Emission factor, CO_2 per physical unit.

Fuel	Emission factor	Unit	Source
Electricity (Emission intensity of the power sector)	465.8	g of CO_2 per kWh in 2020	https://www.climate-transparency.org/wp-content/uploads/2021/10/CT2021Japan.pdf
Natural Gas intensity	54.87	kg CO_2 per thousand cubic feet	https://www.eia.gov/environment/emissions/co2_vol_mass.php
Motor gasoline	8.78	kg CO_2 per gallon	https://www.eia.gov/environment/emissions/co2_vol_mass.php
Diesel and light fuel oil (heating)	10.19	Kg CO_2 per gallon	https://www.eia.gov/environment/emissions/co2_vol_mass.php
Coal (all type)	1764.83	kg CO_2 per short ton	https://www.eia.gov/environment/emissions/co2_vol_mass.php

3.7 Energy unit converters

Finally, it is necessary to convert energy units to the appropriate units for Japanese fuel excise duties and subsidies. The following Table 6 contains the energy unit conversions used.

Table 6: Energy unit converters used in this study.

Fuel	From		Equal to	
Electricity	1	MWh	0.001	GWh
Oil	1	litre	0.264172	Gallon
Coal	1	ton	1.10231	short ton
LPG	1	litre	0.27	m3

4. Results

4.1 Direct carbon price

After taking into account the size of emissions covered, the three existing direct carbon prices-National Carbon Tax, Saitama ETS, and Tokyo CAT-can be aggregated at the national level to a single weighted direct carbon price (Figure 3). Despite the recent collapse in the Saitama ETS price and the spike in the Tokyo ETS price around the same time, the share of national emissions covered by these two measures is small (less than 1%). Consequently, the national direct carbon price mainly reflects the national carbon tax, which covers around 80% of national CO_2 emissions. The direct carbon price in Japan in 2022 is estimated to be 288 JPY per ton of CO_2 (or around \$1.9 USD/tCO_2).

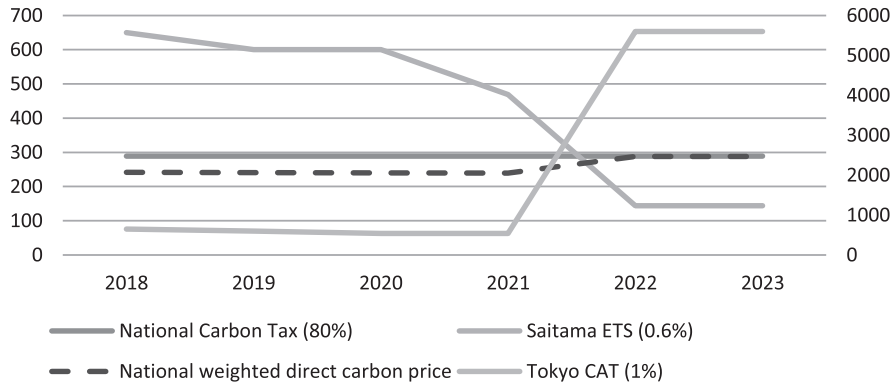

Figure 3: Direct Carbon Price in Japan, 2018–2023.

Source(s): Author's calculation.

4.2 Indirect carbon price

Indirect carbon prices applicable to Japan include fuel excise duties and fuel subsidies, as detailed in the data section. The VAT rate for energy products in Japan does not differ from the standard rate for other goods and services and is therefore not considered in the total carbon pricing exercise. The excise duties are converted from JPY per physical unit to JPY per ton CO_2, using emission factors specific to each fuel. This is then aggregated to a sector average indirect carbon price from excise duties, weighted by the sector's fuel consumption by fuel type. Finally, the indirect carbon price from excise duties is aggregated to the national level using the sectors' emission shares in total CO_2 emissions (Figure 4). Since the excise duty rates have not changed between 2018 and 2023, the indirect carbon price from fuel excise duties at the national level remains at 5560 JPY/tCO_2.

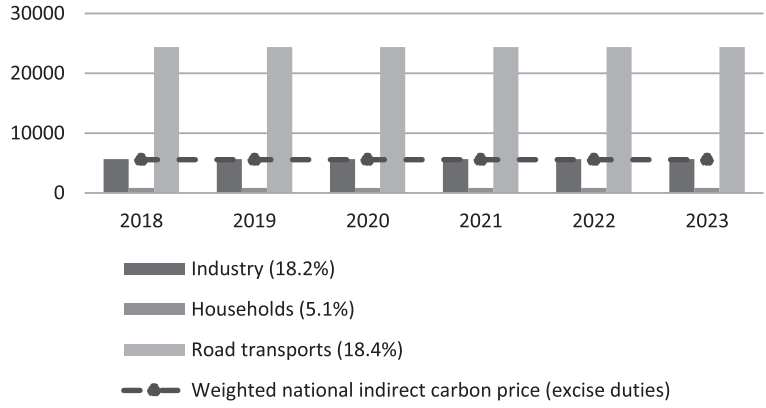

Figure 4: Indirect carbon price estimated from excise duties (JPY/tCO_2)

Source(s): Author's calculation.

The fuel subsidies introduced in 2022 represent a negative carbon price. Similar to fuel

excise duties, the CO_2 content of the fuel and the coverage share of the subsidies need to be accounted for before converting them to an indirect carbon price at the national level. Figure 6 below shows that oil, electricity, and gas fuel subsidies equate to 10,800 JPY/tCO_2, 15,000 JPY/tCO_2, and 550 JPY/tCO_2, respectively. Taking into account the coverage weights, the indirect carbon price from subsidies in Japan in 2023 is 3,940 JPY per tCO_2.

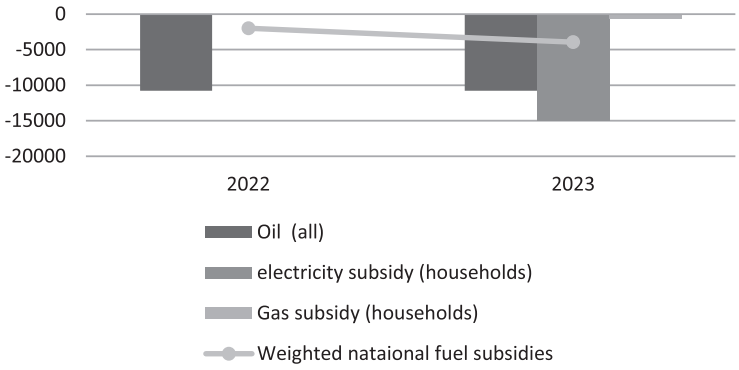

Figure 5: Indirect carbon price estimated from fuel subsidies (JPY/tCO_2)
Source(s): Author's calculation.

4.3 Total carbon price

Putting together the direct carbon price from the carbon tax and ETS with the indirect carbon price from excise duties and fuel subsidies helps us understand the recent evolution of Japan's total carbon price (Figure 6 and 7). It is clear that the direct carbon price in the country is low; while the national carbon tax has countrywide coverage, its tax rate is very low. The two regional ETS schemes have higher permit prices but cover less than 1% of national

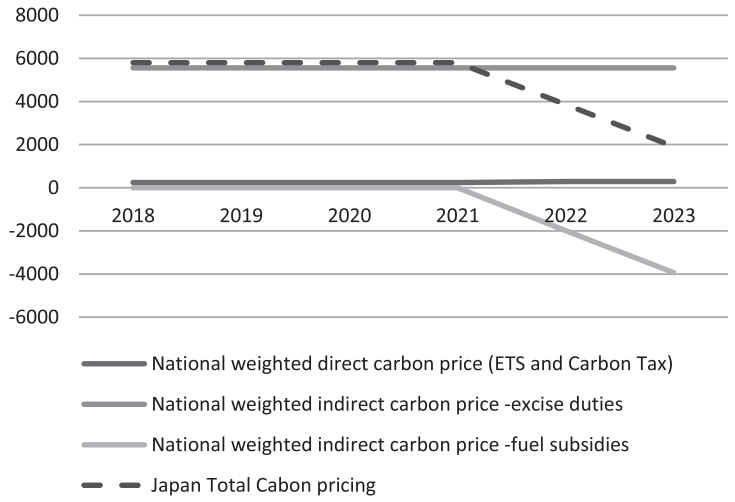

Figure 6: Total carbon price in Japan, JPY/tCO_2
Source(s): Author's calculation.

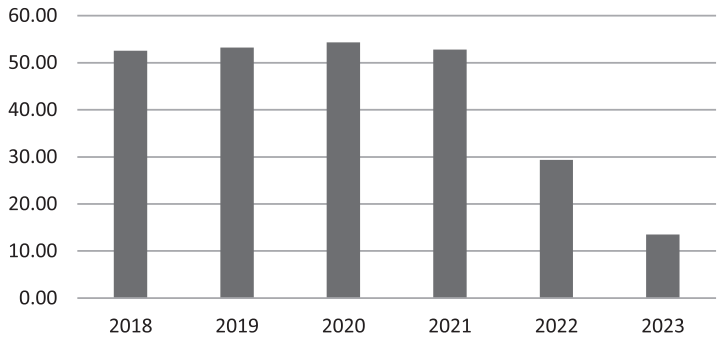

Figure 7: Total carbon price in Japan, $/tCO$_2$

Source(s): Author's calculation.

emissions.

The bulk of carbon pricing in Japan actually comes from the indirect carbon price arising from its fuel excise duties, which apply to many fossil fuels. However, since the introduction of fuel subsidies in 2022, the effectiveness of total carbon pricing has been significantly reduced. The subsidies have counteracted the price signals intended to encourage the reduction of fossil fuel consumption and the adoption of renewable energy sources. Consequently, Japan's total carbon pricing strategy has become less effective in driving meaningful climate action.

5. Conclusion

Japan's direct carbon price, at approximately 288 JPY per ton of CO_2 (around $1.9 USD/$tCO_2$), is quite low compared to international standards. In contrast, Japan's excise duties on fuels are similar to those in other countries and, when converted to an indirect carbon tax at the national level, equate to 5,560 JPY/tCO_2 (around 36.7 USD/tCO_2), a much higher level. These excise duties provide a significant indirect carbon price signal, contributing to the overall carbon pricing framework. However, the effectiveness of these excise duties is undermined by the subsidies currently in place since 2022.

Fuel subsidies, introduced to stabilize rising energy prices, have the unintended consequence of negating some of the positive impacts of carbon pricing mechanisms. By artificially lowering the cost of fossil fuels, these subsidies reduce the incentive for consumers and businesses to switch to renewable energy sources or adopt energy-saving measures. This diminishes the overall effectiveness of Japan's carbon pricing strategy. To enhance the impact of carbon pricing, it is crucial for Japan to reconsider the role of subsidies in its energy policy. Phasing out subsidies while maintaining or increasing excise duties could strengthen the price signal for carbon emissions, making carbon pricing more effective in driving the transition to a low-carbon economy.

In contrast to Japan, the European Union (EU) has implemented a comprehensive and robust carbon pricing framework that combines both direct and indirect mechanisms. The EU

Emissions Trading System (EU ETS) covers major sectors such as power, industry, and aviation. Beyond the EU ETS, several European countries have introduced national carbon taxes on top of the ETS, such as Sweden, Finland, and Denmark. These carbon taxes complement the ETS by targeting sectors not covered by the trading system, such as transportation and heating fuels. Moreover, the EU employs indirect carbon pricing mechanisms, including high fuel excise taxes, which further signal the need for emissions reductions. Recent reforms in the EU's Fit for 55 package also aim to align indirect carbon pricing with its ambitious 2030 and 2050 climate goals. According to the World Bank study, TCP in the EU countries range between $100–$200 per ton of CO_2 (World Bank, 2023).

When comparing Europe to Japan, the EU's stronger and more consistent carbon pricing signal has been a key driver of its decarbonization efforts. While Japan has made strides in introducing both direct and indirect carbon pricing mechanisms, fuel subsidies introduced during periods of high energy prices have undermined the effectiveness of its total carbon pricing strategy. Europe's experience shows that phasing out such subsidies and integrating both market-based and regulatory approaches can enhance the overall impact of carbon pricing on emissions reductions.

From the 2023/2024 fiscal year, Japan has introduced a nationwide ETS on a voluntary basis, with full-scale operation expected around 2026/27. Additionally, a carbon levy will be introduced around 2028/29 on fossil fuel mining operators and importers, such as refiners, trading houses, and electricity utilities. These recent developments are not fully captured in our analysis and represent significant future changes in Japan's carbon pricing landscape. To achieve carbon neutrality, it is crucial that Japan's currently low total carbon price is reflected in the nationwide emissions trading system scheduled for implementation in 2026/2027 (both the cap and coverage) and the carbon levy system planned for 2028/2029. Ensuring these mechanisms account for the real carbon price signal will be essential for driving meaningful emissions reductions and aligning Japan with global climate goals.

This study acknowledges several limitations that should be considered when interpreting the results. While this paper focuses on carbon pricing mechanisms, it is important to recognize that Japan also employs non-pricing instruments that are highly effective in promoting the adoption of renewable energy. Policies such as renewable energy standards, feed-in tariffs, and government incentives play a crucial role in driving the transition to a greener economy. The accuracy of this study is contingent upon the coverage and emission intensity of the data used. Our analysis relies on available data sources, such as the IEA Japan Energy Policy Review (2021) and the IEA Data Service (2024), which may not fully reflect the latest emissions and fuel consumption trends. Moreover, the emission factors and sectoral data used are based on the most recent available international data but may not account for recent changes in emission content or national-specific factors.

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