German Japanese Energy Transition Council

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Carbon pricing – opportunities, challenges, and social acceptance

Fact sheet and results of the discussions at the GJETC meeting on 18/19 February 2025

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METI Ministry of Economy, Trade and Industry

Table of Contents

List of Abbreviations, Units and Symbols

Abbreviations	
AEA	Annual Emission Allocation for EU Member States under the ESR
BMWK	German Federal Ministry for Economic Affairs and Climate Action
CBAM	Carbon border adjustment mechanism (of the EU)
CCS	Carbon capture and storage
ESR	Effort sharing regulation
ETS	Emissions trading system
EU	European Union
EUA	EU allowances, 1t of allowed CO_{2eq} emissions
F-gases	Fluorinated hydrocarbons
Fig.	Figure
FIT	Feed-in tariff
GDP	Gross domestic product
GHG	Greenhouse gas
GJETC	German-Japanese Energy Transition Council
GX	Green Transformation
IEA	International Energy Agency
KSG	Klimaschutzgesetz (Germany's Climate Protection Law)
KTF	Klima- und Transformationsfonds (Germany's Climate and Transformation Fund)
LRF	Linear reduction factor in the EU-ETS
METI	Minister of Economy, Trade, and Industry
NDC	Nationally Determined Contribution
nETS	Germany's national ETS
OECD	Organisation for Economic Co-operation and Development
R&D	Research and development
SAF	Sustainable aviation fuels
SCF	Social Climate Fund (of the EU)
SMEs	Small and medium-sized enterprises
Tab.	Table
UBA	Umweltbundesamt (Germany's Federal Environment Agency)

Units and Symbols	
€	Euro
ct	(Euro-)Cent
US$, USD	US dollar
%	Per cent
°C	Degrees Celsius
bn	Billion
CO_2	Carbon dioxide
CO_{2eq} or CO_2e	Carbon dioxide equivalents
g	Gram
GJ	Gigajoule
h	Hour
kg	Kilogram
kWh	Kilowatt hour
l	Litre
mn	Million
MW	MegaWatt
N_2O	Nitrogen dioxide
t	Tonne
yr	year

List of Tables

List of Figures

Executive Summary

Carbon pricing is an important element of the policy mix for mitigating climate change and for advancing the energy transition. Both in the EU with Germany and in Japan, carbon pricing schemes have existed for a long time, and new schemes will be introduced in the next few years. Therefore, the GJETC chose this as a subject for its work in the Japanese fiscal year 2025.

What is 'carbon pricing'? According to the OECD (2023), it is encompassing fuel excise taxes, carbon taxes and emissions trading systems. If these tax or price rates are related to the corresponding carbon dioxide emissions, their total will be called *effective carbon rates*. They can also be related to amounts of energy used, which will yield *effective energy rates*. In addition, any subsidies on energy production or use may be balanced with carbon pricing to calculate *net effective carbon rates*.

Carbon pricing is implemented in order to create a desired impact: to contribute to the reduction of carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions. An important factor for this is the relation between the carbon price and the marginal GHG abatement costs as well as the damage costs of carbon emissions. However, there may also be secondary impacts, which may or may not be desirable. These include impacts on competitiveness of industries and social and distributional impacts. Therefore, balancing undesired effects may be needed to improve acceptance of carbon pricing. For the impacts and the policies to balance undesired impacts, the use of the revenues from carbon pricing and the surrounding policy mix are also important factors.

These are among the aspects of opportunities, challenges, and social acceptance of carbon pricing that the GJETC discussed at its 18th meeting in Tokyo on February 18th and 19th, 2025. This GJETC paper serves to provide 1) a fact sheet with supporting background information on the topic of carbon pricing and social acceptance, and 2) the results of the GJETC's discussions. It covers

- the existing and planned energy taxation and carbon pricing schemes in both countries and, for Germany, the EU, as well as the resulting current and expected future levels of effective carbon and energy rates
- evidence and analysis related to impacts of carbon pricing and to policies to improve social and economic aspects and acceptance
- results from the discussion in the GJETC, including policy recommendations.

Maybe the most important finding is that carbon pricing needs to be embedded in a policy mix. Carbon pricing is an important tool designed to reduce GHG emissions; however, it is not enough to meet the target. The ETS in the EU and Japan must be embedded in a climate action policy mix to achieve targets faster and with lower carbon prices, which will support acceptance of the carbon pricing. The ETS must also be aligned with industrial and trade policies.

Furthermore, the situation varies by sector, necessitating a tailored policy mix for each sector. Carbon pricing works best if market actors can choose between alternatives and/or if the necessary infrastructures are in place. Other findings include the necessity to periodically review the policy and to make appropriate use of the revenues to the state budget from carbon pricing for funding the policy mix, particularly financial support for climate action.

1 Introduction

Carbon pricing is an important element of the policy mix for mitigating climate change and for advancing the energy transition. Both in the EU with Germany and in Japan, carbon pricing schemes have existed for a long time, and new schemes will be introduced in the next few years. Therefore, the GJETC chose this as a subject for its work in the Japanese fiscal year 2025.

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First of all, it is important to understand the existing and planned energy taxation and carbon pricing schemes in both countries and, for Germany, the EU, as well as the resulting current and expected future levels of effective carbon and energy rates. This has been collected in chapter 2.

Next, evidence and analysis related to impacts of carbon pricing and to policies to improve social and economic aspects and acceptance is important and is presented in chapter 3.

Chapter 4 compares key findings between both countries and presents key results of the GJETC's discussions. Chapter 5 finalizes the paper with conclusions and outlook.

Note: There is considerably more experience and analysis in the EU and Germany than in Japan, since explicit carbon pricing has been in place in the EU for many years for the industry and power sectors, and for three years in Germany for buildings and transport. Correspondingly, there is a higher share of information regarding evidence and analysis related to impacts of carbon pricing on the EU or Germany in this input paper. The lessons learned so far in the EU might be helpful for the discussion on the opportunities and challenges of carbon pricing.

2 Status quo and expected development of carbon pricing

In this chapter, we collect information on existing and planned carbon pricing schemes as well as fuel excise taxes, for both the EU and Germany (chapter 2.1) and Japan (chapter 2.2). In each case, the current status and the expected development of the schemes and the resulting carbon prices or energy taxes are presented. We also compare the level of these prices to the market prices for different types of fuels, to enable an easier comparison on their potential economic incentive and impact to save or substitute fossil fuels.

2.1 Carbon pricing schemes in the EU and Germany

2.1.1 The structure, status, and trends of the carbon pricing schemes

In Germany, there are currently two explicit carbon pricing schemes existing, which are

1) the EU emissions trading system I (EU-ETS I) mainly for electricity, heat, and industry and

2) the German national emissions trading system (nETS; in German: nationales Emissionshandelssystem, nEHS, created by the law named Brennstoffemissionshandelsgesetz, BEHG) for all other sectors and fuel-combusting installations.

Fuel excise taxes exist in addition to these two. There are other implicit carbon prices, such as the road toll for trucks and lorries of €200/t CO_2 (Expertenkommission, 2024).

In 2027, the nETS is expected to be replaced by the new EU emissions trading system II (EU-ETS II). Table 2-1 presents the main characteristics of these existing and planned energy taxes and carbon prices.

Table 2-1: Overview of fuel excise taxes and carbon pricing systems in the EU/Germany

Measure	Fuel excise taxes	EU emissions trading system I (EU-ETS I)	National emissions trading system (nETS/BEHG)	EU emissions trading system II (EU-ETS II)
Country coverage	Germany	EU Member States and Iceland, Liechtenstein and Norway	Germany	EU Member States and Iceland, Liechtenstein and Norway
Sector coverage	all	Electricity, Industry (energy-intensive sectors; heat/power generators above 20 MW), Off-road transport (intra-EU aviation), but also heat/power generators above 20 MW in other sectors (Buildings/district heat; Agriculture and fisheries)	Buildings, Transport (except aviation), all fuels not covered by EU-ETS I in other sectors (Industry, agriculture and fisheries)	Buildings, Transport (except aviation), industry sectors not covered under the EU-ETS I
Gases covered	(indirectly, all energy-related emissions)	CO_2, N_2O, F-gases	CO_2	CO_2
Point of regulation	Upstream	Downstream	Upstream	Upstream

Measure	Fuel excise taxes	EU emissions trading system I (EU-ETS I)	National emissions trading system (nETS/BEHG)	EU emissions trading system II (EU-ETS II)
Actors in charge	Energy suppliers	Industry companies; owners of power/ heat generators	Energy suppliers	Energy suppliers
Start date	1930 (transport fuels)/1960 (heating oil)	2005	2021	2027 (In case of exceptionally high gas or oil prices in 2026, start could be postponed to 2028.)
End date	n.a.	n.a.	2027 or 2028 (to be replaced by EU-ETS II)	n.a.
Development of caps	n.a.	Linear reduction factor (LRF) of 4.3 %/yr (compared to average 2008-12 emissions) between 2024 and 2027; LRF 4.4 %/yr from 2028. Last allocations are expected for ca. 2038.	n.a.	Linear reduction factor (LRF) of 5.1 %/yr between 2024 and 2027; LRF 5.38 %/yr from 2028. Last allocations are expected for ca. 2043.
Current level/trend of implicit or explicit GHG price (€/t CO_2 or CO_{2eq})	Transport: • Gasoline: 65.45 ct/l, ca. 281 €/t CO_{2eq} • Diesel: 47.04 ct/l, ca. 179 €/t CO_{2eq} • LPG: 409 €/1000kg, ca. 138 €/t CO_{2eq} Buildings: • Natural gas: 0.55 ct/kWh, ca. 30 €/t CO_{2eq} • Light fuel oil: 6.135 ct/l, ca. 22 €/t CO_{2eq} Industry: • Heavy fuel oil: 130 €/1000kg, ca. 41 €/t CO_{2eq} • Coal: 0.33 €/GJ, ca. 3 €/t CO_{2eq} Electricity (residential/SMEs): • 2.05 ct/kWh, ca. 55 €/t CO_{2eq}	Ca. 60-70 €/t CO_2 (2024) February 2025: ca. 80 €/t CO_2 But free allocations for emissions-intensive and trade-exposed industries	2021: 25 €/t CO_2 2022: 30 €/t CO_2 2023: 30 €/t CO_2 2024: 45 €/t CO_2 2025: 55 €/t CO_2 2026: between 55 and 65 €/t CO_2 2027: tbd via emissions trading (under EU-ETS II, if activated; otherwise, national trading)	n.a. (trading has not started yet) During the first three years that the ETS2 is operational, if the price of allowances exceeds €45 (in 2020 prices, i.e. adjusted for inflation), additional allowances may be released from the ETS2 market stability reserve to address excessive price increases.

Measure	Fuel excise taxes	EU emissions trading system I (EU-ETS I)	National emissions trading system (nETS/BEHG)	EU emissions trading system II (EU-ETS II)
Expected future levels of implicit or explicit GHG price (€/t CO_2 or CO_{2eq})	Unclear; unlikely to increase, as nEHS and EU-ETS II are introduced	EEX EUA Futures for 2030: ca. €95/t as of early February 2025 (eex, n.d.); higher in 2035/40: €150/t or €200/t? E.g., €179/t in 2040 according to Agora et al. (2024)	n.a. from 2028	Expected to be ca. €45/t to €80/t_{2020} in 2027-32, maybe somewhat more (see above), but some studies expect higher levels if carbon pricing was the only instrument (€126 to €350/t in the sources evaluated by Fiedler et al., 2024); higher in 2035/40: €150/t to €200/t? (sources: Prognos et al. (2022); €179/t in 2040 according to Agora et al. (2024))If carbon pricing was the only instrument: €370 to €670/t in one study cited by Fiedler et al. (2024)
Amount of revenues	Ca. €39 bn (2023) Of which 85% (€33.2 bn) from gasoline (€15 bn) and Diesel (€18.2 bn); most of rest from natural gas	Plan: ca. €8.2 bn (2024), based on certificate price of €90/t; probably less in reality, due to lower certificate prices	Plan: ca. €12.2 bn (2024) May increase to ca. €15 bn/yr in 2025/26	Ca. € 260 bn in EU expected 2027-2032 based on €45/t; at that price, would be ca. €12 bn/yr in Germany

Measure	Fuel excise taxes	EU emissions trading system I (EU-ETS I)	National emissions trading system (nETS/BEHG)	EU emissions trading system II (EU-ETS II)
Use of revenues	General budget; for road fuels: level used to be justified by demand for road investments; but no earmarking	Basically, revenues must be used for different kinds of climate change mitigation measures, or support of vulnerable third countries. In Germany: all revenues go to the Climate and Transition Fund (KTF), are used for all kinds of financial incentives for climate mitigation (especially in buildings: BEG programme) and to cover the incremental costs of the electricity generation from renewable energies (under the EEG law), instead of the former levy; Between 2024 and 2030, 4.5 % of revenues go to the Modernisation fund.	Revenues go to the Climate and Transition Fund (KTF) of the German government. Most of the KTF's resources are used to fund financial incentive programmes for climate mitigation, especially in buildings and industry, but also for supporting new chip factories	Revenues go to Member States (%) and to the Social Climate Fund (see below). Member States must use their portion of revenues for purposes related to decarbonization and addressing the social impacts of the policy (Article 30d (6) Directive (EU) 2023/959). In Germany: all revenues are expected to go to the Climate and Transition Fund (KTF). The Social Climate Fund (SCF) will mobilize EUR 86.7 billion from the ETS II revenue in the 2026-2032 period to support vulnerable citizens in the energy and climate transition.

Sources: Energiesteuergesetz (energy taxation law)(BMJ, 2006/2024); EU Emissions Trading Directive (EUR-Lex, 2024); Brennstoffemissionshandelsgesetz (national emissions trading law) – BEHG (BMJ, 2029/2023); Emissionsberichterstattungsverordnung 2030 (BMJ, 2022); European Commission (2024)

What is the impact of these carbon rates on fuel and electricity prices? For the situation in 2024, this is shown for selected fuels in the figure below. For electricity, the EU-ETS I increases net prices by ca. 2.6 ct/kWh in 2024.

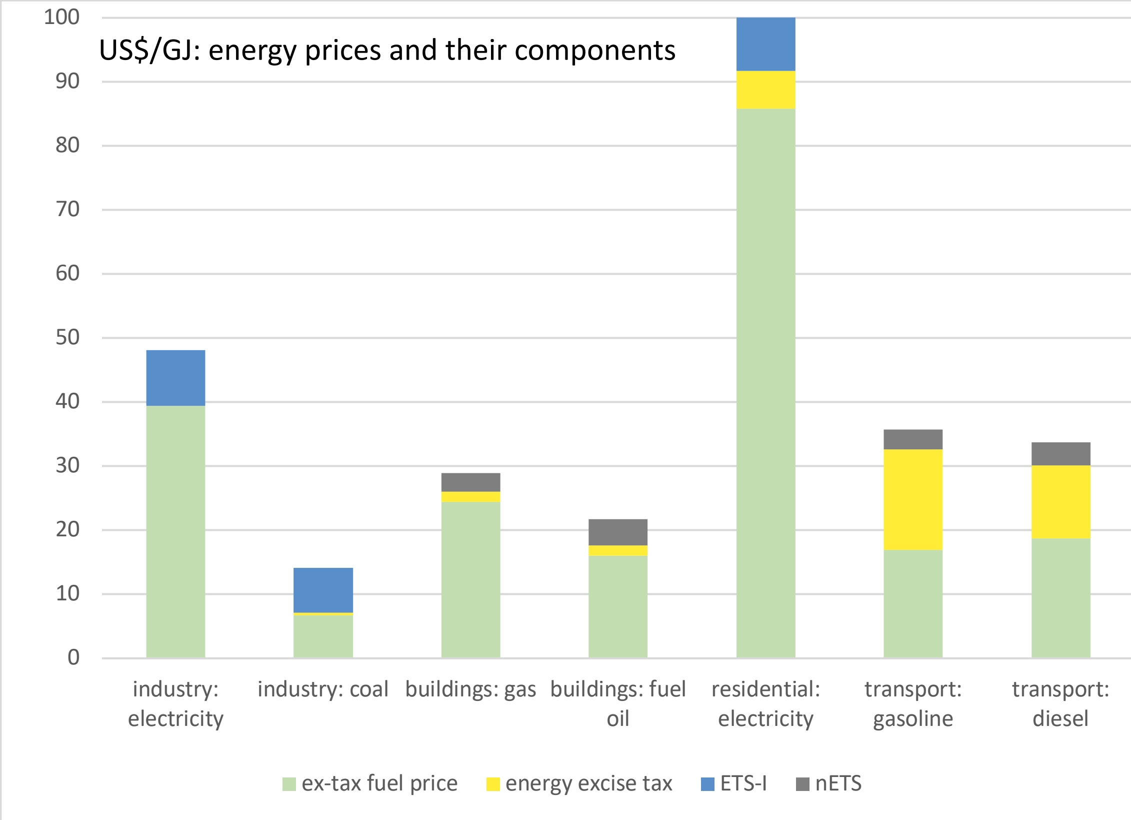

Figure 2-1: Carbon prices in relation to market prices of energy and fuel excise taxes (excl. VAT) in Germany, year 2024

Source: own calculations based on Destatis and other sources

Note: 19 % of VAT will be added on all price components alike, if sold to final consumers.

The ETS-II is expected to lead to similar prices for CO_2 in the buildings and transport sectors in all EU Member States with very different economic strenghts, comparing e.g. Romania with Germany. Therefore, as an instrument to compensate for hardships and to improve social acceptance, the **Social Climate Fund** (SCF) has been established by the Regulation (EU) 2023/955 in parallel to the new EU-ETS II. EUR 86.7 billion from the ETS II revenue in the 2026-2032 period (which would be ca. 1/3 of the revenue, if the price were around €45/t) will be used to help vulnerable groups reduce fossil fuel use, such as the decarbonization of heating and cooling systems in buildings, and the roll out of zero and low-carbon mobility options; as well as direct income support to those most affected during the transition period. EU Member States will have to develop Social Climate Plans with such measures and receive SCF funding based on a formula that prioritizes the less wealthy Member States.

The **Modernization Fund** is a program from the European Union to support 13 Member States to meet energy targets by helping to modernize energy systems and improve energy efficiency. The total revenues of the Modernization Fund are taken from the EU-ETS I and amount to €57 billion from 2021 to 2030, assuming a carbon price of €75/tCO_2.

In 2023, the EU also introduced the **carbon border adjustment mechanism** (**CBAM**) to avoid competitive disadvantages for companies based in the EU. It states that importers of certain goods of iron and steel, aluminium, cement, fertilizers, electricity, and hydrogen, will have to pay the equivalent of the EU-ETS I price for the embedded emissions to produce these goods:

- Transitional Phase: CBAM will begin with a transitional phase which started October 1, 2023, in which importers need to report the carbon emissions embedded in their products without financial obligations.
- Full Implementation: The mechanism is expected to be fully operational by January 1, 2026, when importers will need to start purchasing CBAM certificates.

This phased approach was decided to allow companies to adapt to the new requirements and to give policymakers time to refine the system.

Currently, at least 57% of certificates in the EU-ETS I are auctioned, but there is free allocation for the goods mentioned above from energy-intensive and trade-exposed industries. Between 2026 and 2034, this free allocation will gradually be abolished for the goods under CBAM, and the CBAM duties for payment will be phased in with the same speed.

2.1.2 The interplay in the EU legal framework, Effort Sharing Regulation (ESR) , ETS I, and ETS II combined, and its impacts for Germany

The embeddedness of the German carbon pricing system into the EU carbon pricing framework has very strict and binding implications, when the EU- Effort Sharing Regulation (ESR; Regulation - 2018/842 - EN - EUR-Lex, 2018) and its relation to ETS I and ETS II are considered.

Binding targets up to 2030 set by the ESR

The Effort Sharing Regulation (ESR) sets **binding annual emissions reduction targets** for each EU country up to 2030, based on GDP per capita and cost-effectiveness. The ESR focusses on greenhouse gas (GHG) emissions in sectors not covered by the EU-ETS I. The ESR sectors include transport, buildings, agriculture, small industries and waste management, which together account for nearly 60% of total EU emissions. Hence, there is an overlap with the EU-ETS II concerning transport and buildings.[1]

According to the 2030 Target of ESR, Germany must reduce its non-ETS I sector emissions by 50% compared to 2005 levels. This is among the highest targets in the EU due to Germany's strong economy and high emissions. Compliance is monitored with annual limits from 2021 to 2030, ensuring a gradual reduction.

The reduction is not linear—it follows a steeper decline after 2025 due to stricter targets. The Annual Emission Allocations (AEAs) shrink every year using a trajectory approach:

- 2021-2025: Gradual reductions based on previous commitments.
- 2026-2030: Faster decline to meet the -50% target by 2030.
- Each country must ensure that its emissions stay within the allocated allowances.

Under its Climate Protection Act (KSG), Germany aims for a 65% total emissions reduction by 2030 (compared to 1990 levels). The ESR implies stricter cuts for non-ETS I sectors, achieving 65% emissions reductions vs. 1990 in these sectors as well to meet the 50% ESR requirement.

[1] The ESR covers agriculture and waste, which are not included in the EU-ETS II. The ESR sets binding national emission reduction targets, while the ETS II operates on a cap-and-trade system. As both cover road transport and buildings, the ESR continues to apply until ETS II takes full effect.

If Germany falls short of its ESR target, it may have to buy emission allowances from other EU countries.

EU binding legal framework up to 2045/2050

The European Commission has not yet defined whether ESR obligations will be extended beyond 2030. But even if ESR is phased out, Germany might rely entirely on the EU-ETS II and national climate laws and policies to reach its binding 2045 net-zero goal

Concerning the 2050 target, the EU aims for net-zero emissions (GHG neutrality) by 2050, which includes all sectors. Germany has committed to climate neutrality by 2045, five years ahead of the EU. This means a nearly complete phase-out of fossil fuels also in non-ETS sectors, such as transport and buildings.

Germany will have binding targets under the EU-ETS I and II from 2030 to 2045, but these are not country-specific targets. Instead, Germany participates in the EU-wide cap-and-trade system, which sets a declining emissions cap for covered country sectors. The total number of allowances decreases annually under the linear reduction factor (LRF). The current LRF for the ETS I is 4.3% per year until 2028 and will increase to 4.4% after 2028 to ensure the system aligns with the EU's 2040 climate targets (see Table 2-1). German companies in these sectors must purchase or receive allowances to cover their emissions.

As has been mentioned, the EU-ETS II starts in 2027 with a carbon price on fossil fuels. There will be a gradual tightening of emission caps with zero available certificates by 2043 (see Table 2-1 for the LRFs). If emissions are not reduced fast enough in transport and heating, Germany must buy allowances from other EU states in the ETS II market.

There are only a few flexibilities built in the EU ETS I and EU ETS II.[2] But concerning the current EU legal framework conditions, the overall impact for Germany will be that there are no further carbon allowances under the ETS I beyond 2039 and under the ETS I beyond 2043.

2.2 Carbon pricing schemes in Japan

Petroleum and Coal Tax

The petroleum tax was introduced in 1978 for crude oil and petroleum products in Japan. This tax was subsequently extended to include natural gas in 1984 and coal in 2003, at which point it was renamed the petroleum and coal tax. Additionally, since 2012, the taxation for climate change mitigation, often termed the global warming measures tax, has been gradually implemented. As of 2024, the combined tax rate for the petroleum and coal tax and the global warming measures tax stands at 2,800 yen/kl (17.50 euro/kl)[3] for oil, 1,860 yen/t (11.63 euro/t)

[2] For example Banking & Borrowing: unused allowances can be used for later years or borrowed up to 7.5% from future allocations. Trading: Allowances can be bought from other EU countries if needed. Removals: from Land Use, Land Use Change, and Forestry (LULUCF) can be used to offset emissions.

[3] 1 euro = 160 yen.

for gas, and 1,370 yen/t (8.56 euro/t) for coal, with the global warming measures tax component accounting for approximately 300 yen/tCO_2 (1.88 euro/tCO_2) for every fuel.

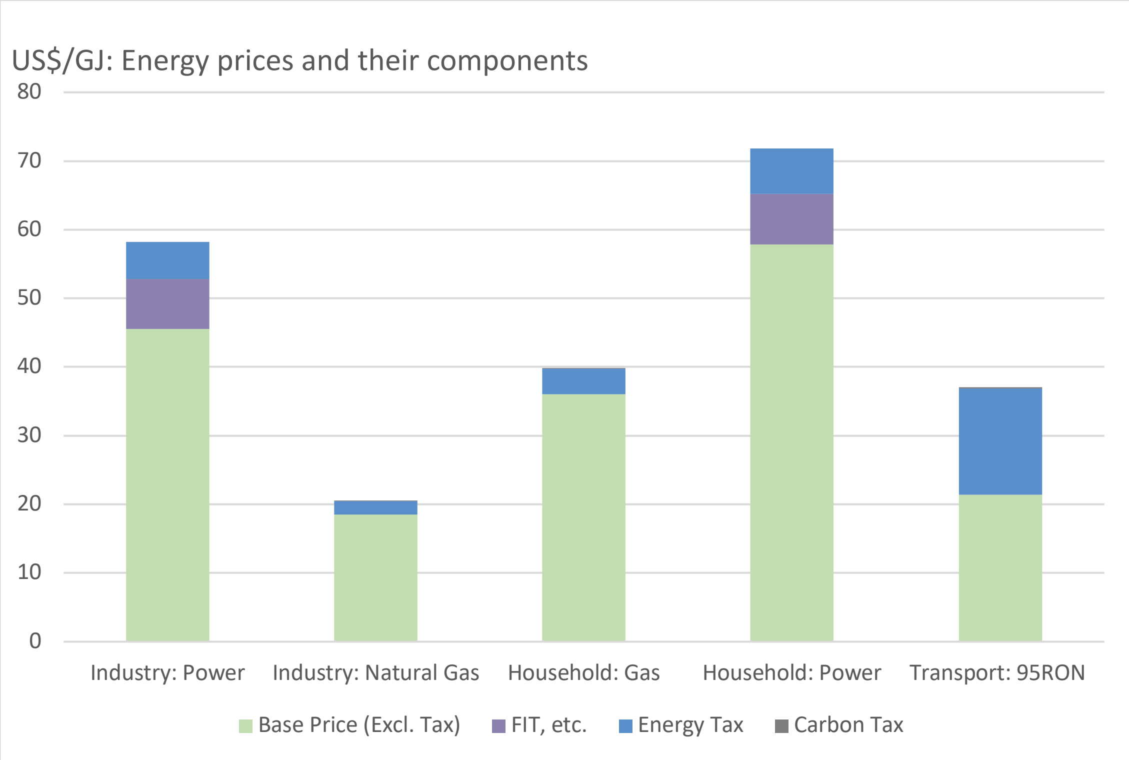

Figure 2-2: Carbon prices in relation to market prices of energy and taxes in Japan, year 2022

Source: IEEJ estimates based on IEA statistics.

Note: 1 US$ = 131.5 yen.

GX Promotion Act

In January 2023, the Japanese government announced the Basic Policy for the Realization of Green Transformation (GX) and envisioned achieving over 150 trillion yen (937.5 billion euro) in combined public and private GX investment over the next decade through a comprehensive policy package integrating regulation and support measures. To facilitate this objective, the government enacted the GX Promotion Act in May 2023, allocating 20 trillion yen (125 billion euro) in advance investment support. This funding is to be sourced from carbon pricing revenue to redeem GX economic transition bonds. Under the Act, carbon surcharges on fossil fuels will be introduced in 2028, and the emissions quota auction system for power producers will be implemented from 2033.

Discussions regarding the institutional design of the carbon pricing policy were conducted, and in December 2024, the Cabinet Secretariat's Working Group of Experts on Carbon Pricing compiled the outcomes of these discussions. The compilation is expected to be incorporated into a proposed amendment to the GX Promotion Act during the ordinary Diet session of 2025.

1) GX Surcharges on Fossil Fuels

The GX carbon surcharges for fossil fuels are a system in which importers and other relevant entities are charged a levy based on the amount of CO_2 contained in all fossil fuels. The unit price of the surcharges is determined by the Minister of Economy, Trade, and Industry (METI), considering the two points of mitigating energy-related cost burdens over the medium to long term and ensuring the redemption of GX Economy Transition Bonds by 2050. The maximum surcharge amount will also consider the reduction in the petroleum and coal tax revenue (due to reduced consumption of these fuels) and Feed-in-Tariff (FIT) payments (after 2030, when payments to generators that receive the FIT will gradually end), while the minimum amount is set to only cover the annual redemption of GX Economy Transition Bonds.

2) Auction of Emission Allowances for Power Producers and the GX ETS

The GX Promotion Act includes the establishment of a system for the auction of emission quotas by power producers. Under this system, emission credits will be allocated to power generation companies through auctions, beginning in FY 2033.

Prior to the enactment of the GX Promotion Act, the first phase of the GX Emissions Trading Scheme (GX ETS), a voluntary emissions trading mechanism, was launched in 2023 as part of the GX League—a group of companies striving ambitiously toward carbon neutrality. Participants in Phase 1 set their own greenhouse gas reduction targets and publicly disclose their progress on the GX Dashboard. Collectively, the emissions from participating companies account for over 50% of Japan’s total greenhouse gas emissions.

In Phase 1, only direct domestic emissions are subject to emissions trading. Companies failing to meet their voluntary targets are required to either procure excess reduction units or carbon credits or clarify the reasons for the failure. Excess reduction units eligible for sale to other companies must exceed Japan's Nationally Determined Contribution (NDC) level (a 46% reduction compared to 2013) as a direct result of company-led efforts. Additionally, third-party verification is mandatory for the calculation and reporting of actual emissions by each company. When applying for the issuance of excess reduction units, obtaining reasonable assurance from a third-party verifier is particularly essential. As this initiative relies on companies setting voluntary targets, certain variation exists in reduction targets both within and across industries.

From 2026, GX ETS will transition into its second phase, adopting a more mandatory framework. It will apply to corporations with direct emissions of 100,000 t-CO_2 or more, requiring them to amortize allowances equivalent to their annual emissions.

The allocation of emission credits to targeted companies will be conducted without charge, calculated according to government-established standards. Free allocation will follow two methods: industry-specific benchmarks for energy-intensive sectors and a grandfathering approach for sectors where benchmark formulation is challenging. The extent, to which these benchmarks and grandfathering amounts may be reduced, e.g. by an annual reduction factor, has yet to be decided.

To avoid excessive burdens, the following factors are considered when determining free allocation amounts:

- Emissions reductions achieved before the system's implementation are considered in calculating free allocations through grandfathering
- Risks of carbon leakage
- Corporate investment in research and development (R&D)

Adjustments to annual free allocation amounts will be made in response to new installations or decommissioning of facilities during the second phase.

From 2026, price controls will also be introduced to stabilize the GX ETS. A maximum and minimum price for emission credits will be established, but the levels of these prices are yet to be decided by the government of Japan (expected in 2026 or later). If the credit price exceeds the maximum level, companies will be allowed to meet their obligations by paying the predetermined maximum price, thereby preventing excessive compliance costs. Conversely, if the market price drops below the minimum level, the government will conduct reverse auctions for emission credits and may tighten future quota standards to address prolonged stagnation.

Unlike Phase 1, Phase 2 aims to enhance fairness across companies. A monetary penalty, tentatively termed an "equivalent charge for unamortized amounts," will be imposed on companies that fail to meet their retirement obligations.

Later, GX ETS will be a platform for emission allowance auctions for electricity producers in 2033.

However, how to avoid an overlap between the carbon tax (GX Surcharges) and GX ETS is unclear.

Table 2-2: Overview of Petroleum and Coal Tax and GX ETS carbon pricing systems in Japan

Measure	Petroleum and Coal Tax	GX Surcharges on Fossil Fuels	Auction of Emission Allowances for Power Producers (Part of GX ETS)
Country coverage	Japan	Japan	Japan
Sector coverage	All	All	Electricity
Gases covered	CO_2	CO_2 etc. (consistent with the Act on Promotion of Global Warming Countermeasures)	CO_2
Point of regulation	Upstream	Upstream	Electricity generation
Actors in charge	Fossil fuel importers Fossil fuels used for raw materials (such as coking coal for steel, naphtha, coal for cement, and fuels for agriculture, forestry, and fisheries) are exempt from taxation.	Companies and groups of companies emitting over 100,000 t-CO2/year Approx. 300-400 companies (50–60% of domestic emissions)	Power Producers

Measure	Petroleum and Coal Tax	GX Surcharges on Fossil Fuels	Auction of Emission Allowances for Power Producers (Part of GX ETS)
Start date	2003 (coal added to the petroleum tax), 2012 (global warming measures tax added)	2028	2033
End date	n.a.	n.a.	n.a.
Development of caps	n.a.	Not planned to be set.	Not planned to be set.
Current level/trend of implicit or explicit GHG price (€/t CO_2 or CO_{2eq})	Power generation and transportation: • Coal: 1,370 yen/t ca. 590 yen/t CO_{2eq} • Natural Gas: 1,860 yen/t ca. 689 yen/t CO_{2eq} • Oil: 2,800 yen/kl, ca. 1,068 yen/t CO_{2eq} (The prices above include 280 yen/t CO_{2eq} of global warming measures tax)	n.a.	n.a.
Expected future levels of implicit or explicit GHG price	n.a.	Determined by the Minister of Economy, Trade, and Industry (METI), considering energy-related cost burdens and the redemption of GX Economy Transition Bonds by 2050. Ceiling price will be introduced as maximum amount and set a minimum amount through government purchases via reverse auctions.	
Amount of revenues	660 billion yen (2023) as the revenue for the special accounts of the government.	n.a.	n.a.
Use of revenues	Energy efficiency measures, expansion of renewable energy, and the reduction of energy-related CO_2 emissions through the cleaning of fossil fuels, etc.	Redemption of GX Economy Transition Bonds, Promotion of GX investment, etc.	

3 Analysis of impacts and of policies to improve social and economic aspects and acceptance

Carbon pricing is implemented in order to create a desired impact: to contribute to the reduction of CO_2 and other greenhouse gas emissions. An important factor for this is the relation between the carbon price and the marginal GHG abatement costs as well as the damage costs of carbon emissions, which is discussed in chapter 3.1. Chapter 3.2 will then collect evidence from literature on the desired impact on carbon emissions.

However, there may also be secondary impacts, which may or may not be desirable. These include impacts on competitiveness of industries (chapter 3.2) and social and distributional impacts (chapter 3.3).

Balancing undesired effects may be needed to improve acceptance of carbon pricing. Chapter 3.4 discusses existing and suggested policies to improve social and economic aspects and acceptance.

3.1 Costs of carbon emissions (damage costs or marginal abatement costs)

Until today, there does not seem to be a consensus in neither academic research nor policy debate on whether policies such as carbon pricing should use the costs of damage caused by climate change or the marginal GHG abatement costs as the benchmark. We therefore present estimates for both. Interestingly, the ranges for both damage and marginal abatement costs presented below are reasonably similar, between 250 and 900 Euros or US$ per ton of CO_2. In any case, they are much higher than carbon pricing levels reached anywhere in the world (World Bank, 2024). However, *average* abatement costs are likely to be considerably lower than marginal costs and damage costs, making climate change mitigation policies cost-effective overall from a societal perspective.

The World Bank (2024) estimates that the carbon price level consistent with limiting temperature rises to 1.5°C may be between US$ 226-385/tCO_2e in 2030. The source also cites a 2030 price range recommended by the High-Level Commission on Carbon Prices to limit temperature rise to well below 2°C of US$ 63-127/tCO_2e.

3.1.1 Damage costs

The range of environmental costs of fossil and renewable energy production and use in the electricity, heat and (road) transport sectors in Germany is systematically determined and regularly updated by Germany's Federal Environment Agency (UBA, 2024). The lion's share of these results from the estimated climate damage costs are caused by greenhouse gas emission.[4] However, the environmental costs of air pollutants from electricity and heat production and from road traffic also play a role. In the case of road traffic, other external costs such as noise pollution, tire wear and negative effects on nature and agriculture are also estimated.

4 In the following, the costs are cited as cost per t CO_2e. The costs due to emissions of other GHG are measured according to the Global Warming Potential: This means that 265 times the CO_2 costs apply to nitrous oxide (N_2O) and 28 times the CO_2 costs to methane (CH_4).

Environmental costs are highly relevant economically in that they are not usually borne by those who are responsible ("polluter pays principle") without government intervention (hence they are also referred to as so called "external costs"), but they will burden current and future societies and particularly poor, vulnerable societies with exorbitant damages. This was already shown by the so-called "Stern Report" (Stern, 2006), which estimated the costs of climate change to be up to 20% of global gross domestic product annually. A recent and more comprehensive study by Kotz et al. (2024), which quantified the damage caused by climate change (by changes in temperature and precipitation) for 1,600 worldwide regions over the last 40 years, came to the following conclusion: "We find that the world economy is committed to an income reduction of 19% within the next 26 years independent of future emission choices (relative to a baseline without climate impacts, likely range of 11–29% accounting for physical climate and empirical uncertainty). These damages already outweigh the mitigation costs required to limit global warming to 2°C by sixfold over this near-term time frame and thereafter diverge strongly dependent on emission choices." Depending on the level of ambition of the future avoidance strategy, the damage can increase up to around 40% of income reduction.

Estimates relating to Germany also show the economic significance of the costs caused by air pollutants and greenhouse gases alone. For example, German greenhouse gas and air pollutant emissions in the areas of road traffic, electricity and heat generation will cost at least €241 billion in 2021.

In this respect, for reasons of damage reduction, everything speaks in favor of including at least part of the damage costs – for example through emissions trading or a CO_2 tax – in the cost calculation of those who cause the damage.

The Federal Environment Agency (UBA) recommends using a cost rate of 300 Euros_{2024} per ton of carbon dioxide (t CO_2) for greenhouse gases emitted in 2024 (1% time preference rate). If the welfare losses of current and future generations caused by climate change are weighted equally (0% time preference rate), the cost rate is 880 Euros_{2024} per ton of carbon dioxide. Euro_{2024} refers to the purchasing power of the Euro in 2024. It is expected that the damages caused by greenhouse gas emissions will increase over time, for example as the value of buildings and infrastructure damaged by extreme weather events increases. Therefore, further rising cost rates are assumed in the future (cf. Table 3-1).

Table 3-1: Values for damage costs of CO_2 emissions recommended by the German federal environmental agency

Damage costs per ton of CO2 in Euros 2024	2024	2030	2050
1% pure time preference rate (higher weight of present generation's welfare vs. future generations' welfare)	300	335	435
0% pure time preference rate (equal weight for each generation's welfare)	880	940	1,080

Source: UBA, 2024

3.1.2 Marginal abatement costs

As an example of many sources of analysis for the marginal abatement cost, which is the cost for the last metric ton of emissions that needs to be avoided in order to achieve a certain mitigation target, Table 3-2 presents a comparison between Japan and other major economies.

Table 3-2: Marginal CO_2 abatement costs for major economies in comparison, based on a study by RITE

Comparison of Marginal CO_2 Reduction Costs Across Countries (2040)

	Japan's 2040 Reduction Rate	Japan	USA	China	EU	Others
Growth Scenario	**-60%**	294	294	294	298	294
	-73%	364	293	293	298	293
	-80%	504	292	292	296	292
Low Growth Scenario	**-60%**	410	410	428	410	410
	-73%	602	410	428	410	410
	-80%	850	409	428	409	409

Unit: USD/tCO_2 (prices in 2000)

It is based on the assumption that the major developed countries, including the U.S., U.K., and EU, will achieve carbon neutrality by 2050 in terms of GHG emissions.

- **At a 60% reduction rate, the marginal CO2 reduction costs are nearly equal across countries, indicating a globally consistent level of reduction.**
- **At a reduction rate of 73% or higher, Japan's marginal reduction costs surpass those of other countries, reflecting its more ambitious reduction targets.**

Note: European Commission suggest 90% CO2 emissions reduction in 2040.

Source: Translated by IEEJ based on RITE (2024).

3.2 Impacts on carbon emissions

Carbon pricing aims at creating an economic incentive to reduce carbon emissions, by way of increasing the cost of these emissions. In the energy conversion or end-use sectors, this will be conveyed through a higher price of the energy produced or used.

The main question in relation to this desired effect is its magnitude that can be expected, directly in relation to the level of carbon pricing as well as indirectly through the climate and energy policy mix in which the carbon price is embedded, and the use of the revenues from the carbon pricing.

Evidence for the direct effect from the level of carbon pricing is provided by the empirical analysis of price elasticities, which has been performed on energy price elasticities for a long time. In addition, there is vast literature on the form of carbon pricing, such as the discussion on carbon taxation versus emissions trading systems (e.g., see chapter 3.1 in OECD (2023), which also includes other general aspects of carbon pricing).

A simplified general representation of the role of carbon pricing in the policy mix to reduce carbon emissions is developed by IEA (2011). Carbon pricing is deemed most effective and efficient in the middle range in Figure 3-1, with slightly positive carbon abatement costs. However, these potentials could also benefit from additional policies to reduce barriers. This cost situation is often the case for fuel switch, e.g., from coal to gas or to some renewable energy sources. Carbon pricing may be less effective, if investments are already cost-effective but facing barriers, so that additional policies are needed to unlock this potential. This mostly concerns energy efficiency, including flexibilities, and increasingly renewable energy sources. Carbon pricing may also be less effective for innovative technologies with abatement costs above the expected carbon price, so that technology policy will be needed for enabling a pathway along the learning curve and economies of scale. Examples of technologies in this situation include green hydrogen or green steelmaking. This analysis is summarized in Figure 3-1.

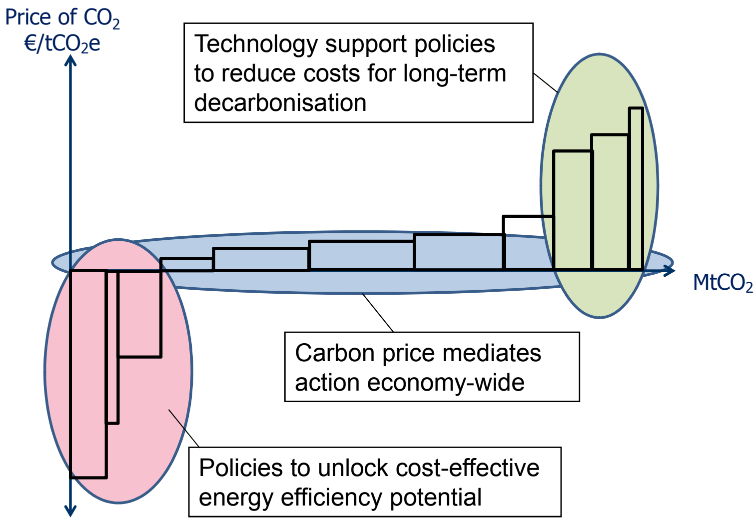

Figure 3-1: The core policy mix: a carbon price combined with energy efficiency and technology policies

Source: IEA (2011)

An example of a large empirical study of the effectiveness of policy mixes was performed by Stechemesser et al. (2024), by searching for policies or combinations that seem to have caused large emission reduction reactions in a number of countries. In most cases, they found that effect sizes are larger if a policy instrument is part of a mix of regulation, incentives, pricing, and information, rather than implemented alone. This was also the case for carbon pricing policies, particularly in the buildings and transport sectors. Only in the industry sector in developed economies, some 42 % of such reduction events were caused by pricing alone; however, the majority of pricing policies studied were fossil subsidy reforms, not explicit carbon pricing.

Given this finding that policy mixes are more effective in reducing GHG emissions than carbon pricing alone, using a part or all of the revenues from carbon pricing to fund the other policies in the mix may significantly enhance the overall effect, particularly if there are no alternative ways of funding the companion policies.

3.2.1 Germany/EU

In the energy end-use sectors, price elasticities may be used to estimate the impact of carbon pricing. Table 3-3 presents some historic empirical values of price elasticities in Germany. The values for natural gas for space heating in Germany have largely been confirmed by the reaction of gas demand to the gas price crisis in 2022/23. They mean that for example in heating, a doubling of consumer prices for energy would reduce energy consumption and the corresponding GHG emissions by 20%. That would be much less than the cost-effective potential for energy savings through energy efficiency and low-carbon heating, which is between 50 and

80% in Germany (cf., e.g., Prognos, 2022). And a doubling of (ex-tax) heating energy prices would require carbon prices between €200 and €500/ton, which may be difficult to politically achieve in the short term. The current carbon price of €55/ton may, therefore, lead to short-term savings of up to 5 % (own calculation based on current energy prices presented in chapter 2.1 and Table 3-3).

Table 3-3: Short-term price elasticities of energy demand by end use and energy source in the residential, services, and transport sectors

Sector	*End use*	*Energy source*	*Price elasticity*
Residential	**Space heating**	Heating fuel	-0,2
		Natural gas	-0,2
		Electricity	-0,2
	Water heating	Heating fuel	-0,05
		Natural gas	-0,05
		Electricity	-0,05
	Electric appliances	Electricity	-0,025
Services	**Space heating**	Heating fuel	-0,2
		Natural gas	-0,2
		Electricity	-0,2
Transport	**Transport and mobility**	Gasoline	-0,25
		Diesel	-0,05

Source: Prognos (2013), based on BMWi (2011); cited and adapted after Suerkemper et al., 2019

On the supply side, short-term reactions in energy markets are more likely to be influenced by carbon pricing, which impacts e.g. the competitive edge of coal vs. gas power generation costs. The shifts in generation can be easily modelled and monitored to estimate emissions reductions.

Certainly, long-term price elasticities may be higher (e.g., Verbruggen and Couder, 2003), because they include investments in reaction to increased energy prices. However, the pace of these investments can be accelerated through the combination of carbon pricing with other instruments in the policy mix. These will be needed to reduce the manifold barriers and lock-ins of end-use and supply infrastructures limiting the effect of pricing instruments.

There is a two-way link between carbon prices, the policy mix for mitigation, and the use of revenues from carbon pricing. If the revenues fund mitigation measures, the impact of the carbon pricing will be multiplied by a certain positive factor, and the likelihood of achieving mitigation targets will be increased (Thomas et al., 2019).[5] In addition, if the mitigation measures are cost-effective for society and/or investors, economic net benefits will be realized more

5 We are not aware of studies that estimated the multiplication factor for the impact of carbon pricing, but the studies that are comparing the carbon price needed with and without a policy mix, which are discussed in the next paragraph, indicate that the factor may be three or more: the factor between the carbon price needed without a policy mix (up to €300/t CO_2) vs. embedded in a policy mix (€50-100/t CO_2) is at least three.

quickly, and there will be positive effects on the state budget. Reducing fossil fuel imports will increase energy security and can create additional added value and jobs.

In the second direction of results of this linkage, the more that emissions are reduced through the policy mix and the removal of barriers that it entails, the lower will be the carbon price that is needed to achieve the mitigation targets. A level between €50/t and €100/t CO_2 may be sufficient in Germany (Gerlach-Günsch and Seeliger, 2024). If the carbon pricing is the only instrument, economic analysis finds that it will need to be much higher, reaching several hundred €/t CO_2 (up to €300/t already in 2030 and more afterwards) in the EU, due to the scheduled reduction of the amount of emissions certificates in the EU-ETS I and II (Fiedler et al., 2024). Figure 3-2 illustrates this effect for an example of achieving the same economic result – doubling the cost-effectiveness of a GHG mitigation investment with either carbon pricing alone – left side – or with a combination of using the revenues for financial incentives to stimulate investment – right side).

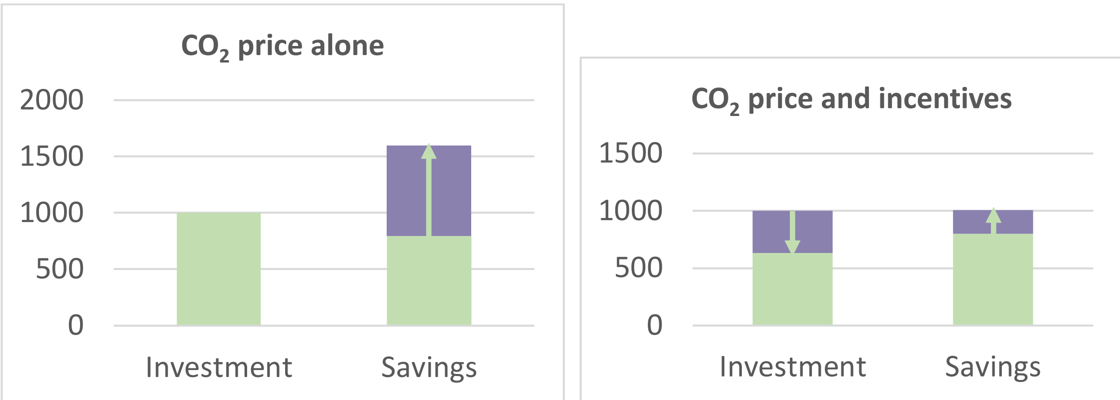

Figure 3-2: Two ways to double cost-effectiveness of an investment with very different resulting carbon prices

Levelized annual amounts of investment and cost savings in Euros. Left – doubling the energy price via a high carbon price, right – increasing the energy price by 26% and subsidising the investment with 37%, using the revenues from carbon pricing. In both cases, the benefit-cost ratio doubles from 0.8 to 1.6.
Source: own calculations based on a typical buildings energy efficiency investments

3.2.2 Japan

In the second phase of the GX ETS, companies with direct emissions of 100,000 t-CO_2 or more will be required to participate in mandatory emissions trading. The government estimates that the number of companies subject to the scheme will be approximately 300 to 400, which is expected to account for around 60% of Japan’s total greenhouse gas emissions. This makes the scheme a crucial element in promoting future emissions reductions in Japan.

However, the effectiveness of the scheme in reducing emissions and its economic impact will depend on the progress of ongoing discussions concerning its design. The establishment of a methodology for free allocation, through benchmarking and grandfathering, as well as the determination of the upper and lower price limits, are critical factors in assessing the potential impact of the scheme. At present, these aspects have not yet been finalized. Moving forward, attention will be focused on the detailed design of the scheme, with full-scale implementation anticipated in 2026.

3.3 Impacts on competitiveness

Higher energy prices or production costs caused by the carbon pricing mean that either the prices of products will increase or the surplus of a company will decrease, or both, unless the company finds other ways of decreasing its costs or achieving higher prices (see below). If the surplus effectively decreases, there will be a negative effect on the company's competitiveness.

On the other hand, if the company reacts by converting to green production and if there is a market for 'green' products at sufficiently higher prices, the company may even increase its competitiveness. The same holds for companies supplying GHG reduction technologies.

3.3.1 Germany/EU

The arguments discussed in the public debate in Germany are mostly the same as those mentioned in the introduction to this section 3.3. However, the impact of carbon pricing differs widely between companies/sectors that are emissions-intensive and trade-exposed, such as steel, chemicals or pulp and paper, and other sectors, e.g., most sectors of the manufacturing industry that only have energy costs in the range of 1 to 3% of their total costs.

Therefore, the EU has so far practically exempted a number of emissions-intensive and trade-exposed sectors from the EU-ETS I by way of free allocation, and these exemptions will only be abolished at the same pace as the CBAM is introduced (see chapter 2.1). The CBAM will put EU production on par with imports of the goods it covers. However, industry misses an instrument to refund carbon prices when goods are exported to countries without or with lower levels of carbon pricing.

In addition, during the first 15 years of the EU ETS-I, the price of an EU allowance remained relatively low, usually below €20/t or €30t. Only recently, it rose to levels between €60/t and €100/t. Therefore, empirical evidence is missing on which impact such levels may have.

Furthermore, ex-tax energy prices also rose a lot during the recent energy price crisis, although they now are almost back to pre-crisis levels. Electricity prices for medium-sized industries in Germany are now lower than before 2022, since the German government decided to pay the incremental cost of renewable energies from the budget instead of the former EEG levy, and to reduce the electricity tax from €20.5/MWh to €0.5/MWh, which is the minimum level mandated by EU law. All of this is making an empirical analysis of the impacts of carbon pricing alone on industrial competitiveness difficult.

For the period until 2022, when EU-ETS prices were still lower, Deutsche Bundesbank analysis found that virtually no carbon leakage occurred, i.e., German industrial companies did not increase the investment outside of the European Economic Area due to the EU-ETS I. In addition, German companies reduced their GHG emissions within the European Economic Area more strongly than in other countries, which may indicate an emissions reduction impact of the EU-ETS I (Deutsche Bundesbank, 2024).

The impact on competitiveness will obviously depend on whether other or even all countries introduce similar levels of carbon pricing. Ward et al. (2019) analyzed the hypothetical introduction of USD 50/t in all countries of the world. They found that both Germany and Japan would see a slightly positive effect on GDP in this hypothetical case.

In addition, the impact of carbon pricing on competitiveness will also depend on the use of the revenues. Funding investments in emissions-reducing technologies and the net-zero transition for industry, thereby fostering the roll-out of innovation, e.g. through carbon contracts for difference (CCfD)[6], may future-proof domestic industrial production and make it more competitive in the long run than without carbon pricing.

3.3.2 Japan

The two main pillars of the GX initiative in Japan are positioned as the support for forward-looking investments through GX Economy Transition Bonds and the implementation of regulations and systems such as carbon pricing.

GX Economy Transition Bonds have been issued as green bonds since February 2024, with a total of 20 trillion yen expected to be raised by 2032. The objective is to secure financial resources to support national emissions reductions in line with the goal of achieving net-zero emissions by 2050, with the bonds scheduled to be redeemed by that year.

The government's sector-specific investment strategy aims to contribute to both industrial competitiveness and economic growth, while also supporting domestic emissions reductions. The basic principles of these investment promotion measures are to support projects that would be challenging for private companies to invest in independently, prioritizing those that are most difficult to fund. Additionally, regulatory and institutional measures are being implemented to change corporate investment behavior and demand-side actions in a coordinated manner.

The investment areas cover 22 sectors, including manufacturing (steel, chemistry, pulp & paper, cement), transportation (automobile/battery, aircraft/SAF, shipping), lifestyle, resource circulation, semiconductor, and energy (hydrogen, nuclear, next-generation renewable energy, CCS).

To date, approximately 3 trillion yen (18.75 billion euro) has been allocated in advance, with an additional 10 trillion yen (62.5 billion euro) planned for future investment based on the sector-specific strategy.

These funds will be used as a source of revenue to create new tax incentives for the production and sale of green steel, green chemicals, sustainable aviation fuel (SAF), and electric vehicles (EVs), as well as to support the price difference for hydrogen and the transition from blast furnaces to electric furnaces.

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[6] This is a novel form of subsidy for investments in low-carbon industrial plants or equipment. It aims to increase investment security by the following mechanism: If the annual cost of the low-carbon plant or equipment, e.g. using clean hydrogen, is higher than the cost of the reference conventional plant or equipment using unabated fossil fuel combustion and paying the carbon price, the difference will be reimbursed as a subsidy. Conversely, if the clean technology has lower annual costs, the company has to pay back the difference to the state budget.
The first 15 contracts were concluded on 15 October, 2024, with companies from the glass/ceramics, pulp and paper, and chemical industry, following an auction. The maximum amount of subsidies is €2.7 bn, but the actual amount is expected to be lower. The contracts are expected to avoid 17 mn tons CO_{2e} of GHG emissions during the next 15 years (Bundesministerium für Wirtschafts und Klimaschutz (BMWK), 2024).
A second round of contracts with an even higher volume (more than €10 bn) had been under preparation before the federal government coalition broke up in November 2024, so it is currently on hold.
Similar contracts of several billion Euros were made under a different scheme with three major steelmakers for the conversion to direct iron reduction using natural gas initially and green hydrogen in the future.

For instance, in the steel sector, the government is implementing a project under the GX Promotion Act to support the steel manufacturing process. Government support of up to approximately 100 billion yen (625 million euro) has been allocated for the conversion to innovative electric furnaces.

It is too early to assess the impact of carbon pricing on competitiveness, as the new approach has only just begun. However, we can at least say that the purpose of introducing new carbon prices is to incentivize the private sector to invest more in clean energy while not to harm or even enhancing competitiveness of Japanese industry (see the Chapter 2.2 for some detail of the design of recently implemented carbon pricing scheme). Detailed design is needed to reduce potential side effects on competitiveness, which higher energy costs would cause to private companies. Therefore, the government starts by conducting GX investment support and investment tax reduction through the GX bond. After that support, the GX surcharge and the price range of the GX ETS will significantly rise to enable redemption for the GX bonds year by year. Also, free allocation in the GX ETS will be reduced.

3.4 Social and distributional impacts

3.4.1 Germany/EU

In this section, we collect aspects and evidence regarding social and distributional impacts for private households and companies separately.

Social and Distributional effects for households and options for revenue recycling

Without a specific compensation or financial and technical support in reducing emissions, carbon pricing may have negative net economic effects, which would cause a social problem particularly for low-income households. In addition, these may be socially unbalanced effects in relation to income distribution (“vertical dimension”) and in relation to different CO_2 intensities of households (“horizontal distribution”) (Edenhofer et al., 2021; see Appendix). Therefore, carbon pricing, depending on the amount of the induced energy price increase (without compensation), can cause social resistance and hinder the transformation to net zero GHG emissions. There is an ongoing debate in Germany on the question whether and how the distributional effects of the nETS/ EU-ETS II system should be compensated[7].

In practice, the payments to power producers from renewable energy sources, which cover the difference between the feed-in tariffs/prices and the wholesale market prices for electricity, are paid from the general budget since July 2023, when the previous feed-in levy was abolished. This amount of money is estimated to be between 15 and 20 billion Euros/year, which is about twice the revenues from the EU-ETS I that covers power generation and industry (see Table 2-

[7] The coalition treaty of the federal government that took office in 2021 included the following sentence: “We are introducing a “Klimageld” to redistribute the revenue of CO_2 pricing in a socially fair way. In this way, we ensure that the revenue from CO_2 pricing flows directly and fairly back to citizens.” (own translation by the authors). The lump-sum refunds called the ‘Klimageld’ was not implemented yet. Experts assume that the next, probably CDU led, government, will decide after the election in February 2025 on a “Klimabonus”, which may be implemented as a subsidy of electricity prices.

1). It can be seen as an enormous monetary compensation for the carbon pricing and the electricity tax.

Distributional and equity considerations concerning CO_2 emissions are not only related to the mainly discussed horizontally and vertically dimensions above, which are both highly correlated with *income distribution.* It has been calculated e.g. that the richest 10% of the German households emit on average more than 4 times as much CO_2 from gasoline and diesel as the 10% of the households with low income (Agora, 2023).

But what about the distributional effects on CO_2 emissions in relation to *wealth*? Concerning the Gini coefficient of *income distribution*, Germany (between 0.29-0.31) is located in the middle field compared to other OECD countries. But when it comes to *wealth distribution,* the inequality in Germany – measured also by the Gini coefficient of 0.76 - 0.80 - is much stronger by international comparison. The unequal wealth distribution in Germany implies that about 60% of the wealth is concentrated with 10% of the upper rich. About 50% of the poorer households own only 1%-2% of the wealth. This has important equity and justice implications concerning extremely unequal CO_2 emissions in relation to wealth distribution as well as unequal financial capabilities to avoid CO_2 emissions e.g. by retrofitting buildings or buying an electric vehicle (Chancel et al., 2022; *WID*, n.d.; Khalfan et al., 2023).[8]

To address these wealth-related highly unequal CO_2 emissions, carbon pricing on luxury consumption or on highly carbon intensive investments in theory might be possible (Club of Rome, 2022; Piketty & Rendall, 2022). However, due to data deficits and administration problems this does not seem to be an effective measure. In addition, compensation measures (as shown in Figure 7-1 in the Appendix) will never be enough to enable the high share of households with marginal wealth resources to invest in mitigation actions that require high investments, even if they often are cost-effective. These are two further key reasons, in addition to what was discussed in chapter 3.1, why carbon pricing must be embedded into a comprehensive climate mitigation policy mix, which combines effective steering capacities and measures with just transition measures that enable low-income households to invest and/or benefit from reduced energy costs through energy-efficient and low-carbon solutions.

In the largest financial incentive program by the Federal government, there is now a special 30% extra subsidy for low-carbon heating systems, if the homeowner earns less than €40,000 per year. The investment grants for heating or thermal insulation can also be combined with low-income loans to enable home or building owners who lack capital to invest. By contrast, since end of 2023, there is no financial support for investing in battery-electric vehicles any more.

As discussed in chapter 3.2.1., the more that emissions are reduced through the policy mix, including the use of revenues from carbon pricing to fund these measures, the lower will be the carbon price that is needed to achieve the targets. This lower carbon price will reduce distributional effects. If the mitigation measures provide specific support for lower-income consumers or homeowners, they may even see a net benefit from the policy mix including carbon pricing (e.g., Thomas et al., 2024). For example, building energy efficiency improvements

8 For example: in Germany the average CO_2 emissions of the poorest 50% are about 6t of CO_2/cap/year, but for the richest 1% it is about 105t CO_2/cap/year, the overwhelming part of which is caused by investments in carbon intensive facilities.

will also reduce energy poverty. A convenient and affordable public transport will reduce mobility poverty.

Distributional effects and compensation for companies

The nETS/EU-ETS II system also covers CO_2 emissions in the commercial and industrial sector, namely small and medium enterprises (SMEs) with power plants less than 20 MW. Some of these SMEs or large commercial buildings might be rather energy intensive and therefore strongly affected by energy costs increase due to carbon pricing. Nevertheless, the direct distributional effects on competitiveness for the major part will be less influential because of two reasons. First, most companies will be able to pass on cost increases to customers through the prices for their goods and services. Second, starting in 2027, the EU-ETS II system affects all EU Member States, and therefore the EU interior competitive conditions will be put on a more level playing field than today. Nevertheless, a targeted support for SMEs might be necessary to incentivize climate mitigation technologies or reduce specific economic risks. This is likewise the case for coping with the impacts of the EU-ETS I on electricity prices.

3.4.2 Japan

The introduction of carbon pricing could have negative societal impacts, primarily due to rising fossil fuel prices and increased household costs. Energy is a basic necessity, and even if energy prices increase, it is challenging to significantly reduce consumption. As a result, higher energy prices lead to a reduction in disposable income. Furthermore, for consumers, efforts to reduce costs, such as replacing equipment by energy-efficient alternatives, may represent a substantial burden of initial investment and are time-consuming, making it difficult to adapt to high energy prices.

Another concern is the tendency for the burden of rising prices to disproportionately affect lower-income groups, a phenomenon known as “regressive taxation.” Even if energy prices rise due to carbon pricing, making energy efficiency more cost-effective, low-income earners may not be able to replace their appliances with more energy-efficient alternatives, which simply exacerbate their financial burden.

The social impact of rising energy prices due to carbon pricing is not limited to income groups but is also influenced by social factors such as regional climate conditions and infrastructure development. In Japan, energy expenditure is becoming an increasing burden in colder regions of northern Japan and rural areas where public transportation options are limited (Hoshino and Ogawa, 2021; Ogawa and Hoshino, 2024). In cold regions, the electrification rate for heating is low, leading to high demand for fossil fuels, while in rural areas, gasoline consumption for cars is higher compared to urban areas (Hoshino and Ogawa, 2021).[9]

Due to the inelastic nature of demand against energy prices, even the recent rise in fossil fuel prices has not necessarily led to a significant reduction in demand, and the burden on consumers

[9] In Northern Japan, the proportion of households using kerosene ranges from 70% to 80%, which is higher than in central Japan (30% to 40%) and Western Japan (approximately 50%). The share of electricity in household energy demand is 38% in Northern Japan, lower than in other regions, and 27% in Hokkaido, the lowest among all prefectures.

continues to grow. Consequently, the government has been providing subsidies to mitigate the rising costs of oil, gas, and electricity.

The increase in energy prices has the potential to provoke social resistance, and it is possible that carbon pricing alone will not suffice to achieve the dual goals of alleviating household burdens and reducing CO_2 emissions. Moreover, from the perspective of a just transition, careful consideration must be given to preventing undue burdens on different regions and income groups. Therefore, it is crucial to maximize the effectiveness of a policy mix that includes other supportive measures. This includes developing and promoting the adoption of affordable and stably available energy sources to replace fossil fuels, along with providing necessary policy support. By integrating technologies such as hydrogen, carbon capture, utilization, and storage (CCUS), and energy storage systems with the development of power grids and charging infrastructure, the cost-competitiveness of non-fossil energy can be improved, enabling carbon pricing to effectively drive substitution.

Given these factors, it is essential for the government to transparently communicate the significance and expected outcomes of carbon pricing to the public, while taking measures to foster understanding and support for the policy.

3.5 Policies to improve social and economic aspects and acceptance

In this section, we discuss policy options that may be relevant for both countries, Germany and Japan.

Optimally, any policies to improve social and economic aspects and thereby acceptance would enhance the climate mitigation impact at the same time. Therefore, key criteria to assess potential policy solutions would include to improve economic efficiency or at least not to deteriorate it; to reduce negative distributional impacts or even make them positive, while not creating new negative impacts; and to achieve an additional climate mitigation impact as part of the policy mix.

There are many different potential policies discussed in the literature (see also the Appendix for some examples). They are often linked to the use of the revenues from carbon pricing, but their cost might differ from the total amount of revenues; any balance would flow to or from the general budget. The policy options may be broadly allocated to three types of measures:

- Reducing energy excise taxes or levies, or other elements of energy prices; this effectively means a switch of pricing from an energy basis to a carbon basis
- Financial support for climate action, particularly energy efficiency, and innovation; this aims to support energy users in reducing their energy and carbon costs, and to enhance the climate mitigation impact of carbon pricing as part of the policy mix
- Lump-sum refunds per capita or household, possibly for lower income groups only, and per employee for companies; this aims to mitigate distributional effects and is often motivated by the aim to increase societal acceptance, especially, if levels of carbon pricing rise to €100/t or more.

Table 3-4 presents a high-level comparison assessment of these three types of options, followed by some explanations in Table 3-4.

Table 3-4: Comparison of options for the use of revenues using key criteria

Option	Economic efficiency	Climate mitigation impact	Distribution effects	Consequences for acceptance of carbon pricing
Reducing energy excise taxes or levies	- to +	- to +	- to 0	0
Financial support for climate action, energy efficiency, innovation	+ to ++	++	- to +	- to +
Lump-sum refunds	+	0	+	+

Source: Based on Suerkemper et al., 2019

The next table provides a brief summary of the considerations behind the assessments in the previous table.

Table 3-5: Assessment of options for the use of revenues using key criteria

Option	Assessment by criteria
Reducing energy excise taxes or levies	**Economic efficiency:** Due to low price elasticities, GHG mitigation impact and resulting cost savings may be limited. Reducing energy taxes will reduce incentives for energy efficiency and sufficiency.
	Climate mitigation impact: Same considerations as for economic efficiency. Reducing electricity prices for electrification technologies may be useful.
	Distribution effects: Those who are not able to invest in electrification may lose. Overall, small impact, since the reduction of taxes or levies counteracts the price effects of the carbon pricing.
	Consequences for acceptance of carbon pricing: Close to neutral, since effective carbon rates may not be high with this kind of using revenues. Depending on distributional effects and level of carbon pricing.
Financial support for climate action, energy efficiency, innovation	**Economic efficiency:** This will be high, if the measures funded overcome barriers for cost-effective mitigation actions, e.g., energy efficiency or renewable energies.
	Climate mitigation impact: For the same reason, much higher than for the other two options.
	Distribution effects: Those who are not able to invest in mitigation actions may lose, those who invest will benefit. Need to enable as many as possible to benefit, particularly vulnerable households and industries.
	Consequences for acceptance of carbon pricing: Depends on balancing of distributional effects and active communication of the link between carbon pricing and measures funded. May be enhanced by a combination with lump-sum rebates.
Lump-sum refunds	**Economic efficiency:** Progressive effect on household incomes; resulting purchasing power effect may lead to a slight increase in GDP. Similar net effect, if companies get refund based on sum of wages (like in Switzerland).

Option	Assessment by criteria
	Climate mitigation impact: No additional impact on top of the impact of the carbon pricing itself can be expected. Increased GDP would be a form of rebound effect.
	Distribution effects: Progressive effect on household incomes is likely, as they usually have lower energy bills (Prognos, 2017).
	Consequences for acceptance of carbon pricing: Recent survey show good acceptance for this way of using revenues; sometimes, higher for a refund to low-income households only; sometimes, higher acceptance for financial support to mitigation actions.

Source: Based on Suerkemper et al., 2019

Based on these considerations, a combination of using the revenues for 1) financial support for climate action and 2) lump-sum refunds to households (at least the lower to middle income strata) and companies, or reducing electricity prices for businesses, seems most appropriate to optimize the impact regarding all key criteria simultaneously. Particularly if the carbon price exceeds a level of €50/t, the lump-sum refunds may become more important to both cushion distribution effects and improve social acceptance.

As mentioned in chapter 2.2 and 3.3.1, the EU has introduced the CBAM to ensure competitiveness of EU-based production of certain energy-intensive raw materials compared to imports from other countries. Japan is so far not considering this type of policy.

4 Comparison of key results of the analysis and policy recommendations

4.1 Findings in comparison

4.1.1 Status quo and expected development of carbon pricing

Both countries, Japan and Germany (as an EU Member State), have introduced energy excise taxes long ago. Both also have strong carbon pricing in place or, in the case of Japan, under development. Table 4-1 summarizes how the different schemes and systems cover the various sectors.

Table 4-1: Net effective carbon rates (total consumption) for the year 2023

Measures		Industry	House-holds	Buildings	Transport	Power genera-tion	Notes
Germany /EU	EU ETS 1	✓		(✓)		✓	All power/ heat generators >20MW$_{th}$
	EU ETS 2	✓	✓	✓	✓		Industry SMEs
	nETS	✓	✓	✓	✓		
	Energy Taxes	✓	✓	✓	✓		Lower rates or refunds for industry
Japan	Petroleum and Coal Tax	✓	✓	✓	✓		Exempted for material use
	GX Surcharge	✓	✓	✓	✓		
	Auction of Emission Allowance for Power Producers (Part of GX ETS)	✓			✓	✓	

ETS = emission trading system

Source: Chapter 2

OECD analysis yielded the following results of effective carbon rates by sector for both countries, for the year 2023.

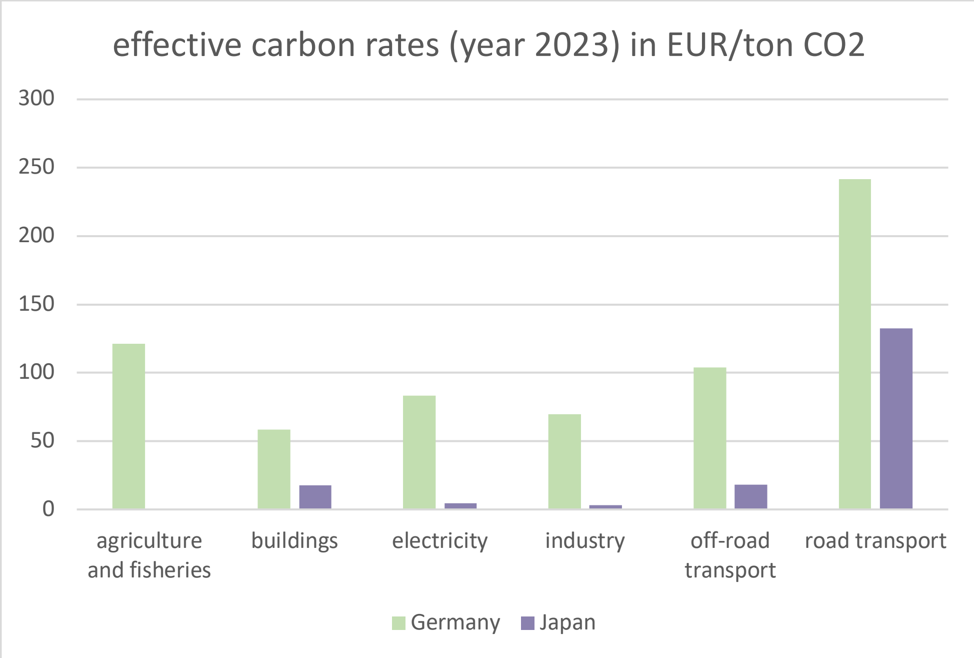

Figure 4-1: Effective carbon rates by sector for Germany and Japan in 2023

Source: OECD (2024b)

In addition to carbon rates, there have also been energy price subsidies in place in both countries. The fuel price subsidies for buildings that existed in 2023 in Germany were temporary, due to energy price crisis caused by the war of Russia against Ukraine, and have been abolished in 2024. The energy price crisis was also the reason for the fuel price subsidies introduced in Japan; although they have recently been extended, their levels are also decreasing.

4.1.2 Analysis of impacts and of policies to improve social and economic aspects and acceptance

Comparing the evidence collected in chapter 3, several general findings may be drawn, including:

- Average GHG emission abatement costs appear to be much lower than damage costs from the societal perspective. Hence, abatement is, on average, cost-effective.
- However, there is the challenge to reconcile the private investors' or energy users' perspectives and the societal perspective, and to overcome barriers for mitigation actions. Policies and measures will be needed to achieve this.
- The discussion about competitiveness and social/distributional impacts appears similar in both countries.
- It appears politically difficult to introduce high carbon prices that come close to marginal abatement costs or even damage costs.
- However, embedding carbon pricing into a policy mix to reconcile the private and societal perspectives, and to overcome barriers for mitigation actions, is likely to achieve GHG mitigation targets faster and with much lower carbon price levels needed.
- The combination of carbon pricing with financial and technical support for abatement (either directly funded from carbon pricing or at least introduced simultaneously or even

before the carbon pricing, as in Japan) seems key for acceptance of carbon pricing by citizens and businesses.

- Particularly if the carbon price needs to exceed a level of €50/t, lump-sum refunds, which may specifically benefit low- to middle-income groups, may become more important to both cushion distribution effects and improve social acceptance.

4.2 Policy recommendations and other results of the GJETC's discussions

This section provides key results of the GJETC's discussion on 18 and 19 February 2025. Some of these are generally valid policy recommendations with regard to carbon pricing or specifically to Emissions Trading Systems (ETS). Other results concern findings on experiences especially with regard to aspects of the EU-ETS I, which may be useful for countries considering the introduction of an ETS, but also include observations on plans regarding the GX ETS in Japan.

- Carbon pricing needs to be embedded in a policy mix
  - Carbon Pricing has its limits. It is not a magic rod depending on the sectors, but it is important.
  - Carbon pricing is a tool designed to reduce GHG emissions; however, it is not enough to meet the target. The ETS in the EU and Japan must be embedded in a climate action policy mix to achieve targets faster and with lower carbon prices, which will support acceptance of the carbon pricing. The ETS must also be aligned with industrial and trade policies.
  - The situation varies by sector, necessitating a tailored policy mix for each sector, if necessary. Carbon pricing works best if market actors can choose between alternatives and/or if the necessary infrastructures are in place.
  - The impact of carbon pricing on industrial competitiveness must be addressed in a wise manner. How to pass on the additional costs of carbon pricing, when transitioning from free allocation to auctioning of allowances, needs to be considered.
  - The external environment, including energy prices and carbon costs, can fluctuate over time, making it essential to periodically review the policy and establish conditions for assessing and improving carbon pricing.
- Making appropriate use of the revenues to the state budget from carbon pricing
  - Germany: Allocating revenue for financial and technical support to climate action, infrastructure investment, etc. is preferrable; designing the support to mitigate social or competitiveness side effects at the same time.
  - Japan: Integrating regulation for carbon pricing and support is necessary to alleviate concerns.

  - Both EU and Japan: Starting with support and introducing carbon pricing later to fund the support seems important for acceptance. This has been decided both for GX funds and ETS in Japan, and for the EU's Social Climate Fund and EU-ETS II.
- Carbon Border Adjustment Mechanism (CBAM)
  - Germany/EU: CBAM is to protect EU producers, while ending free allocation, and at the same time to advocate for introducing carbon pricing similar to the EU ETS in countries outside the EU.
  - Japan: The need for implementing CBAM will depend on the actions of other nations.
- Allocation of allowances
  - Germany: The EU ETS experienced windfall profits in the electricity sector during its early stages. Therefore, the EU decided to transition to auctioning in 2013. The system is undergoing phased revisions, enabling policy learning and promoting emissions reductions by gradually altering the cap's slope and the allocation method.
  - Japan: In the GX ETS, grandfathering and free allocation through benchmarking are being planned. The power sector is set to transition to auctioning by 2033.
- Use of Offset Credits
  - Germany: Offset credits for GHG emission reduction in third countries were previously permitted in the EU, but they are now excluded due to their minimal impact on emissions reductions in other countries, and because the ETS primarily serves to achieve domestic GHG emission reductions.
  - Japan: To encourage emissions reductions outside of the ETS, the use of offset credits should be flexible. Additionally, to foster emissions reductions internationally, international trading should also be included.
- Instruments to limit ETS price volatility, such as a price corridor
  - By establishing upper and lower limits on the price of emission credits, it becomes possible to preemptively address unnecessary price fluctuations, the sudden increase in cost burdens due to price hikes, and the uncertainty regarding future investments stemming from price stagnation.
  - However, there must be a rational justification for setting these price levels.
  - The EU has chosen a different instrument, which is the Market Stability Reserve and articles 29a and 30h in the ETS directive, also known as the safety valve. German experts estimate that this may enable a more market-based development of the price than a price corridor defined by the authorities.

5 Conclusions and outlook

During their discussion at the GJETC meeting on 18 and 19 February 2025, GJETC members agreed that carbon pricing is a key policy instrument for reducing emissions and protecting our climate. They emphasized that carbon pricing ought to be coupled with other policy instruments as part of a policy mix and coordinated with trade and industry policy. This policy mix will strongly support the achievement of GHG emission reduction targets more reliably and at much lower carbon prices than through carbon pricing alone.

Both Germany and Japan have different approaches to achieving GHG emission reduction targets through carbon pricing; however, the goal of achieving these targets with minimal negative impacts for competitiveness and social equity remains the same. The EU, including Germany, introduced an emissions trading system that encompasses power generation and industry through the EU-ETS 1, and Germany has addressed buildings and transport via its national ETS (which will be replaced by EU-ETS 2 in 2027). The revenue generated from these emissions trading systems has been allocated to emission reduction policies, such as renewable energy and energy efficiency. As prices of carbon allowances may rise further, a lump-sum refund per capita, especially to lower income groups, is being discussed. Japan will implement the GX surcharge in 2028 and the GX ETS in 2026, which will generate revenue to redeem the GX bonds until 2050. By allocating funds from the GX Bonds for investment to technology development and deploying innovative equipment prior to the introduction of the carbon pricing through the GX surcharge and GX ETS, Japan is aiming to maximize GHG emission reductions while fostering economic competitiveness and acceptance for the carbon pricing.

A key aspect of enhancing carbon pricing policy is to learn through practical experience, drawing on the best practices of Germany and Japan. During the meeting with the GJETC members, we shared numerous practices, experiences, and concerns regarding carbon pricing. Importantly, Germany has extensive experience establishing, developing, and managing emission trading systems, which are crucial for Japan and will serve as a reference for carbon pricing.

Still, both countries will need to further explore and test the optimal development of carbon pricing and the surrounding policy mix to maximize achievements for GHG emission reductions, competitiveness, and social equity. Continuing the bilateral exchange in the GJETC and other for a will be useful to enable mutual learning.

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7 Appendix

A comparison of simulated economic effects of carbon pricing with and without different discussed relief measures for different typicized households in Germany is shown in Figure 7-1. The (net) effect is estimated in Euros per household and year, assuming a carbon price of 50€/t in comparison to the net effects of no compensation.

Figure 7-1: Net economic effects for different socioeconomic groups with and without various compensation measures (in € per household and year)

	All households	Long-distance commuter	Tenants	Urban areas	Rural areas	Households with car	Households with oil heating	Long-distance commuters with oil heating
Share of population (%)	*100*	*26*	*53*	*48*	*21*	*79*	*21*	*5*
No compensation	250	409	177	225	275	296	358	536
Landlord-pay regime	245	407	140	220	272	295	344	526
Long-distance commuting compensation	224	311	159	201	247	266	332	435
Oil heating compensation	224	383	156	203	131	268	233	411
Electricity price reduction	95	211	66	76	112	126	200	340
Long-distance commuting compensation + Electricity price reduction	85	133	59	68	100	113	190	258
Equal-per-capita payment	– 5	47	– 40	– 21	12	20	101	165
Long-distance commuting compensation + Equal-per-capita payment	– 5	– 16	– 37	– 20	10	17	100	101

Source: Data from Einkommens- und Verbrauchsstichprobe (EVS), Umweltökonomische Gesamtrechnungen, and Mikrozensus; own calculation.

Source: Edenhofer et al (2021)

Notes: a. Landlord-pay regime: Landlord covers 50% of tenants` heat related carbon costs; b. long distance commuting: carbon price related additional costs are covered for households commuting more than 20 km independent of travel mode, c. oil heating compensation: the cost difference to an average household without oil heating is compensated; d. electricity price reduction: partial coverage of the EEG levy.

The first row demonstrates which share of the population is affected by the measures. It shows that the target groups for steering and distributional effects by carbon pricing are diverse. An equal-per-capita payment achieves a progressive and highest net effect for households in the lowest income quintile. To accelerate this effect, the redistributed amount could be reduced or completely phased out above a certain income limit, where enough own private financial resources can be assumed. On the other hand, compensating for apparent hardship conditions (e.g. long commuting distance of low-income households), an additional hardship compensation could be paid.

Although this study seems to indicate that the relief effect is highest for the equal per-capita payment, it has to be noted that the total amount of compensation varies a lot between the different measures analyzed.