ISSN 1880-9286

IEEJ Energy Journal

Vol.19, No.1 2024

IEEJ Outlook 2024 - summary-

Bringing about both low-carbonisation and a stable power supply by shifting electricity usage to the morning/noon period!

European Union Emissions Trading System (EU ETS)

Emissions Trading System by Eastern States of the United States (RGGI)

New Zealand Emissions Trading Scheme (NZ ETS)

Output Based Pricing System (OBPS) of the Canadian Federal Government

The Institute of Energy Economics, Japan

Contents

IEEJ Energy Journal Vol. 19, No. 1 2024

IEEJ Outlook 2024

Energy, Environment and Economy

Complexity of achieving the energy transition under multiple pathways

Overview

The Institute of Energy Economics, Japan

Rejean CASAUBON
Seiya ENDO
Ryou ETOU
Hiroshi HASHIMOTO
Takehiro IWATA
KAN Sichao
Kenji KIMURA
Yoshikazu KOBAYASHI
Ken KOYAMA
Ichiro KUTANI
Tomoko MATSUMOTO
Tetsuo MORIKAWA
Soichi MORIMOTO
Taiju MORIMOTO
Tomoko MURAKAMI
Yuto NAKANO
Yasushi NINOMIYA
Junichi OGASAWARA
Atsuo SAGAWA
Toshiyuki SAKAMOTO
Yoshiaki SHIBATA
Shigeru SUEHIRO
Yoshiaki TAKAHASHI
Kazuki YAMAMOTO
Yukari YAMASHITA
Akira YANAGISAWA

Summary

Energy supply and demand outlook

- Under the "Reference Scenario" (REF), in which the prevailing changes from the past continue, energy consumption in 2050 will increase by 1.2 times over 2021. Energy demand in China, which has thus far driven global demand growth, will peak around 2030, with India, the Association of Southeast Asian Nations (ASEAN), the Middle East and Africa becoming the main regions for demand growth.
- Energy consumption under the "Advanced Technologies Scenario" (ATS), in which the introduction of energy and environmental technologies is strengthened to ensure a stable supply of energy and combat climate change, will plateau around 2030, and consumption in 2050 will be roughly 0.9 times that in 2021. It should be noted that this outlook is a forecast-type future projection that is based on assumptions about technology and policy trends, and contrasts with a backcast-type analysis that defines a future "landing point" and charts a path to reach it.
- In the Reference Scenario, global energy-related carbon dioxide (CO_2) emissions will remain roughly flat until 2050, and in the Advanced Technologies Scenario, they will be 14.7 Gt (down 56% from 2021), indicating that the world is halfway to achieving carbon neutrality. Reducing to the point of almost eliminating emissions in the non-power generation sectors and Emerging Market and Developing Economies remains a challenge.
- Electricity generation will double from the current level due to economic growth, electrification, and a boost in demand for green hydrogen. As the expansion of variable renewable energy is expected to continue for the foreseeable future, measures such as electricity storage and thermal power generation (with carbon capture and storage [CCS], hydrogen, etc.) will become extremely important to provide stabilisation and balance between electricity supply and demand.
- Oil and natural gas will increase throughout the Reference Scenario but, in the Advanced Technologies Scenario, they will start to decline in the 2020s and the 2030s, respectively. Still, fossil fuels together account for 73% of primary energy consumption (2050) in the Reference Scenario and 53% in the Advanced Technologies Scenario. Along with efforts to improve efficiency and reduce emissions with technologies such as CCS, securing a stable supply will continue to be an important issue.

Toward fulfilling the role of LNG and natural gas

New investment needed for stable supply of LNG and natural gas

- Cumulative required investments in the natural gas production sector from 2022 to 2050 are $9.8 trillion in the Reference Scenario and $7 trillion in the Advanced Technology Scenario. The liquefied natural gas (LNG) production sector will require an annual capacity addition ranging from 8 Mt/year (ATS) to 18 Mt/year (REF) on average, during the outlook period up to 2050.

- There is also uncertainty over those projects for which investment decision have already been made, with possible delays and failures to materialise.

Cost trends in LNG production projects and challenges in procuring LNG for Japan

- Since 2021, supply chain disruptions triggered by the pandemic have caused delays and rising costs in the construction of LNG production projects. The overall cost pressures associated with the Russo-Ukrainian war are growing. Even after investment decisions have been made, rising instability factors in host countries of LNG production projects have caused delays.
- At the same time, technological innovations in small- and medium-scale liquefaction facilities and the expansion of modular systems ("design-one-and-build-many" strategies) are being introduced to control cost increases.
- In order to secure Japan's necessary LNG procurement in the 2030s and beyond, it will be important to form procurement partnerships such as joint purchasing and volume optimisation between multiple buyers, to make Japanese companies semi-portfolio players, and to provide public-private cooperation and policy support in these areas.

Clarification of LNG role and need for stronger security presented at G7 and at LNG Producer-Consumer Conference

- Whilst the Group of Seven (G7) recognised the importance of natural gas and LNG, it will be crucial to establish standards for acceptable 'abated' LNG in the energy transition. The importance of an internationally aligned approach for measurement and reporting of methane and greenhouse gas (GHG) emissions and their mitigations was emphasised at the G7 Ministerial Meeting and at the LNG Producer-Consumer Conference in 2023.
- The enhancement of the International Energy Agency's (IEA) role in strengthening gas and LNG security, which was presented at the LNG Producer-Consumer Conference, is also noteworthy.
- Furthermore, close dialogue between LNG producing and consuming countries through bilateral government-level consultations, procurement cooperation among consuming countries, and promotion of emergency accommodation cooperation will be important to strengthen gas and LNG security.

Issues for long-term stabilisation and development of the LNG market

- In the international LNG market, LNG investment and construction activities are advancing, especially in the United States, partly supported by LNG offtake commitments under long-term contracts. On the other hand, projects for which investment decisions were made in the past also face uncertainty and delays. Therefore, there is no guarantee that buyers' procurement of LNG with a combination of measures including long-term contracts, as well as suppliers' capability of LNG delivery, are secured yet.
- It is necessary to develop a variety of financial instruments to meet the funding needs of LNG production projects.
- Building partnerships between LNG buyers from the same and/or different countries, including joint procurement, will be effective in light of the buyers' desire for flexibility, especially from emerging LNG markets with the expanding composition of buyers. Such partnership will also contribute to ensuring the stability of Japan's LNG requirements, including long-term contracts.

Growing importance of negative emissions technology

- Interest in negative emission technologies (NETs), which capture GHGs from the atmosphere and store them elsewhere to stay over long periods of time, has increased in recent years both domestically and internationally. It is extremely difficult to achieve carbon neutrality without the contribution of NETs, especially in the industry and long-haul transport sectors, where the use of fossil fuels is certain to continue. Countries should more clearly and specifically position the use of NETs in their emissions reduction plans for long-term carbon neutrality.
- There are a wide variety of NETs, but many will take time to be commercialised. For individual NETs, countries need to take early steps to understand the potential for carbon removal in their countries, consider accurate and transparent methods for measuring removal, reduce removal costs, establish the value chains required for the introduction of each NETs, and assess the impact on surrounding ecosystems.
- International cooperation is also essential to the full-scale introduction of NETs. First, there is a need to widely share international recognition that NETs are an essential means of achieving carbon neutrality, and to accelerate preparatory work towards the establishment of internationally shared measurement, reporting and verification (MRV) systems and carbon removal certification and removal credit systems. At the same time, it is important to deepen discussions at the intergovernmental level in the future with a view to creating a mechanism to realise cross-border removal projects and their reflection in Nationally Determined Contributions (NDCs).

Paths towards ASEAN's energy transition

- ASEAN, with its remarkable economic development, will be at the centre of future global energy demand growth, and of the emission reductions. ASEAN will affect the success or failure of the global decarbonisation. As such, cost reductions are essential for achieving both economic growth and carbon neutrality, while an economically rational energy mix should be pursued.
- Assumptions about future economic growth and energy efficiency improvements will make a big difference in projecting future energy demand. It is not enough to focus only on the 'ratio' of renewable energy, because the total amount of energy demand will significantly change the energy mix we should be aiming for.
- The power generation cost by renewable energy is expected to be low among zero-emission power sources, making it a promising power source. However, it should be kept in mind that there is a possibility of higher electricity costs if the power facilities are spread beyond the suitable area, and that integration costs for stabilising electricity supply and demand will increase if variable renewables account for the majority of the power supply. It is necessary to determine the optimal quantity according to demand, weather conditions and land availability.
- Natural gas plays a major role in reducing emissions in the industry sector (especially for high temperature demand that is difficult to be electrified) and balancing electricity supply and demand. It can be an affordable fuel, especially in reducing emissions during the

transition period toward zero emissions. Expansion of supply capacity and stabilisation of the natural gas supply will contribute to reducing energy transition costs.

IEEJ Outlook 2024

October 2023

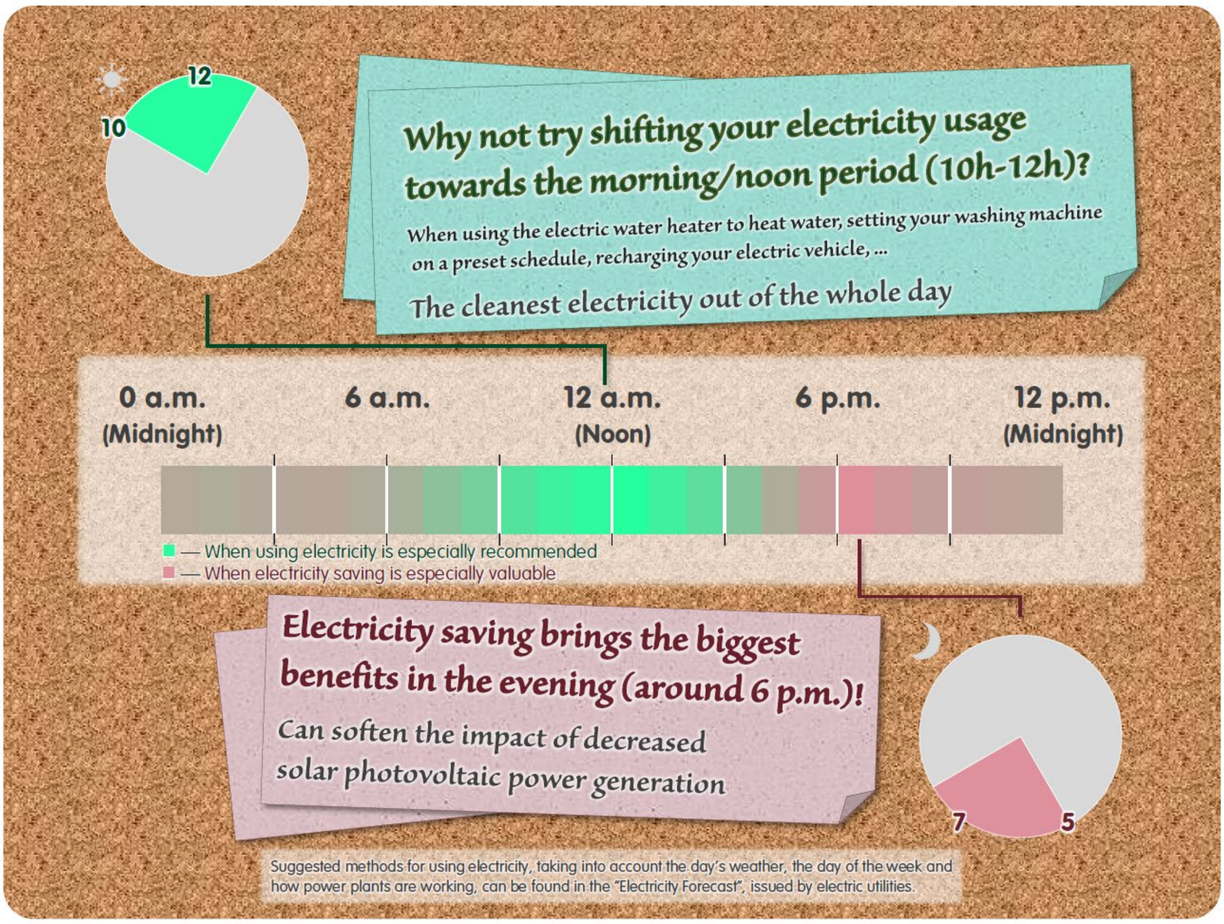
The Institute of Energy Economics, Japan

Data deep dive

Bringing about both low-carbonisation and a stable power supply by shifting electricity usage to the morning/noon period!

The value of electricity saving is especially high in the evening

YANAGISAWA Akira
Executive Economist, The Energy Data and Modelling Center, The Institute of Energy Economics, Japan

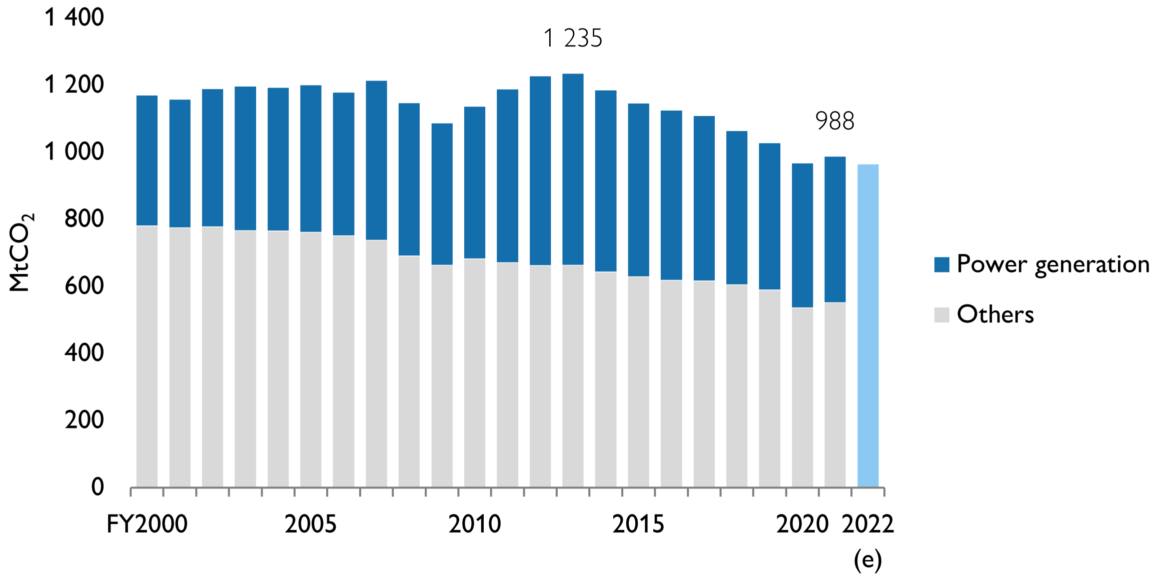


Keywords: Electricity, low-carbonisation, power supply stabilisation, carbon intensity, monthly, hourly

Expectations for energy low-carbonisation and reality

Energy-related carbon dioxide (CO_2) emissions in Japan have been on a downward trend since peaking in FY2013 (Figure 1). Although FY2021 saw emissions rising year-on-year for the first time in eight years due to the gradual recovery of socio-economic activities following the Covid-19 pandemic, from mid-FY2022 onwards emissions began to gradually decrease once again. This declining trend has come about due to decreasing emissions from the power generation sector following a sharp increase in such emissions in the years leading up to FY2013, as well as due to a steady decrease in emissions from sectors other than power generation.

Figure 1 | Energy-related CO_2 emissions



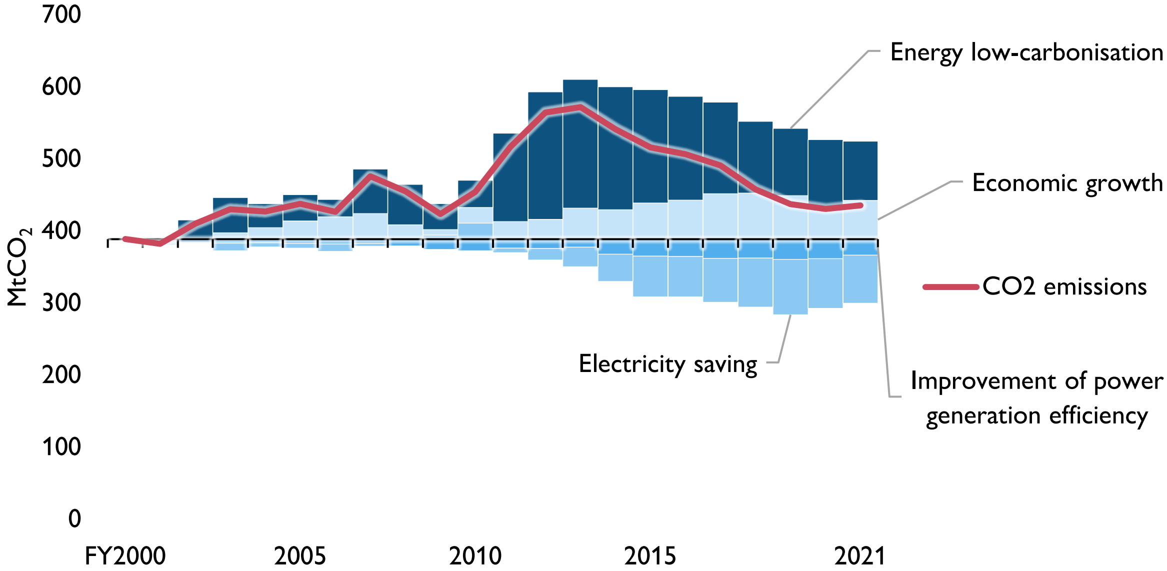
Note: Direct emission basis
Sources: Compiled from Agency for Natural Resources and Energy (ANRE) "Comprehensive Energy Statistics" (https://www.enecho.meti.go.jp/statistics/total_energy/, accessed on 18 September 2023), and The Institute of Energy Economics, Japan (IEEJ) "EDMC Energy Trend" [FY2022]

This reduction in CO_2 emissions outside the power generation sector has been supported exclusively by energy conservation efforts. Meanwhile, reduction measures in the power generation sector (the biggest emitter of all sectors[1]) include suppressing the volume of electricity generated (that is, demand suppression) and improving power generation efficiency. It, however, is generally believed that low-carbonising the energy sources used (i.e. inputs) through the use of renewable energy and nuclear, etc. plays a much larger role. Indeed, we are witnessing the enormous impact that low-carbonisation in power generation can have.

However, it cannot yet be stated that energy low-carbonisation in Japanese power generation has fully played its role in CO_2 emission reduction. This is because, in fact, the decrease in emissions seen in the recent past represents nothing more than a gradual return to the previous levels of emissions that jumped due to the stagnation of nuclear power generation following the Great East Japan Earthquake of 2011. For example, when the current situation is compared with FY2000, energy low-carbonisation not only continues to make no contribution to decreasing emissions, but in fact, has contributed to an increase of 80 Mt in FY2021 (Figure 2). The key factor in the decrease in emissions witnessed over the past two decades has been a continued fall in the volume of electricity generated per unit of gross domestic product (GDP)—that is to say, electricity saving.

[1] Direct emission basis

Figure 2 | Contributing factors behind increases/decreases in CO_2 emissions from the power generation sector (compared with FY2000)



Notes: Direct emission basis. The contributing factors were calculated based on: CO_2 emissions from power generation sector = GDP × Electricity generated per unit of GDP × Energy consumption (inputs) per unit of electricity generated × CO_2 emissions per unit of energy consumption in power generation sector. "Energy low-carbonisation" refers to the contribution of the decrease in the CO_2 emissions per unit of energy consumption in power generation sector; "Economic growth" refers to the contribution of the increase in GDP; "Improvement of power generation efficiency" refers to the contribution of the decrease in the energy consumption per unit of electricity generated; "Electricity saving" refers to the decrease in electricity generated per unit of GDP.

Sources: Compiled from ANRE "Comprehensive Energy Statistics" (https://www.enecho.meti.go.jp/statistics/total_energy/, accessed on 18 September 2023), and Economic and Social Research Institute, Cabinet Office "National Accounts of Japan" (https://www.esri.cao.go.jp/jp/sna/menu.html, accessed on 19 September 2023)

Growing usage of output control in solar PV power generation

Japan has set out a goal of achieving carbon neutrality by 2050, implying the reduction of total emissions of greenhouse gases (GHGs), of which energy-related CO_2 accounts for a large portion, to net zero, and for the intervening period has also set a goal of reducing GHGs to 46% of FY2013 levels by FY2030 as its Nationally Determined Contribution (NDC). There are high expectations of low-carbonisation of the energy used in power generation as a means for achieving this. However, the power generation mix that is obtained by simply extending a line from the current situation, in which Japan has still not even succeeded in offsetting the increase in CO_2 emissions that occurred following the Great East Japan Earthquake, will not be sufficient for attaining these targets.

Meanwhile, even in the current situation in which solar photovoltaic (PV) power generation makes up a mere 8.3% [2] of total annual electricity generated, an impediment to its utilisation is already apparent. This impediment is the difficulty of human-controlled adjustment of intermittent renewable energy sources such as solar PVs and wind. If the supply-demand balance for electricity breaks down and becomes unstable, this can cause power outages and damage to electrical equipment[3]. As more solar PV power generation has been introduced, oversupply of electricity, in which supply (the generation volume) greatly exceeds demand at certain times, is becoming a problem. Measures adopted to counter this include suppression of thermal power generation, transmission of electricity to other areas, and creating extra electricity demand by using electricity up as water-pumping power[4]; however, when oversupply cannot be resolved through such means, "output suppression" or "output control" is used to suppress generation of some of the solar PVs or wind. Having already been carried out in places such as the Kyushu area where solar PVs have been introduced on a scale that are large compared with electricity demand in the area, output control was carried out in the Kansai and the Chubu areas for the first time in 2023. Even in areas, where regions with such high electricity demand such as the Kinki and the Chukyo located, and the problem of excess power generation was thought to be less likely to manifest, steps have needed to be taken to put output control measures in place due to the considerable progress made with the introduction of solar PVs.

Making efficient use of renewables—and ultimately, using it in larger amounts—requires more than simply laying out solar PV panels, and building more wind turbines in an unplanned manner. The use of the electricity generated also needs to be handled appropriately[5]. New methods for doing this will include large-scale augmentation of the interregional power grid and the introduction of large numbers of storage facilities; however, it is evident that the costs of introducing grid equipment and storage facilities in Japan (where the electric current frequency differs between East and West Japan) will be high. In addition to these "hardware-related" or supply-side measures, the supply-demand balance can also be controlled through "software-related" or demand-side measures—that is, by bringing about temporal shifts in electricity demand by shifting the timing when electricity is used[6].

[2] In FY2021. ANRE "Comprehensive Energy Statistics" (https://www.enecho.meti.go.jp/statistics/total_energy/, accessed on 18 September 2023)

[3] Supply of electricity is an extreme example of the "just in time" approach, being required to match demand at all times. Not only supply shortages but also oversupplies can destabilise the power grid. In Japan, public awareness of the issue of supply shortages was shared widely following the Great East Japan Earthquake, yet there is still little understanding of the problem of oversupply.

[4] In pumped-storage hydro (PSH) power generation, one method of hydro power generation, water which has been allowed to descend in the course of generation is then pumped back up to an upper reservoir using electric pumps, where it can then be used for more generation. This system thus provides an energy storage function in the form of the gravitational potential energy of water. The electricity consumed in powering the pumps which move the water is referred to as "water-pumping power". Pumped-storage hydro power generation began as an operational method in which pumped water can be used to augment the supply of electricity for short periods of time, whilst the water is pumped at times when there is slack in the electricity supply. In recent years, it has begun to play a crucial role in proactively creating extra electricity demand, because it offers a way to use up electricity as water-pumping power during times of electricity oversupply.

[5] This does not mean that solar PVs will not be suppressed by one kWh whatsoever.

[6] In addition, experiments are also being made with the use of renewable electricity to produce hydrogen by using electrolysis to split water, the hydrogen then being used to generate electricity at the appropriate timing, which could enable the supply of and demand for electricity to be shifted by month or season.

Electricity becomes low-carbon in spring

In the 2000s, discussions began on the estimation of the season and hourly carbon emission factors for electricity, with the aim of reducing CO_2 emissions by making use of relatively low-carbon electricity. For example, the Three-Year Plan for Promotion of Regulatory Reform (Revised) (Cabinet Resolution, 2008), states the following:

Providing incentives for consumers to shift their electricity consumption from daytime to nighttime hours would be an effective means for reducing emissions of CO_2 generated from Japan's power generation plants (However, this would be the case only in situations where a daytime to nighttime shift causes CO_2 emissions to fall. Conversely, in some cases, usage will need to be shifted from nighttime to daytime hours.) In addition, providing incentives to the user to select electric utilities for each timeslot after taking into account the emissions of CO_2 generated by electricity consumption by the consumer's company may also be effective. To enable this, discussions must include the adoption of "average seasonal emission factors" and conclusions reached on this matter.

However, given the recognition that (1) carbon emission factors for electricity did not necessarily show fixed seasonal trends, (2) differences between daytime and nighttime hours were limited [7], and (3) accurate estimation of seasonal and hourly values was a difficult task, seasonal carbon emission factors were not adopted in the end. In recent times, however, Japan has experienced electricity oversupplies and demand shortfalls in the spring as demand for air-conditioning falls even while solar PV power generation rises, while at the same time, low-carbon energy is forming an increasing share of Japan's power generation.

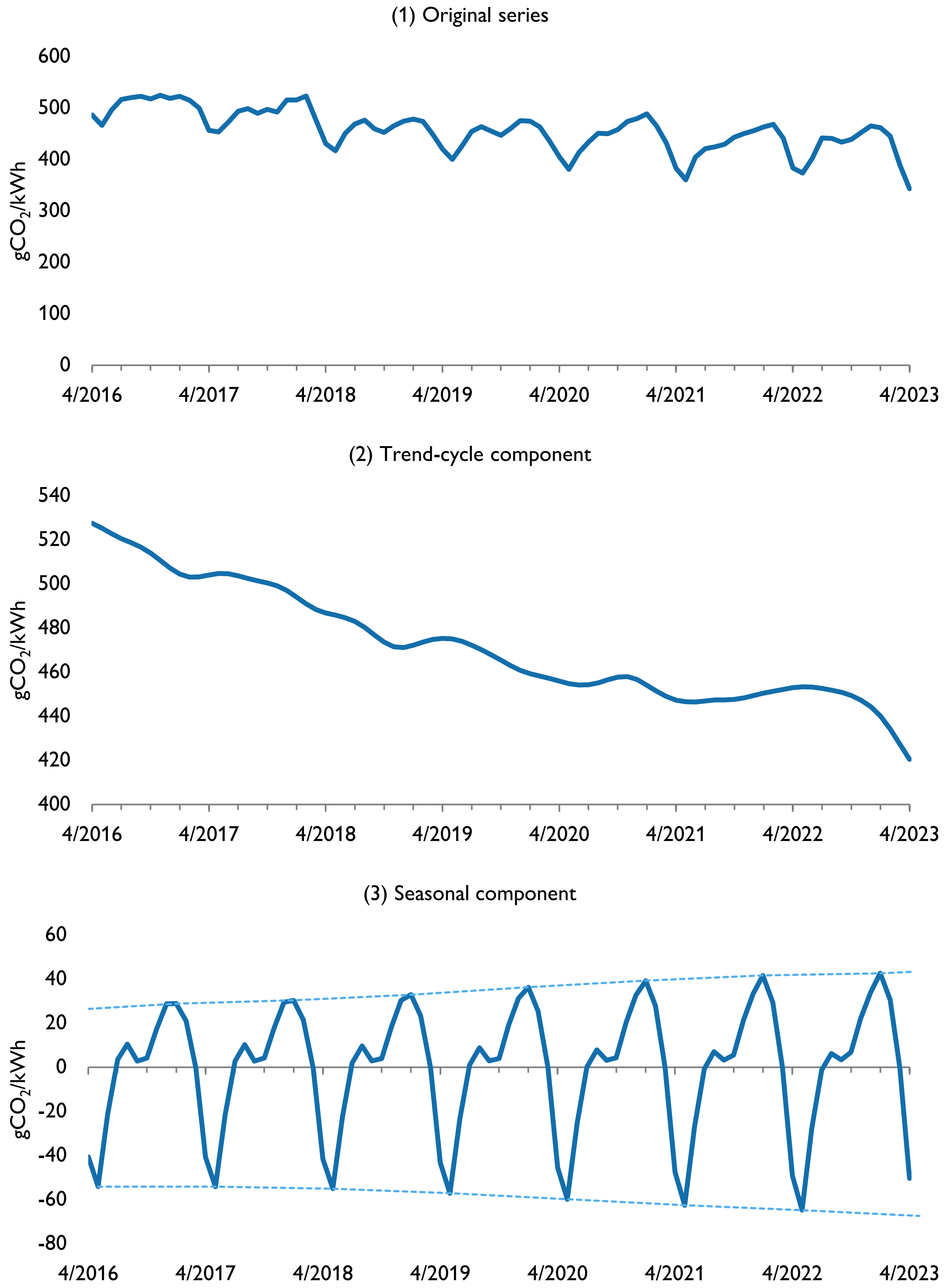
At the national level hereafter, the carbon intensity of Japan's electricity (CO_2 emissions per unit of electricity generated)[8], considered one indicator for measuring the level of electricity low-carbonisation), exhibits unstable trends (Figure 3-(1)). However, if the trend-cycle component alone is displayed as in Figure 3-(2) with the aim of analysing the overall trend, there is a general downward trend in carbon intensity as a result of the growing introduction of solar PV power generation and the increased biomass-fired power generation. Or, if we display only the seasonal component as shown in Figure 3-(3), it is apparent that the size of the cyclical fluctuations by season—lowest in May and peaking in January—has grown greater over the years. The magnitude of these fluctuations grew from just over 80 gCO_2/kWh in FY2016 to just under 110 gCO_2/kWh in FY2022, and is projected to grow still further in the years ahead in line with the increase in solar PV power generation.

There seems little reason not to make effective use of the low-carbon electricity that is available on a cyclical basis and is predictable in nature. Bringing about a shift in demand for electricity by suppressing consumption of the relatively high-carbon electricity of winter months and proactively using the lower-carbon electricity available in the spring would be helpful for encouraging efficient energy low-carbonisation.

[7] Against a 24-hour average of 453 gCO_2/kWh in FY2007, the average for daytime hours (8h-22h) was 462 gCO_2/kWh, while that for nighttime hours (22h-8h) was 435 gCO_2/kWh. Secretariat, Study Group on Methods of Calculating a Utility-Specific Emission Factor Based on the Act on Promotion of Global Warming Countermeasures, Ministry of the Environment "Introduction of an average seasonal emission factor" (https://ghg-santeikohyo.env.go.jp/files/calc/kento_j04/mat04.pdf, accessed on 18 September 2023)

[8] Estimated from "Electric Power Statistics" and from standard calorific values and carbon emission factors. In addition, volumes of other heavy fuel oil are divided into heavy fuel oil A and heavy fuel oil C proportionately according to their consumption ratio, mixed gas are divided into coke oven gas, blast furnace gas, and converter gas proportionately according to their consumption ratio, other gas is treated in the same manner as city gas, and carbon emission factors of others are set at 0. For electricity received from entities other than electric utilities, the carbon intensity of electricity by thermal power generation is set at the same level as that of generation at electricity utilities. Credits for GHGs are not taken into account.

Figure 3 | The monthly carbon intensity of electricity supplied by utilities, the trend-cycle component and the seasonal component



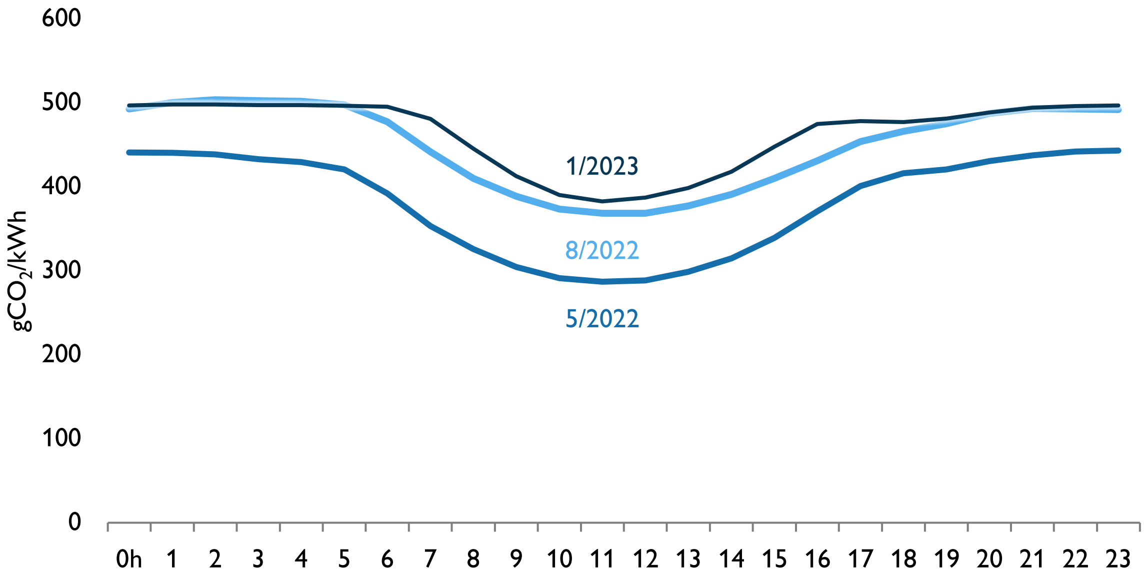
Source: Estimated based on Ministry of Economy, Trade and Industry "Electric Power Statistics", and other sources.

Daytime electricity is lower-carbon than nighttime electricity

However, shifting the timing of electricity usage by month or season is often challenging or offers limited scope. This means we should also consider shifting usage on an hour-by-hour basis, which poses fewer hurdles.

It may be surmised that the carbon intensity of electricity varies from hour to hour as well. It, however, is difficult to estimate such values accurately since data relating to the power generation/fuel consumption status for each type of generation in each timeslot is not publicly available. This paper therefore greatly simplifies the picture based on the actual data available for use, by creating an approximate estimate for the carbon intensity of electricity for each hour based on the assumption that the hourly carbon intensity for thermal power generation for any given month remains constant at the values obtained in the previous section (Figure 4)[9].

Figure 4 | Example of the hourly carbon intensity of grid electricity



Note: The carbon intensity of thermal power generation does not vary by hour within any given month, and is represented by the values shown in Figure 3-(1).
Source: Estimated based on the actual supply-demand data for general electricity transmission and distribution utilities

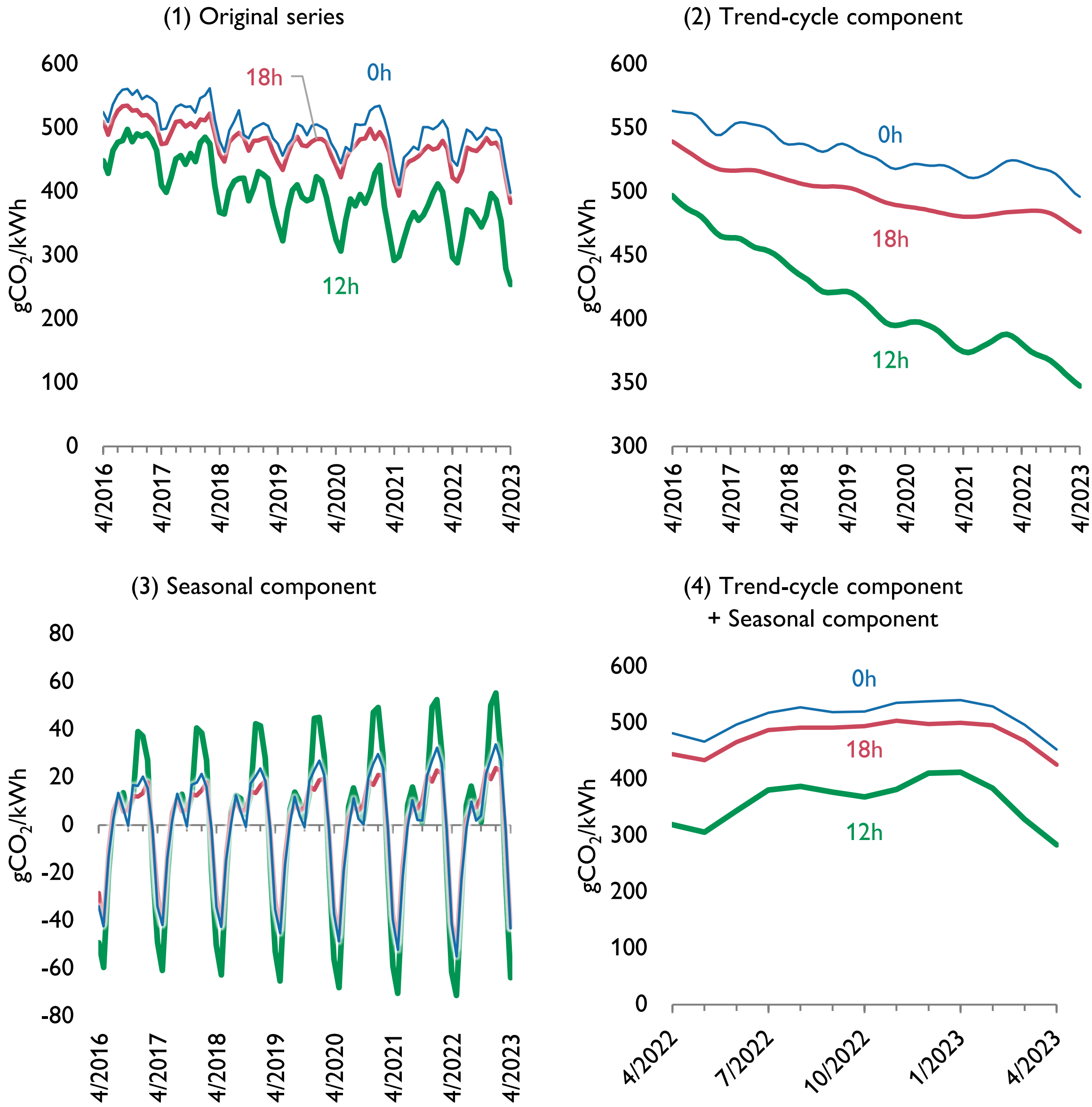
Electricity grows lower-carbon as time moves from midnight to daytime hours; it then grows higher-carbon once again as time moves from daytime towards midnight. It is possible to observe seasonal trends for the 12h noon timeslot, the 18h evening timeslot, and the 0h midnight timeslot, from the monthly shifts in carbon intensity for each timeslot (Figure 5). Looking at the trend-cycle component, it is the carbon intensity of the 12h timeslot (a time when solar PVs are highly active) that has seen the most dramatic decline in carbon intensity over the years. Turning to the time series where both the trend-cycle component and the seasonal component have been added (that is, the series that is easiest to predict), it can be seen that although the 12h timeslot does see a somewhat larger rise than the others around the New Year, it constantly remains at a level lower than the 0h timeslot, unlike in earlier years[10]. In other words, it looks as though shifting electricity demand from the nighttime to daytime hours would be effective from the perspective of making use of lower-carbon electricity. In addition, as the 18h timeslot occupies a slightly lower level than the 0h timeslot, a shift from nighttime to evening would also be effective to a

[9] Estimated based on the actual supply-demand data for general electricity transmission and distribution utilities and on “Electric Power Statistics”. Values for each timeslot are the average for the month in question.

[10] For example, at the time of the discussions for the Three-Year Plan for Promotion of Regulatory Reform (Revised) (Cabinet Resolution, 2008), there was a general perception that electricity was lower carbon in the nighttime hours when the share of nuclear formed a higher share of electricity generated, because these discussions preceded the Great East Japan Earthquake and the introduction of the Feed-in Tariff (FIT) system (in 2012), which triggered the introduction of solar PVs on a huge scale.

certain extent. This, however, cannot be treated as a conclusion to this matter.

Figure 5 | Hourly carbon intensity of grid electricity (0h midnight timeslot, 12h noon timeslot, 18h evening timeslot), trend-cycle component, seasonal component and trend-cycle component + seasonal component



Note: The carbon intensity of thermal power generation does not vary by hour within any given month, and is represented by the values shown in Figure 3-(1).
Source: Estimated based on the actual supply-demand data for general electricity transmission and distribution utilities

The pitfall of focusing exclusively on CO_2 must be avoided

There are risks in using low-carbonisation alone as the standard when shifting electricity demand. In some cases, such an exclusive emphasis can result in grid instability. In recent times, the danger of electricity supply shortages has been experienced more frequently in seasons of high demand (summer and winter). Then pumped-storage hydro power generation and delivering water-pumping power are being used as a barometer for tight or slack supply-demand situations [11]. With pumped-storage hydro power generation, different timeslots exhibit different monthly/seasonal fluctuation patterns for the volumes that are generated, unlike the patterns seen for carbon intensity (Figure 6)[12].

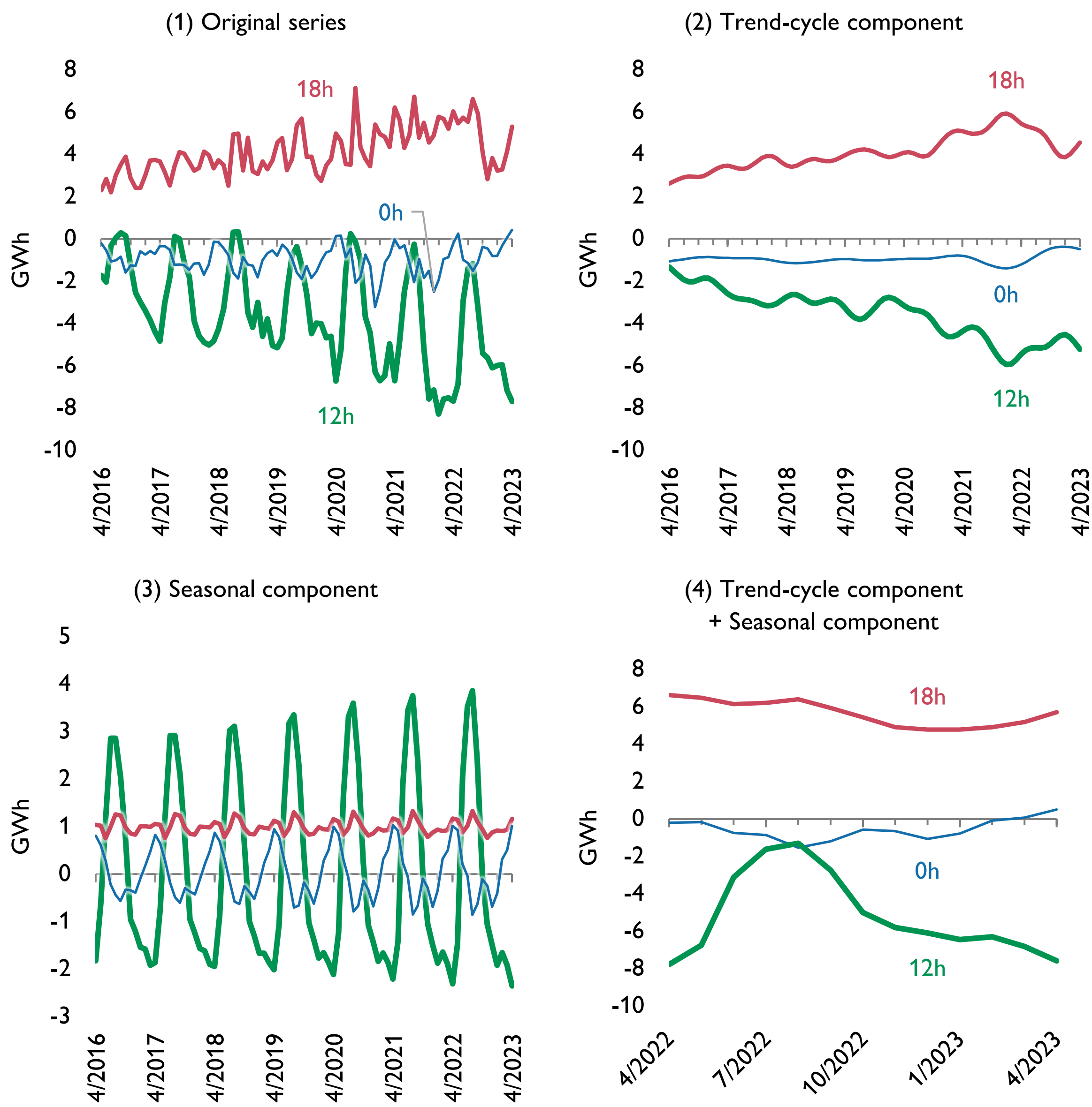
This fact can serve as a source for analysing monthly shifts in the value for each timeslot as carbon intensity, in order to evaluate shifts in electricity demand from the perspective of supply stability. At the 12h timeslot, large volumes of electricity are used for water pumping from winter through spring. Meanwhile, in summer, there is a gradual change from electricity generation during the high-load period to electricity consumption for water pumping. At the 0h timeslot, electricity is generally being used as water-pumping power, although the volume is usually lower than at 12h. Conversely, at the 18h timeslot, electricity generation is always carried out regardless of month or season. This suggests that overemphasis on a single perspective could potentially result in the 18h timeslot experiencing shortages of electricity supply against demand all year round[13]. If electricity supply stability is used as the evaluation criterion, a shift in electricity demand towards the evening hours would actually need to be avoided, a very different conclusion to that reached when low-carbonisation is treated as the yardstick. When supply stability is the criterion, the most favourable period to which to shift demand is the period from 10h to 12h, where there is a need to create more demand or there is relatively ample slack in the supply capacity, regardless of the season.

[11] Pumped-storage hydro power generation requires the water that will provide the hydroelectric power sources to be pumped into an upper reservoir. This pumping of the water consumes electricity. In recent years, a strong tendency has developed for this kind of pumping to be used to proactively create extra demand for electricity in order to use up the excess electricity generated by solar PVs. Whichever way these systems are viewed, it is fair to assume that the pumping of water will take place at times when there is relative slack in the electricity supply. Conversely, although the pumped-storage hydro power generation itself may sometimes be undertaken with the aim of disposing of water from reservoirs that have filled to capacity, as a general principle it is carried out at times where additional electricity supply is needed. Therefore, Pumped-storage hydro power generation and water-pumping power are here used as simple proxy indicators for the electricity supply-demand balance.

[12] Values for each timeslot are the average for the month in question.

[13] This is the time period corresponding to the head of the duck suggested by the so-called “duck curve”.

Figure 6 | Hourly pumped-storage hydro power generation (0h midnight timeslot, 12h noon timeslot, 18h evening timeslot), trend-cycle component, seasonal component and trend-cycle component + seasonal component



Notes: Values for each timeslot are the average for the month in question. Negative values indicate the consumption of electricity for water pumping.
Source: Estimated from actual supply-demand data for general electricity transmission and distribution utilities

Using electricity over the 10h to 12h period: Helping to achieve a balance between promoting low-carbonisation and ensuring a stable supply

The above discussion suggests that, in general, shifting nighttime electricity demand towards the morning/noon period (10h through 12h) would be beneficial for both low-carbonisation and supply stabilisation (Figure 7)[14]. Conversely, the timeslot to which shifting demand should most be avoided (or, to put it another way, where shifting demand away from the timeslot in question is the most important) is around 18h.

Figure 7 | Evaluation of different timeslots as destinations for shifted demand of grid electricity

Carbon intensity (gCO_2/kWh)

	0h	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Overall evaluation																								
FY																								
Apr.	482	488	483	481	481	472	446	401	365	332	317	315	319	329	346	374	406	435	445	450	456	470	477	477
	467	467	465	461	458	450	421	381	356	326	314	309	306	325	344	366	392	415	434	439	448	460	466	468
	498	499	501	498	494	485	456	421	393	363	349	342	344	358	374	399	422	445	466	476	482	495	498	496
Jul.	518	520	534	533	530	516	493	461	429	400	387	381	381	393	405	427	447	467	487	499	503	514	516	515
	528	537	549	549	547	538	511	473	437	408	394	388	387	397	411	438	456	475	492	502	509	521	523	523
	519	525	536	534	531	524	502	463	425	393	378	374	377	389	409	434	463	482	492	501	505	514	516	516
Oct.	520	522	528	525	521	518	506	464	423	384	368	364	369	382	409	446	480	490	494	504	507	517	519	519
	536	539	540	538	535	535	528	494	439	394	377	373	382	398	430	476	502	502	504	512	518	529	532	533
	538	543	550	549	546	540	529	508	462	421	405	400	411	420	444	482	500	499	498	505	511	525	530	532
Jan.	541	546	557	557	555	546	533	514	468	429	414	407	413	424	443	478	500	506	500	507	511	527	533	536
	530	533	540	538	536	532	522	499	451	408	390	383	384	397	414	447	480	496	496	503	503	518	523	525
	497	500	506	505	503	495	477	442	392	350	331	324	329	341	359	405	430	442	468	475	470	486	490	492

Pumped-storage hydro power generation (GWh)

	0h	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
FY																								
Apr.	-0.20	-0.66	-0.40	0.40	0.98	0.69	0.89	-0.63	-1.81	-3.34	-4.81	-6.19	-7.79	-5.94	-4.17	-1.86	1.28	3.91	6.62	5.70	3.88	2.27	1.12	0.58
	-0.17	-0.77	-0.38	0.50	1.07	0.42	-0.47	-2.57	-3.44	-4.14	-5.14	-5.79	-6.75	-5.04	-3.26	-0.97	1.98	4.19	6.48	5.71	3.88	2.43	1.53	0.85
	-0.74	-1.73	-1.64	-0.95	-0.43	-1.15	-1.61	-2.67	-1.85	-1.76	-2.01	-2.27	-3.11	-1.65	-0.65	0.57	2.68	3.74	6.14	4.49	2.37	1.21	0.69	0.14
Jul.	-0.86	-2.36	-2.79	-2.70	-2.68	-2.84	-2.51	-3.44	-1.92	-1.21	-1.28	-1.22	-1.63	-0.50	0.53	1.79	4.05	4.99	6.21	4.59	2.38	1.02	0.51	0.07
	-1.53	-3.46	-4.42	-4.24	-4.12	-4.14	-3.76	-3.41	-1.40	-0.83	-0.95	-1.28	-1.30	-0.07	1.15	2.69	5.02	6.11	6.40	5.13	2.45	1.00	0.45	-0.11
	-1.19	-2.63	-2.96	-2.37	-1.66	-1.99	-1.79	-2.53	-1.82	-1.70	-2.22	-2.21	-2.74	-0.96	0.49	2.11	3.81	5.30	5.94	3.39	1.52	0.60	0.28	0.17
Oct.	-0.57	-1.23	-1.07	-0.25	0.27	0.00	0.21	-0.40	-1.12	-2.29	-3.21	-4.20	-5.01	-2.75	-0.93	0.73	2.77	4.26	5.44	2.75	1.39	0.64	0.34	0.12
	-0.66	-1.24	-0.69	0.00	0.40	0.09	0.83	0.49	0.13	-1.49	-3.41	-4.51	-5.81	-3.28	-1.22	0.53	2.45	3.52	4.90	1.94	1.02	0.50	0.21	0.00
	-1.06	-1.57	-1.29	-1.06	-0.87	-0.94	0.57	1.57	1.95	0.38	-2.14	-4.32	-6.10	-4.04	-1.99	0.11	2.29	3.65	4.78	2.38	1.55	0.87	0.32	-0.08
Jan.	-0.77	-1.33	-1.48	-1.47	-1.34	-1.32	0.38	1.75	2.34	0.76	-2.13	-4.40	-6.45	-5.08	-3.49	-0.99	1.43	3.38	4.78	2.70	1.98	1.21	0.48	0.00
	-0.08	-0.27	-0.23	-0.09	0.09	-0.30	0.88	1.47	1.62	0.07	-2.13	-4.01	-6.30	-5.11	-3.79	-1.70	0.55	2.72	4.91	2.77	1.91	1.21	0.58	0.30
	0.07	-0.05	0.20	0.62	0.91	0.41	1.14	0.44	0.16	-1.28	-3.41	-4.75	-6.82	-4.86	-3.04	-1.18	0.95	2.58	5.18	3.05	2.15	1.42	0.90	0.48

Notes: ■ indicates favourable times to shift demand towards; ■ indicates those that are not favourable. Both the values for carbon intensity and those for pumped-storage hydro power generation reflect the trend-cycle component + seasonal component (FY2022 values). The negative values for pumped-storage hydro power generation represent the electricity consumed by water pumping.
Source: Estimated from actual supply-demand data for general electricity transmission and distribution utilities

[14] However, a different set of recommendations would probably be required if the perspective were that of load-levelling at power supply facilities.

Promoting widespread behavioural changes

The notion of temporal shifts in electricity demand has been in existence for a long time. There are price menus which provide economic incentives to encourage these, including cheaper electricity at nighttime or higher prices in the summer. In recent years, demand response systems have been put together which proactively engage with consumers in the immediate term, aiming to increase the economic efficiency of the electricity supply and stabilise the supply-demand balance. However, in systems which aim to encourage shifts in electricity demand through economic incentives alone, the costs of such inducements must be provided on a reasonable scale to operate the system, and the electricity supply-demand balance must be forecast accurately in order to ensure such costs are not wasted. Yet forecasting supply and demand accurately in advance is no easy task. Furthermore, it is surmised that one of the reasons why seasonal carbon emission factors were not ultimately adopted in the past was the insufficient rigour to form part of a system such as the systems for estimating, reporting and publicly announcing GHG.

The discussion hitherto has been developed by setting out quantitative estimations, and is not intended to give any actual suggestions as to day-to-day operational methods for the electricity supply. Neither is it intended to serve as a detailed guide for electricity saving or shifting electricity demand, which varies according to daily conditions including region, days of the week, weather, temperature, the operational/malfunction status of power plants, and the like. Information of this kind is what the various utilities issue in the form of their "Electricity Forecasts". Rather, what this paper stresses is the importance of ensuring that as many people as possible recognise the kind of typical cyclical patterns that can be predicted in advance, as set out above. As the spread of this kind of awareness leads electricity consumers to voluntarily and habitually change their actions and behaviours, it will promote low-carbonisation of electricity and a more stable electricity supply whilst minimising dependence on high-cost hardware and systems.

One example where the actions and behaviours of electricity consumers can have an impact is water heating by electricity. Previously, electricity during nighttime hours was considered lower-carbon than that in the daytime. For that reason, a strategy of water heating with heat pump water heaters using nighttime electricity was adopted as a measure for effective CO_2 reduction in addition to the high energy efficiency of heat pumps., In recent times, however, daytime electricity has become lower-carbon than nighttime, regardless of the month or season. Getting consumers to alter the time settings for water-heating from nighttime to daytime in line with this change in the situation can boost the CO_2 reduction effects of electric water heaters with no need for additional investment. Turning to the supply-demand balance side, meanwhile, using daytime electricity to heat water is also helpful for stabilising the electricity supply, by creating extra demand for electricity during the times when oversupply is apt to occur. Furthermore, using nighttime electricity to heat water is no longer favoured in the way it once was. This is because the reduction in nuclear power generation following the Great East Japan Earthquake has resulted in a decrease in (low-carbon) baseload power sources operated on a stable basis during the night.

Similar to electric water-heaters, yet in fact predicted to be far more important, are electric vehicles (EVs) and plug-in hybrid vehicles. When EVs are recharged using standard charging methods which require leaving them plugged in for long periods, it should be possible to use the functions of the EV system to ensure that the actual recharging itself takes place automatically during those times that are most favourable from the perspectives of low-carbonisation and supply stabilisation of electricity. However, with fast charging (which charges the vehicle in a short space of time), the actual time that the vehicle is plugged in is inherently short. Given that consumers are typically making use of fast charging at times such as when returning home in the evening, fast charging is not only of limited effectiveness in terms of contributing towards low-carbonisation and supply stabilisation even if the most optimal time within this limited period of time is chosen, but in fact could potentially have negative effects on both aspects. In other words, whether these technologies have positive or negative effects will depend greatly on whether EV owners have at least a vague awareness of what times are generally most favourable for recharging, and whether they habitually put this into practice or not. EV consumes considerable amounts of electric energy (kWh), and fast charging exerts impacts in electric power of the range of tens of kW or still higher, incomparably large when compared with electric water-heater.

Spreading appropriate understanding of this issue is the key to gently inducing changes in actions and behaviours among large numbers of electricity consumers at the mass level. To do this, it is essential that accurate information be provided in clear formats. In other words, rather than issuing highly detailed information specialised for particular regions and days/times that users will need to receive and update frequently, it is best to provide succinct information that has been consolidated and set out in an organised way and which aims to foster awareness of "what the overall picture is". Care should be taken with this point, as overemphasising rigour and precision can lead to communications becoming excessively complex and lengthy, which may make it harder to develop wider understanding[15].

In addition, when information is to be shared across a wide sphere, it is generally thought best to do so earlier. As EVs are starting to be adopted on a wide scale, such information needs to be rolled out as soon as possible. Once misconceptions or outdated information that are no longer appropriate has spread—for example, that EVs do not cause any CO_2 to be emitted, or that top-up charging is harmful[16]—trying to overturn such myths is no easy task. Incorrect ideas, once lodged in consumers' minds, can harm efforts to low-carbonise and stabilise the electricity supply.

Although electricity and other forms of energy are essential for socio-economic activities and our daily lives, the understanding of electricity (of the kind that is often seen in relation to infrastructure) has not permeated society to any great depth. For example, calls for electricity saving on the grounds of power shortages have been frequently heard in recent times; unfortunately, however, it is highly dubious whether the contents of the requests themselves—should users avoid using electricity at peak times? Should they reduce their total electricity usage during some periods?—are being conveyed correctly. Needless to say, efforts are underway to improve situations like this where such information is only known among a select few, but what is needed is guidance that will help consumers naturally act in the right way, without relying on too much detail or specialised theories. If the need for high-cost hardware and systems can be reduced as a result of this, the advantages of such guidance will be considerable.

[15] For example, the values for carbon intensity discussed in this paper are average values, and are not marginal values that indicate changes that occur when shifts have occurred in electricity demand. However, marginal values cannot be obtained from the statistics, and can be greatly differing values since the types of power supply that increase or decrease vary depending on the situation. Having numerous combinations of presupposed conditions and suggested responses ("Do A in the case of X", "Do B in the case of Y", etc.) is not ideal when information needs to be presented succinctly.

[16] The idea that top-up charging is harmful comes from discussions about nickel-cadmium batteries and nickel-metal hydride batteries which are subject to the memory effect, and does not apply to lithium-ion batteries.

European Union Emissions Trading System (EU ETS)

Tohru Shimizu*

The European Union (EU) launched the European Union Emissions Trading System (EU ETS) in 2005 and has revised it several times, currently entering its fourth phase. Additionally, the European Commission (EC) proposed a system revision in July 2021 as part of the Fit for 55 packages, and the EU adopted this revision in May 2023.

1. Overview of climate change policies

The EU has established a greenhouse gas emissions reduction target of -55% compared to 1990 levels by 2030. This target encompasses the EU ETS sectors, which cover large-scale emissions from power generation, iron and steel, chemicals, and cement, and the non-EU ETS sectors, including transport, building, and agriculture. The EU has set specific reduction targets for the non-EU ETS sectors for each member country.

EU has positioned carbon pricing in the EU ETS as the primary policy in its climate change policy. At the same time, it is advancing initiatives for emissions reduction in the entire EU by setting targets for introducing renewable energy and energy efficiency.

Table 1 EU's 2030 targets

Greenhouse gas emissions	-55% compared to 1990 ● EUETS sectors: -61% compared to 2005 ● Non-EU ETS sectors: -40% compared to 2005 reduction within the EU only
Renewable energy	Share in final energy consumption of 42.5% (target for the entire EU)
Energy efficiency	11.7% reduction compared to 2020 BAU

(Source) made by The Institute of Energy Economics, Japan (IEEJ) from European Commission materials.

2. Hydrogen-based direct reduction ironmaking for an example

2.1. An overall of the system[1]

The EU ETS, which plays a significant role in the EU's climate change policies, contributes to achieving the emissions reduction targets of the entire EU by setting caps (emission upper limits) for the target sectors and lowering the emission upper limits in stages. Targeting emissions arising from the burning of fossil fuels and emissions for the use of fossil fuels in industrial processes, the EU ETS covers approximately 40% of the EU's greenhouse gas emissions. European Commission distributed half of the emission rights (European Union Allowance, EUA) by auction, but the free allocation using the product benchmark centered on industrial sectors remains. In 2026, due to the introduction of the Carbon Border Adjustment Mechanism (CBAM), the free allocation for emissions from the production processes within the EU region of products covered by CBAM will be reduced, but this does not mean that the free allocation will eliminate in 2035.

The EU will establish an emissions trading system for buildings and road transport, known as 'ETS 2', in 2027. While the existing ETS addresses direct and process emissions, ETS 2 will require suppliers to purchase and surrender EUA equal to their emissions from selling petroleum products and natural gas. To prevent double regulation, the EU excludes the power generation and industrial sectors covered by the EU ETS from the scope of ETS 2.

Figure 1 shows the trends since the system started in 2005 in emissions from facilities covered by EU ETS, the amount of

* Senior Researcher, Climate Change Group, Climate Change and Energy Efficiency Unit, IEEJ

[1] Refer to the attached System Overview Table regarding the more detailed system.

allocation, surrender, and use of the offset credits (CERs and ERUs (both international credits based on the Kyoto Protocol)). The free allocation amount was more significant than the emissions from 2009 to 2012, and Many of the operators covered by EU ETS had used many inexpensive offset credits. Thus, they have many unused EUA in their account. From 2014 onward, the European Commission has reduced the allocation supply to the market (backloading, the market stability reserve). However, approximately 1.1 billion t-CO_2 of the EUA that became this unused surplus remains.

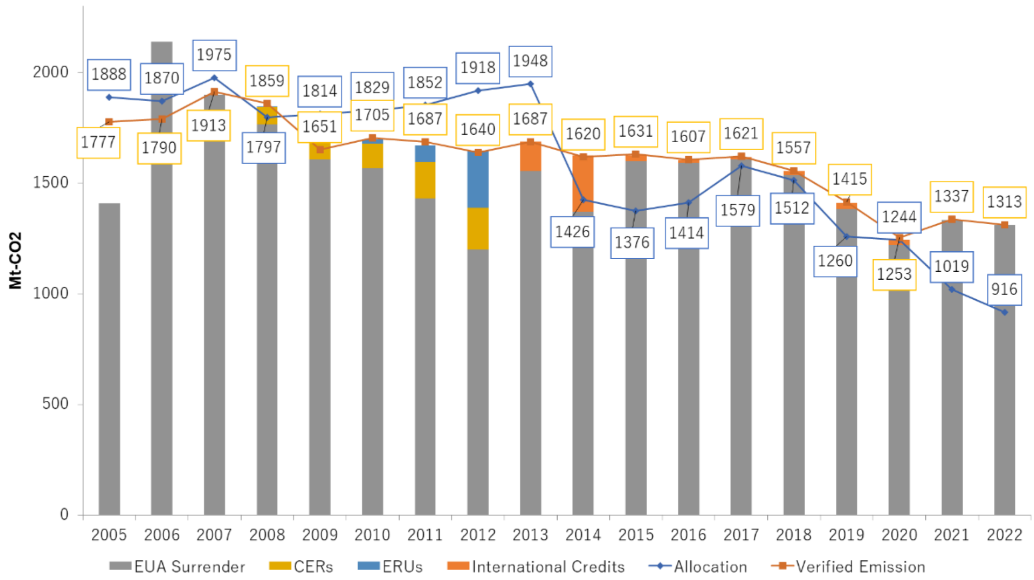


Figure 1: Trends of allocation, verified emission, EUA, and offset credits in the EU ETS sectors

(Source) EUTL and the European Environment Agency (EEA)

Next, Figure 2 shows the trends in the EUA price since the system started. In 2005, the EUA price was about 20 euros/t-CO_2 to 30 euros/t-CO_2, but in 2007, the final year of the first phase, it was clear that the allocation by the European Commission and its member states had exceeded the actual emissions. Therefore, the price plunged. The second phase started in 2008, and initially, the price was at the level of about 30 euros/t-CO_2 because the allocation was tighter than in the first phase, but production activities within the EU region declined due to the bankruptcy of Lehman Brothers. Thus, emissions also decreased, and as a result, it fell to 15 euros/t-CO_2 and fell to the level of five euros/t-CO_2 or less in 2013.

Subsequently, the EUA price has been rising because of the 2018 ETS Directive revision and the rules restricting the EUA supply to the market from 2019 (the Market Stability Reserve, MSR) were implemented. Moreover, in 2021, the EU decided to strengthen the emissions reduction targets of the entire EU for 2030, and the price rose to a level exceeding 60 euros/t-CO_2 due to the release of the Fit for 55 policy package. In addition, speculation that the invasion of Ukraine by Russia will lead to a switch from gas-fired power generation to coal-fired power generation has caused the EUA price to rise to a level exceeding 100 euros/t-CO_2 temporarily.

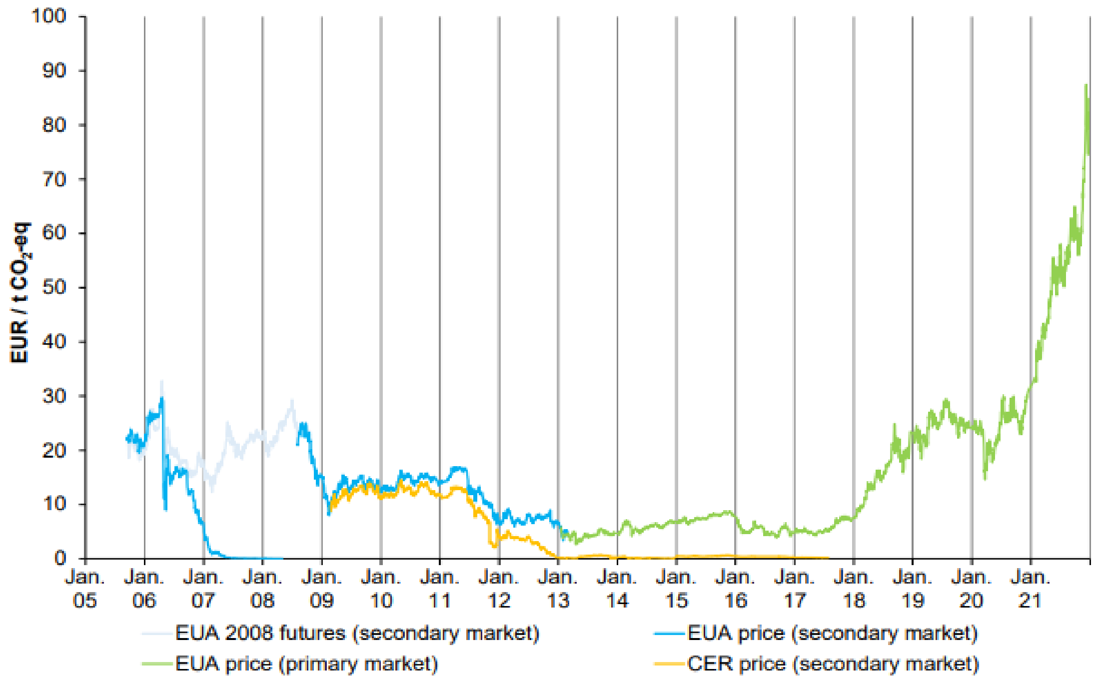


Figure 2: Trends in the EUA price

(Source) Cited from EEA (2022), Trends and projections in the EU ETS in 2022, pp. 31

2.2. Allocation

From 2005 to 2012, free allocations were grandfathering based on actual emissions in the past and allocations by auctions, but from 2013, this was changed to free allocations to industrial sectors using the product benchmark and auction to the electricity sector.

For free allocations to industrial sectors, the European Commission sets the average value of each sector's top 10% efficiency as the benchmark value, and they decide the amount of free allocation amount by incorporating the fluctuations in the number of production activities every year and correction factors. As shown in Figure 3, the member countries calculate the amount of the free allocation using a benchmark incorporating the efficiency improvement rate in the number of equipment activities covered by ETS inside their country. Furthermore, from 2026 onward, emissions from produce products covered by CBAM in facilities covered by the system, a CBAM factor will be added to exclude them from the free allocation. The Commission checks the results reported by the Member States against the results to see if the carbon leakage sector list covers the facility in question if the total free allocation does not exceed the emission cap and, if necessary if the free allocation is adjusted. Then, after this correction, the provisional free allocation amount concerning the facilities covered by the system is decided, but the actual percentage amount rises or falls depending on the number of production activities every year.

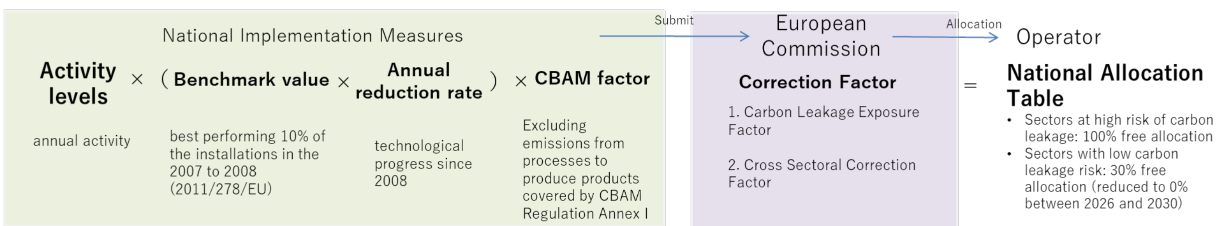


Figure 3: Summary of the calculation formula for the free allocation using the benchmark method

(Source) ETS Directive

The European Commission allocates EUA to each member country based on past emissions. These EUA sales occur on the EU common auction platform or individual country platforms. The European Energy Exchange (EEX) conducts these auctions almost daily. In 2021, auction sales of EUA generated 30 billion euros in revenue (averaging 53 euros/t-CO_2). A portion of this revenue, disproportionately favoring Eastern European countries, contributed to the state revenues of member countries. Poland topped the list in 2021, earning 5.5 billion euros, followed by Germany with 5 billion euros. Some of these revenues also funded the Innovation Fund, supporting technology development and demonstration projects within the EU. Moreover, the EU plans to procure 20 billion euros for REPowerEU through EUA auctions in 2023, enhancing the ETS's role as a significant funding source.

2.3. Offset credits

In the EU ETS, offset credits using CDM and JI based on the Kyoto Protocol were usable until 2012. The European Commission purchased them from 2013 to 2020. They were switched to the EUA and became usable with EU ETS. However, appropriating all emissions with offset credits was prohibited and limited to only some of the emissions. However, from 2021 onward, offset credits became prohibited in principle.

2.4. MRV

Operators with facilities covered by EU ETS must implement third-person verification per the guidance of the European Commission, report their emissions by the end of March every year, and surrender the same amount of EUA at the end of April. Supposing they cannot surrender by the end of April, they are required to submit an improvement report and the EUA for the shortfall by the end of June, and in the case that they cannot do that, they will be subject to penalty. From 2024, entities must surrender EUA by the end of September, as the deadline is changing.

Figure 4 shows the EU ETS compliance cycle. The operators prepare and receive approval for a monitoring plan in advance, measure their emissions based on the plan, obtain reasonable verification results from a third-person, and surrender the same amount of EUA. The European Commission has prepared the related rules and guidance, and the operators that carry out the verification verify the operators' emissions based on them.

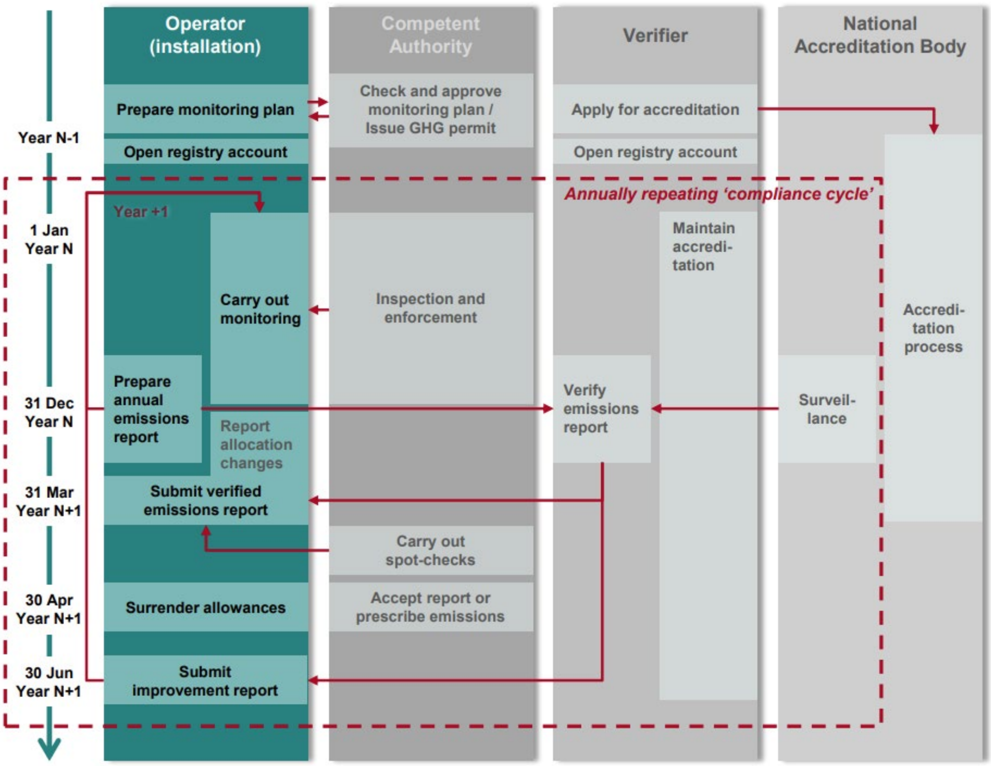


Figure 4: The compliance cycle of the EU ETS

(Source) Cited from the European Commission (2022), Quick guide for verifiers, pp. 2

2.5. Relations with other policies

The EU ETS coexists with each country's energy and carbon taxes in the EU region, but many countries impose only one burden. For example, after introducing a CO_2 tax in 1991, Sweden exempted operators under the EU ETS from this tax from 2005, following the Energy Taxation Directive. In contrast, the Netherlands extended its general fuel tax in 2021 to include industrial sectors previously exempt, taxing them if they fail to meet specific efficiency standards. This change has led to the possibility of a double burden in the Netherlands, combining the general fuel tax with the EU ETS.

In June, Germany recently announced the introduction of Carbon Contracts for Difference (CCfDs) referencing the EUA price for the domestic industrial sectors. CCfDs subsidize the difference between the additional cost burden necessary for new production processes and the EUA price to advance the decarbonization of equipment covered by EU ETS. However, in the case that the EUA price exceeds the cost burden, the operators will have to make a payment to the government.

3. Implications for GX ETS

The EU ETS, established in 2005, serves as a reference for the design of Japan's GX ETS, set to launch in 2024. It is crucial to evaluate and learn from the EU ETS's trial-and-error experience to adapt GX ETS effectively to Japan.

First, we consider the allocation. Initially, the EU ETS used free allocations based on past emissions through the grandfathering. However, actual emissions after 2008 differed significantly from the initial allocation plan, leading to an excessive surplus of EUA. This discrepancy highlights the challenges of allocations in emissions trading systems. Therefore, Japan needs to refine the allocation plan's preparation and implementation, considering changes in free allocations based on operational status and actual production activities, as evidenced by subsequent revisions in the EU system.

Next, the EU transitioned to the allocation plans by the benchmark in 2013. However, finalizing a consensus with industrial sectors took seven years, emphasizing the need for preparation. Japan's GX ETS should consider sector-specific evaluations using the benchmark. While the Act on Rationalizing Energy Use offers a benchmark system, its compatibility with the GX ETS remains uncertain, potentially necessitating adjustments.

Lastly, we address price fluctuations. Prices in the EU ETS varied dramatically, from 3 euros/t-CO_2 to 100 euros/t-CO_2. Surplus allocations contributed to low prices, while the Market Stability Reserve (MSR) and the overall system design influenced high prices. Japan must proactively integrate measures, such as setting price caps and reserve prices and adjusting market emission rights supplies, to stabilize the GX ETS pricing.

References

1) Christian Nissen, Johanna Cludius, Sabine Gores, Hauke Hermann (2022) "Trends and projections in the EU ETS in 2022" https://www.eionet.europa.eu/etcs/etc-cm/products/etc-cm-report-2022-05
2) Refinitiv (2023) "Carbon Market Year in Review 2022" https://www.refinitiv.com/content/dam/marketing/en_us/documents/gated/reports/carbon-market-year-in-review-2022.pdf
3) The European Roundtable on Climate Change and Sustainable Transition (2023) "2023 State of the EU ETS Report" https://ercst.org/2023-state-of-the-eu-ets-report/
4) European Commission Directorate-General for Climate Action (2022) "Functioning of the European Carbon Market in 2022" https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022DC0516

Appendix: Overview of the EU ETS

Overview	Name	EU Emissions Trading System (EU ETS)
	Governing laws	• Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC. • Directive 2004/101/EC of the European Parliament and of the Council of 27 October 2004 amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in respect of the Kyoto Protocol's project mechanisms. • Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community. • Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community. • Directive (EU) 2018/410 of the European Parliament and of the Council of 14 March 2018 amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814 • Directive (EU) 2023/959 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union and Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading system
	Overview	The emissions trading system is mainly responsible for reducing the greenhouse gas emissions of the EU. It covers approximately 40% of CO_2 emissions within the EU region. (When ETS 2 is started, approximately 80%)
	Recent trends	The ETS Directive was revised at the end of 2022 and will be enforced from 2024 onward. Anticipating that the EUA demand and supply will tighten in the future, the EUA price has risen to a level exceeding 100 euros/t-CO_2.
	Background to introduction	In 1997, the introduction of a common carbon tax failed, and instead of that, it was decided in 2003 to introduce the EU ETS to achieve the targets of the Kyoto Protocol, and the system was started in 2005.
	Implementation period	• First phase: 2005 to 2007 • Second phase: 2008 to 2012 (for the aviation sector, 2012 onward) • Third phase: 2013 to 2020 • Fourth phase: 2021 to 2030 • Amended fourth phase: 2024 to 2030 (maritime transport from 2024, ETS 2 from 2027)
Target	Unit	Each piece of equipment (ETS 2 is for each energy operator)
	Coverage requirements	Facilities/equipment for which annual emissions exceed 25,000 t-CO_2 (small-scale facilities (educational institutions, hospitals) can opt-out at the discretion of the member countries even if they exceed 25,000 t-CO_2) • Burning facilities: burning facilities, oil refineries, and coke ovens that have heat input exceeding 20MW. • Industrial facilities: 258 sectors and subsectors, including iron and steel, aluminum manufacturing, nonferrous metals, chemicals, glass, cement, ceramics, paper and pulp • Transport: airlines operating flights which take off or land at airports within the EU region (from 2012) • Maritime transport: emissions of sea journeys from within the EU region to outside the EU region (50%), sea journeys from outside the EU region to within the EU region (50%), sea journeys from within the EU region to within the EU region (100%), and time anchored in port within the EU region. • Operators supplying fuel to the following sectors (basically, identical to the operators that pay energy tax and carbon tax in each member country) ➢ Heat supply using CHP to the civilian and household sectors. ➢ Road transport (excluding agricultural vehicles on paved roads) • CCS: capture, transportation, and underground storage
	Covered gases	CO_2, N_2O, PFC
	Emission point (direct or indirect)	Direct emissions (ETS 2 is for emissions based on the carbon content of the fuel)

	Coverage (emissions of sectors covered by the regulations (or total amount of emission quota) and the coverage ratio (emission quota total amount/ total emissions of the country))	Approximately 40% of the CO_2 emissions within the EU region (approximately 1.3 billion t-CO_2): 2021 ETS 2: approximately 40% planned
	Handling of supplied/purchased heat	In the case that heat is supplied from facilities covered by the ETS to other facilities covered by the ETS, calculated as the emissions of heat consumption facilities. In the case that heat is supplied from facilities covered by the ETS to facilities not covered by the ETS, calculated as the emissions of heat supply facilities
Target-setting method	Objectives and targets	• 20% reduction of GHG emissions in the entire EU in 2020 compared to 1990. • 21% reduction compared to 2005 in the EU ETS sectors (in the aviation sector, 95% of the average CO_2 emissions from 2004 to 2006) • Emissions cap ➢ Third phase: the amount obtained by decreasing 1.74% each year from the average value of the allocated amounts in the second phase (2,039,152,882 t-CO_2) until 2020 (1.843 billion t-CO_2) ➢ Fourth phase: the amount obtained by decreasing the emissions of the third phase by 2.2% every year. ➢ Amended the fourth phase (ETS): decreased by 4.3% every year from 2024 to 2027 and 4.4% every year from 2028 to 2030. Lower the emissions cap to 90 million t-CO_2 in 2024 and 27 million t-CO_2 in 2026. In 2024, the maritime transport sector will be added so that the upper limit will be raised to 78 million t-CO_2 ➢ Amended fourth phase (ETS 2): 43% down compared to 2005
	Allocation methods	• Power generation sector: auctions (however, some free allocation to Eastern European countries with conditions) • Industrial sectors in which there is a danger of carbon leakage: all free allocation with conditions. ➢ In the case the sector begins to be covered by CBAM, the free allocation for emissions about the production of products covered by CBAM in the covered activities will be reduced in stages from 2026. ✧ 2026: -2.5%, 2027: -5%, 2028: -10%, 2029: -22.5%, 2030: -48.5%, 2031: -61%, 2032: -73.5%, 2033: -86%, 2034: 100% ➢ In facilities covered by the system, implementation of countermeasures based on the results of the energy audit based on the Energy Efficiency Directive (EED), Article 8 is obligatory (however, alternative measures converted into GHGs are also allowed) ✧ In addition, in the case of non-implementation of the energy audit and non-preparation of a carbon-neutral plan concerning the bottom 20% of companies in terms of poor efficiency, the free allocation is reduced by 20%. ➢ A preliminary decision is made about the free allocations after the member countries implement the NIM (National Implementation Measures) based on the EU common benchmarks for each product and the cross-sectoral correction factors (CSCFs) that the European Commission has applied. The actual free allocation amount is decided by incorporating the amount of production activities every year. • Industrial sectors in which the danger of carbon leakage is low: some free allocations (30% in 2021 and 0% in 2029), transition to auctions in stages. • In countries with many emissions from district heat supply equipment, in addition to a free allocation of 30%, an additional free allocation of 30% (on the condition of implementation of a CN plan + energy audit results) • 5% of the total allocation until 2030 as the new entrant reserve • Transport sector (aviation sector): concerning the average of the total CO_2 emissions from the aviation sector from 2004 to 2006, free allocations (82%), auctions (15%), and the new entrant reserve (3%), and the ratio of auctions will be raised in stages from 2024 onward. • Maritime transport sector: as a general rule, all auctions. However, EUA is to be surrendered for 40% of emissions in 2024, 70% of emissions in 2025, and 100% of emissions from 2026 onward.

		• ETS 2: in principle, all auctions
Flexibility measures	Banking, borrowing	From 2008 onward, banking is allowed, and borrowing is prohibited
	Utilization of other credits	Fourth phase onward: use prohibited
	Other mitigation measures and leakage countermeasures	• Free allocation to industrial sectors in which there is a possibility of carbon leakage. • Member countries can pay compensation for the increase in indirect costs due to the rise in electricity prices caused by ETS.
	Price countermeasures (setting of a price cap and reserve price, the market surveillance mechanism)	• When the price rises rapidly, urgent auctions supply the EUA to the market. ➢ When the price of the EUA in the past six months became 2.4 times the average price of the past two years, the EUA was released from MSR to the market through 75 million tons of auctions. ➢ The European Commission announces whether or not the release conditions have been met at the start of every month. Furthermore, it announces the price level that meets the conditions for the following month. ➢ After a release to the market, it does not carry out any additional releases for 12 months. • Using MSR, surplus EUA is absorbed by reducing the auction volume while surveilling market demand and supply.
	Penal provisions	€100/t-CO_2 (however, incorporate the inflation rate)
Market	Trends in the prices (trading price and auction price), auction volume, market trading volume, breakdown of the market trading participants)	As of March 2023: approximately 100 euros/t-CO_2 EUA auction volume: approximately 700 million t-CO_2 annually (common auction platform, total for Germany and Poland) Market participants: companies and financial institutions possessing equipment covered by ETS
	Distribution volume	11.164 billion t-CO_2 annually (annual total trading volume of EUA spot and each delivery month futures trading of ICE and EEX)
	Trading format	Spot (following day account settlement), futures (each delivery month), negotiated trading, OTC
	Links to other systems (status of consideration)	Linked to the Swiss ETS from 2019
Other	Effect (reduction effect and impact on the economy, etc.)	
	Uses for auction revenue	Distribution to member countries (88%): However, at least 50% of the auction revenue is limited to use for policies related to climate change. Cohesion and growth of member countries (10%): distribution to low-income countries Consideration for low-income countries (2%): consideration for Eastern European countries
	Compliance cost	The average cost paid by operators for MRV every year is €59,207, or €0.16 per ton, in the EU ETS compliance cycle (12 months of emissions monitoring + six-month compliance period) (DG CLIMA (2016) "Evaluation of EU ETS Monitoring, Reporting and Verification Administration Costs")

Source: made by The Institute of Energy Economics, Japan (IEEJ) from Directive 2003/87/EC.

Emissions Trading System by Eastern States of the United States (RGGI)

Tohru Shimizu[*]

1. Overview of climate change policies

The Regional Greenhouse Gas Initiative (RGGI) is a regional emissions trading system in which 12 eastern states in the United States are participating. As of 2023, the United States had not introduced emissions trading at the federal government level, so it is limited to regional systems such as the RGGI and the California Cap and Trade.

Each of the participating states has set their own emissions reduction targets. Among these, the RGGI aims to set an emission cap for the participating states concerning the CO_2 emissions of the power plants located inside the participating states and gradually lower it to advance emissions reduction in the region overall. Furthermore, a vital characteristic of the RGGI is its primary use of auctions, with the proceeds being actively invested in low-carbon initiatives within the participating states.

2. System design of emissions trading

2.1. An overall of the system

In December 2005, the seven northeastern states of Delaware, Connecticut, Maine, New Hampshire, New Jersey, New York, and Vermont agreed to implement an emissions trading system in the eastern states from 2009 and signed a memorandum concerning its basic framework. Subsequently, New Jersey withdrew, but Massachusetts, Rhode Island, and Maryland began to participate. At the time of the system's start in 2009, nine states were participating, but some states withdrew or participated again due to policy changes accompanying changes in state governors.

The participating states establish specific implementation rules based on the Model Rule released in August 2006. While each state's laws govern the regulations' enforcement, RGGI Inc. was established to monitor market trends, manage the emissions registry, implement auctions, and provide technical support to the participating states.

Following the first program review from 2010 to 2012, authorities reviewed the Model Rule established in 2006. They conducted a second program review from 2015 to 2017; a third review is underway. During these reviews, stakeholders, including state governments, research institutes, and participating companies, convene to discuss and implement revisions to the Model Rule.

Figure 1 shows the trends in emissions from the facilities covered by the RGGI, the emissions cap, and the scheduled auction amount from 2005, before the start of the system, to 2022. Due to the new participation and withdrawal of states, emissions increased and decreased.

Authorities set the emissions cap based on past actual emissions. However, emissions notably decreased from 2005 to 2009, resulting in a significant divergence from the actual emissions once the system began. Consequently, they set a scheduled auction amount that would not exceed the emissions cap. Nevertheless, as Figure 3 illustrates, the actual contracted amount in the auctions from 2010 to 2012 fell below this limit.

Concerning the increase in banking due to this excess supply, in the 2012 system revision, the banked portion of the emission rights possessed by state governments and companies was taken into consideration (the adjustment for banked allowances), and the emissions cap was corrected with a downward adjustment several times from 2014 onward. This adjustment is shown in Figure 1 as the emissions cap under the system (the yellow line) and the post-correction emissions cap (the orange line).

[*] Senior Researcher, Climate Change Group, Climate Change and Energy Efficiency Unit, IEEJ

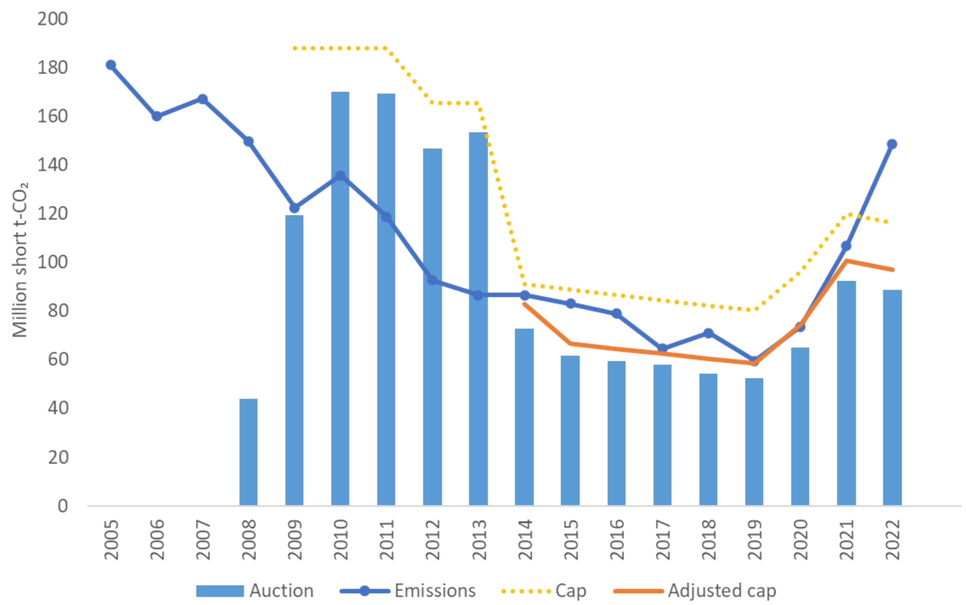


Figure 1: Trends in the emissions from facilities covered by the RGGI, the emissions cap, and the scheduled auction

(Source) RGGI COATS (RGGI CO_2 Allowance Tracking System)

Note 1: The participating states in the RGGI vary over time (as detailed in the Overview of the RGGI System). Since 2022, Pennsylvania has participated, reporting emissions from facilities within the state covered by the system. However, a lawsuit has prevented the implementation of emission rights auctions and any adjustment of the emissions cap in Pennsylvania.

Note 2: In the RGGI, the emissions are all measured in short tons (one t-CO_2 × 0.907 = one short t-CO_2).

2.2. Allocation

As shown in Figure 2, more than 90% of the RGGI consists of sold allocations using auctions, and it is necessary for companies possessing facilities covered by the system to purchase emission rights in the same amount as the emissions. As shown in Figure 3, the auctions are held every quarter, and companies and financial institutions with facilities covered by the system participate. In a recent auction implemented in June 2023, 60% of the bidders were companies possessing facilities covered by the system, and the remaining 40% were financial institutions.[1]

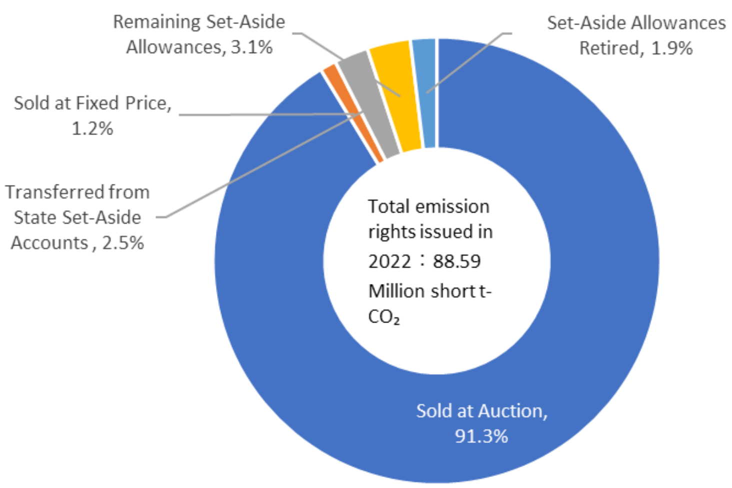


Figure 2: Method of allocation to facilities participating in the RGGI in 2022

(Source) RGGI

Note: This excludes the issuance of emission rights from Pennsylvania, which is currently being disputed in the courts

[1] RGGI (2023) MARKET MONITOR REPORT FOR AUCTION 60
https://www.RGGI.org/sites/default/files/Uploads/Auction-Materials/60/Auction_60_Market_Monitor_Report.pdf

RGGI has set an auction reserve price in its auctions since its inception. Additionally, they introduced the cost containment reserve (CCR) in 2014 and the emissions containment reserve (ECR) in 2021

The CCR releases additional emission rights to the market to curb the trading price in the case that, at the time of the bidding, the market price of the emission rights rises above a predetermined price (refer to the detailed explanation below and the table at the end of this document titled Overview of the RGGI). Annually, RGGI retains 10% of the regional emissions cap as the CCR, supplying it to the market for funding. However, if the market uses this 10% reserve, RGGI will not release additional emission rights, even if the contracted price at subsequent auctions exceeds the CCR trigger price.

On the other hand, the ECR curbs the amount supplied to the market if the price goes below a predetermined level. Retention in the ECR is a maximum of 10% of the emissions cap of the states that have introduced the RGGI (excluding Maine and New Hampshire), and emission rights are transferred to the ECR and cancelled if the price goes below the trigger price.

Note that the CCR and the ECR do not set a price cap on the auction price; they are quantitative measures that release to the market/absorb additional emission rights, and in some cases, the contracted price will go above/below those levels.

Authorities introduced these measures to stabilize the system and prevent the market's emission rights price from reaching unexpectedly high or low levels compared to emissions reduction costs. They determined the price and quantity for triggering these measures by considering emissions trends, model analyses of electricity prices, emissions, macroeconomic factors, consumer impacts, and stakeholder discussions.

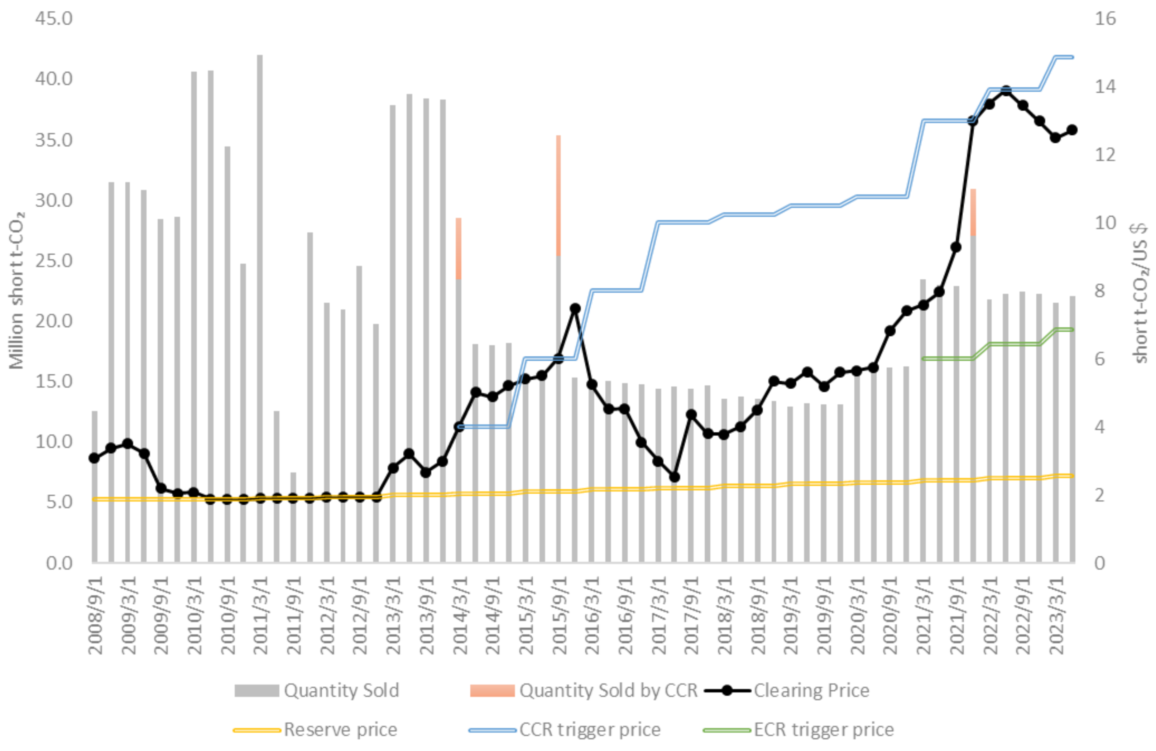


Figure 3: Trends in the contracted amount in auctions, contracted price, and reserve price.

(Source) RGGI

2.3. Offset credits

In the RGGI, using the following offset credits is allowed with 3.3% of the cumulative emissions of the compliance period of three years as the cap.

- Projects allowed under the Model Rule of the RGGI: landfill methane capture, SF_6 reduction projects, afforestation projects, energy conservation in buildings, livestock methane capture.
- Early action offset credits: There is a system for issuing credits to emissions reduction projects carried out before the regulations start, but credits have not been issued.

As of July 2023, there is only one offset credit project registered in RGGI COATS (RGGI CO_2 Allowance Tracking System), which is the registry of the RGGI, and 53,506 short t-CO_2 were issued from 2017 to 2020.

2.4. MRV

Under the RGGI, it is mandatory to utilize the air pollutant emissions (CO_2, NO_x, SO_2) reporting system implemented by the Environmental Protection Agency (EPA) based on federal regulations[2] to report to the RGGI the CO_2 emissions within the emissions reported in that system concerning power plant operating companies. Under these federal regulations, installing the measuring devices necessary to ascertain the emissions of CO_2, etc. in power plants is mandatory, and the results are reported[3] to the EPA each quarter. Furthermore, it is necessary to receive confirmation from an EPA-accredited institution that the measuring devices have been installed and are operating correctly and then apply to the EPA to be accredited. For this reason, emissions based on federal regulations are utilized in the RGGI as emissions using measurement devices and methods that have received the accreditation of the EPA.

Power plant operating companies must surrender emission rights in the same amount as the cumulative emissions of three years in the RGGI. However, they do not surrender the emission rights in the same amount as the cumulative emissions after three years have ended; it is necessary to surrender 50% of the emission rights in the first year and the second year, and after the end of the third year, the final year, to surrender the remaining 200% of the emission rights in order to reach the same amount as the cumulative emissions.

2.5. Relation with other policies

The RGGI is emissions trading based on auctions, and it utilizes the revenue from the auctions to invest in energy conservation. In 2021, US$374 million was invested in the participating states, with 51% invested in energy efficiency enhancement, 13% in funding to lower electricity prices, 13% in promotion of electrification, and 11% in reducing greenhouse gas emissions. According to an estimate[4] by the RGGI, in 2021, it contributed to an annual emissions reduction of 230,000 short t-CO_2 and saved US$94 million on energy bills.

3. Implications for GX ETS

The RGGI is a regional emissions trading system by the northeastern states of the United States that is based on auctions and covers power plants only.

The GX ETS, which will start an emission rights auction covering the electricity sector in FY2033, finds the system design of RGGI a useful reference. RGGI aims to stabilize prices and signal emissions reduction to companies by setting an auction reserve price and establishing a cap and reserve price with quantitative market measures through the CCR and ECR. These strategies offer valuable precedents filled with insights for the design of the GX ETS.

On the other hand, the initial emissions cap set when the system started significantly diverged from actual emissions, leading to adjustments that consider banking in subsequent system revisions. The operational aspects of the system offer many hints, particularly regarding adjustments to align the system with actual emissions and external conditions after its start.

References and literature

1) The Regional Greenhouse Gas Initiative https://www.RGGI.org/
2) US EPA Part 75 Policy and Technical Resources https://www.epa.gov/power-sector/part-75-policy#:~:text=40%20CFR%20Part%2075%20requires,emission%20monitoring%20systems%20(CEMS).

[2] U.S. EPA regulations at 40 CFR Part 75 Continuous Emission Monitoring.
[3] Clean Air Markets Program Data https://campd.epa.gov/
[4] RGGI (2023) The Investment of RGGI Proceeds in 2021 https://www.rggi.org/sites/default/files/Uploads/Proceeds/RGGI_Proceeds_Report_2021.pdf

Appendix: Overview of the RGGI

Overview	System started year	2009
	Period of system	Set every three years from 2009 onward.
	Targets and objectives	In 2017, a target of reducing the total amount of emissions in the facilities covered by the regulations located in the states participating in the RGGI by 30% compared to 2020 was agreed. − First compliance period (2009 to 2011) ➢ 188,076,976 short t-CO_2 (the total amount every year) − Second compliance period (2012 to 2014) ➢ 2012 to 2013: 165,184,246 short t-CO_2 (the total amount every year) ➢ 2014: 82,792,336 short t-CO_2 − Third compliance period (2015 to 2017) ➢ 2015: 66,833,592 short t-CO_2 ➢ 2016: 64,615,467 short t-CO_2 ➢ 2017: 62,452,795 short t-CO_2 − Fourth compliance period (2018 to 2020) ➢ 2018: 60,344,190 short t-CO_2 ➢ 2019: 58,288,301 short t-CO_2 ➢ 2020: 74,283,807 short t-CO_2 − Fifth compliance period (2021 to 2023) ➢ 2021: 100,677,454 short t-CO_2 ➢ 2022: 97,022,454 short t-CO_2 • 2023: 93,367,454 short t-CO_2
	Background	− In December 2005, seven northeastern states of the United States, Delaware, Connecticut, Maine, New Hampshire, New Jersey, New York, and Vermont, agreed to implement an emissions trading system to reduce emissions of greenhouse gases from 2009 and signed a memorandum presenting its basic framework (subsequently, New Jersey withdrew while on the other hand Massachusetts, Rhode Island, and Maryland began to participate). New Jersey began to participate in the RGGI in 2020 and Virginia in 2021, and as a result, 11 states are currently participating in the RGGI. Furthermore, it has been reported that Pennsylvania is also considering participating in the RGGI. On the other hand, there is a possibility that the composition of the participating states will change going forward. For example, the governor of Virginia has expressed an intention to withdraw from the RGGI.
	Penal provisions	− The regulatory authority deducts an emission quota equivalent to three times the shortfall from the compliance accounts of operators who have failed to comply. − If the emission quotas possessed by facilities covered by the regulations are less than the necessary amount, they must promptly transfer the emission quota shortfall to their compliance account. The regulatory authority of each state is allowed to establish fines, etc., concerning facilities covered by the regulations that have failed to comply.
Target	Unit	Operator
	Main requirements for eligibility	− Only the electricity sector (12 states, 318 facilities, 967 units) − Power plants with a capacity of 25MW or greater satisfy the following conditions. (*Equivalent to approximately 85,000 tons in the case of assuming an operating rate of 80% and using the average intensity of all power sources in the United States) ➢ In the case of power plants that commenced operating on or before December 31, 2004, in which 50% or more of the annual heat input is fossil fuels. ➢ In the case of power plants, which commenced operating on or after January 1, 2005, power plants in which 5% or more of the annual heat input is fossil fuels.
	Covered gas	CO_2

	Coverage	Actual emissions in 2022: 148.58 million short t-CO_2 Amounts allocated in 2022: 97 million short t-CO_2 − 2009 to 2011: ten states (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont) − 2012 to 2019: nine states (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, Vermont) − 2020: ten states (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont) − 2021 onward: 11 states (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont, Virginia) 2022 onward: 12 states (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont, Virginia, Pennsylvania)
Allocation method	Allocation method	− Free allocation: the participating states are allowed to implement both the free and sold (bidding) distribution methods, but currently, all participating states are implementing sold allocation only. − Bidding system: bidding is implemented every quarter. An auction reserve price is set, which was US$1.86 in 2008 and US$2 in 2014 and has been raised 2.5% yearly since then. As of 2023, it is US$2.56.
Flexibility measures	Banking and borrowing	Carryover is allowed in the case that a surplus emission quota has occurred. Borrowing is not allowed.
	Utilization of other credits	− Use is allowed within the scope of 3.3% of the emissions of the compliance period. ➢ Projects allowed by the Model Rule: landfill gas, SF_6 reduction projects, afforestation projects, energy conservation in buildings, livestock methane capture. ➢ Early action offset credits: a system for issuing credits to emissions reduction projects carried out before the start of the regulations (actually zero).
	Countermeasures against rapid rises in the price (quantitative measures)	[Price cap and market release] − Additional emission rights are released to the market from the cost containment reserve (CCR) in order to curb the trading price in the case that, at the time of the bidding, the market price of the emission rights rises above a predetermined base price. Ten percent of the emissions cap every year for the region overall is retained as the CCR. − Base price: 2014: US$4, 2015: US$6, 2016: US$8, 2017: US$10, 2018 onward: rose 2.5% each year, from 2021 onward: raised 7% every year from US$13. [Reserve price and release retention] • If the price goes below a predetermined level, the emission quota is retained in the emission contamination reserve (ECR), the amount supplied to the market is restricted, and the retained portion is canceled. Retention in the ECR is a maximum of 10% of the emissions cap of the states that have introduced the RGGI (excluding Maine and New Hampshire).
Market	Price	The auction contracted price of the RGGI's CO_2 allowance in the second quarter of 2022 was US$13
	Trading volume	The trading volume on exchanges was 151 million short t-CO_2 (fourth quarter of 2022)
	Trading format and exchange	Operators, financial institutions, etc., covered by the regulations participate in the trading. Emissions are traded on the commodity exchange ICE, and exchange trading is implemented outside auctions.

New Zealand Emissions Trading Scheme (NZ ETS)

Tohru Shimizu*

1. Overview of climate change policies

In New Zealand, led by the Climate Change Response Act, the Energy Efficiency and Conservation Act, which encourages energy efficiency, energy conservation, and the use of renewable energy, and the Resource Management Act, which encourages the sustainable management of resources, play an important role.

In October 2016, New Zealand announced its greenhouse gas emissions reduction targets under the Paris Agreement. In the September 2017 general election, the government changed from the National Party to the Labour Party in coalition with the Green Party, establishing the Climate Change Response (Zero Carbon) Amendment Act 2019 in November 2019. The Act sets the long-term targets for 2050 and the emissions reduction amount for each greenhouse gas by 2030. Furthermore, the Act established the Climate Change Commission[1] to provide specialized advance and monitor the achievement of long-term targets.

2. System design of emissions trading

2.1. An overall of the system

Since 2008, New Zealand has implemented the Emissions Trading Scheme (NZ ETS[2]) as a critical policy to reduce emissions. Initially covering only the forestry sector, this scheme encompasses all greenhouse gases listed in the Kyoto Protocol. The NZ ETS expanded gradually, including the energy, industrial processes, and transport sectors in 2010, followed by the waste and synthetic gases sectors in 2013. From 2025, the scheme will also incorporate the agriculture sector, the largest emissions source, which previously only had reporting obligations.

Under the revision of the scheme in recent years, the NZ ETS has been transitioning to a scheme that stipulates emissions caps like the EU. From 2008 to the middle of 2015, the NZ ETS adopted a scheme linked to the international carbon market[3] under the Kyoto Protocol and sold fixed-price emission units (NZUs) without limits and no caps for the entire country. Subsequently, the government made several revisions based on experts' opinions, culminating in the June 2020 enactment of the Climate Change Response (Emissions Trading Reform) Amendment Act 2020[4] was established. NZ Government set the cap of the NZ ETS based on the carbon budget, which harmonizes with the greenhouse gas emissions reduction targets and long-term targets. In 2021, alongside the start of NZUs auctions, the government implemented a series of reforms to the scheme. These included abolishing the previous fixed price option[5] and introducing the Cost Containment Reserve (CCR) to maintain a price cap. Moreover, the government firmly established the policy to include greenhouse gases from the agriculture sector, New Zealand's largest source of emissions, in the scheme starting from 2025.

Figure 1 shows emissions from the target sectors since the scheme's start. The agriculture sector, on which there are no obligations in the system, accounts for approximately 50% of the total emissions, and the percentage of industrial processes within the remaining emissions is negligible. Fixed emissions sources (stationary energy) consist of mining, imports, and consumption of fossil fuels, and the suppliers of fossil fuels (liquid fossil fuel) are about 40%. It is mandatory for the forestry sector, covered by the scheme from the start in 2008, to make up the difference between the amount of absorption due to

* Senior Researcher, Climate Change Group, Climate Change and Energy Efficiency Unit, IEEJ

1 https://www.climatecommission.govt.nz/

2 Currently, a revision of the NZ ETS is under way and public consultations were implemented until August 11, 2023. Going forward, New Zealand plans to revise the scheme taking into account the results of the public consultations, so there is a possibility that this paper will not match the final scheme revision, although it is partially reflected. Review of the New Zealand Emissions Trading Scheme https://consult.environment.govt.nz/climate/nzets-review/

3 The available international credits were the ERU (Emission Reduction Unit) using joint implementation (JI), the RMU (Removal Unit) which is the increase in absorption due to afforestation and reforestation, etc., and the CER (Certified Emission Reduction) of the clean development mechanism (CDM).

4 https://legislation.govt.nz/act/public/2020/0022/latest/whole.html

5 From the beginning of the scheme the government was selling emission rights to the covered operators at a fixed price in order to curb soaring emission rights prices. Initially, they were sold at NZ\$25/t-CO_2e, and in 2020 the price was raised to NZ\$35/t-CO_2e. This functioned as a de facto price cap on the prices of the available emission rights (NZUs) and offset credits.

afforestation and the increase in emissions due to felling. This situation increased emissions from more extensive felling between 2012 and 2014. However, in other years, significant absorption has translated into a substantial number of credits.

Figure 2 shows the surrender of NZU and offset credits. Operators used CERs and ERUs extensively as international credits until mid-2015, annually surrendering many to fulfill their obligations. From 2015 onwards, they primarily used forestry emission units (Forestry NZUs), other NZUs, and the fixed price option.

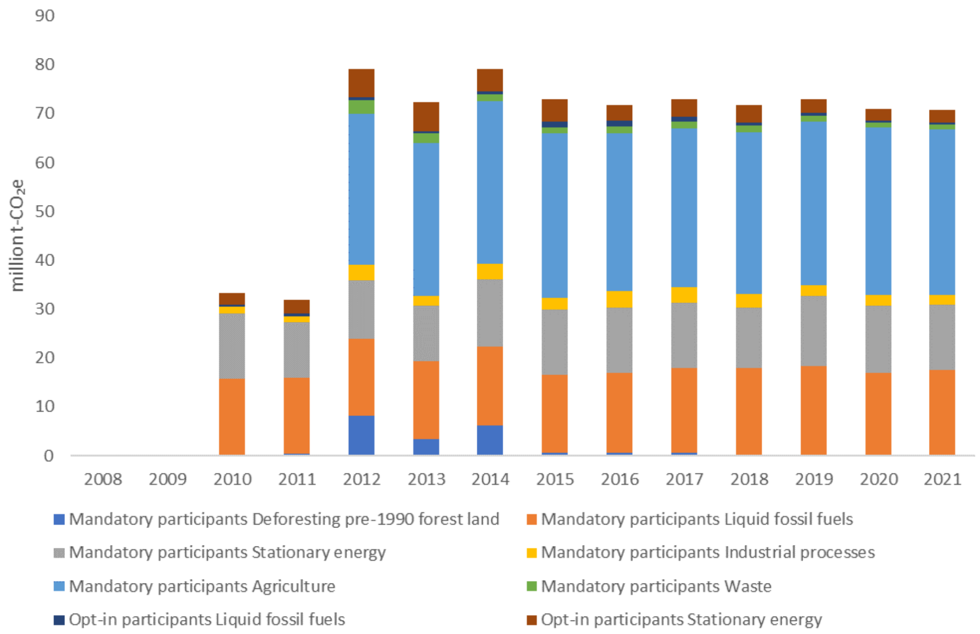


Figure 1: Trends NZ ETS covered emissions

(Source) the Environmental Protection Authority, "ETS Participant Emissions" (October 2022)

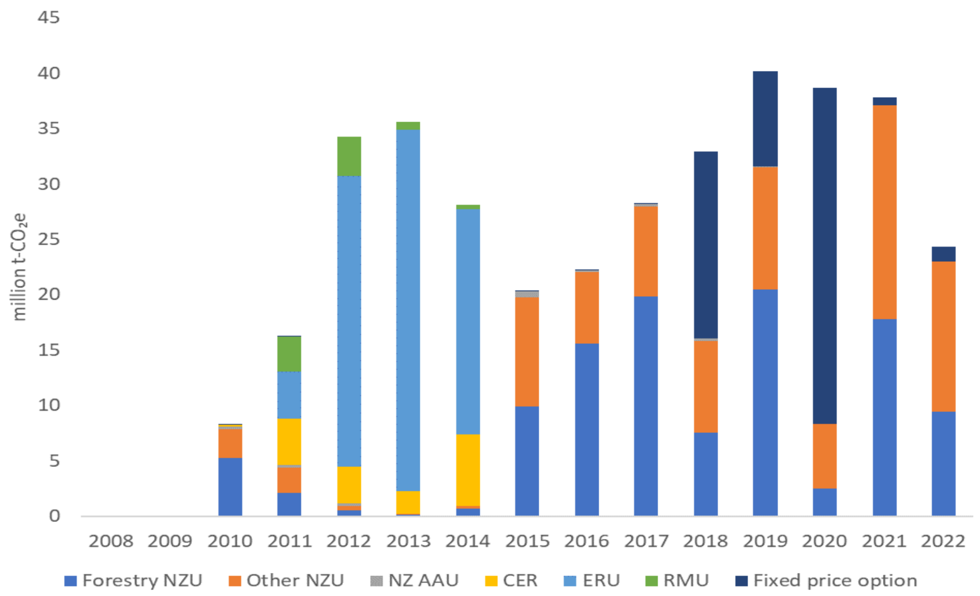


Figure 2: Trends of emission rights and offset credits in NZ ETS

(Source) The Environmental Protection Authority, "ETS Unit Movement Report"

On the other hand, NZUs issued in the past have built up a large surplus (it is called a stockpile). As shown in Figure 3, according to the estimate of the NZ government, 151 million t-CO$_2$e remained in the accounts of NZ ETS participants as of June 2022. The background is that banking of NZUs is allowed in the NZ ETS, and use deadlines, such as in other ETSs, have not been set.

Another cause is that, as shown in Figure 2, from 2012 to 2014, many ERUs were surrendered to comply with the obligations, and NZUs distributed using free allocation were banked in the operators' accounts. The government began considering withdrawal from the offset credit system based on the future Kyoto Protocol in 2012, spurring the stockpiling.

Furthermore, the emission units acquired using the fixed price option from 2018 to 2020 have been amortized and, in the context of ongoing discussions of a scheme revision which would restrict the amount of supply of future NZUs, this has been one of the factors behind many operators selecting the banking of NZUs here as well. In the future, the distribution of NZUs using auctions is planned, but emission rights prices fluctuate due to various factors, so risk avoidance by keeping NZUs close at hand became an objective.

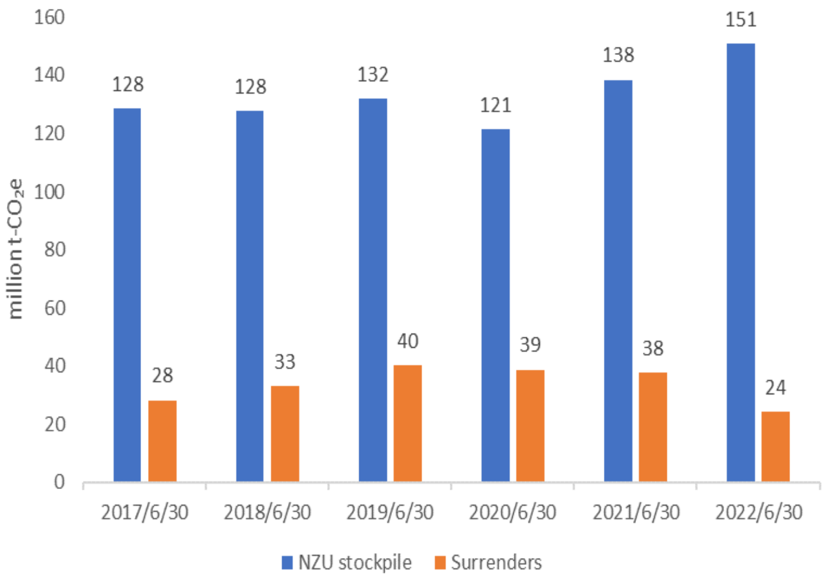


Figure 3: Trends in NZ ETS surplus emission amounts and surrenders of emission rights/offset

(Source) the Environmental Protection Authority, "Privately Held Units" and "ETS Unit Movement Report"

2.2. Allocation

The NZ ETS has gradually reduced the free allocation from when the scheme was initially started and is advancing the transition to sold allocations using auctions.

When the scheme started in 2008, the government provided a one-off free allocation to owners of forests planted before 1990. From 2010, for industrial sectors, to mitigate impacts on international competition and cost burdens, the government used the average CO_2 intensity[6] from 2006 to 2008 in New Zealand as a benchmark (allocative baseline). It distributed 60% of medium emission intensity[7] (800 to less than 1,600 t-CO_2e/million NZ$) and 90% of high emission intensity (at least 1,600 t-CO_2e/million NZ$) as free allocations. Initially, a plan was to decrease these free allocations gradually, but the 2012 revision retracted this. In the 2020 revision, the government reduced free allocations to industrial sectors by 1% annually from 2021 to 2030. Sectors not covered by these free allocations sold NZU using the fixed-price option

The 2020 revision transformed the scheme based on free allocations to auctions. This revision introduced the cost containment reserve (CCR) and a confidential reserve price, in addition to maintaining the previous reserve (floor) price.

The CCR aims to curb rapid rises in the price of emission units by establishing a fixed upper limit to the auction's clearing price and supplying the emission units possessed by the government to the market if the price goes higher than that level. The

[6] The amount of CO_2 emissions when calculating the benchmark of the CO_2 intensity is the sum of the amount of direct emissions and the amount of indirect emissions (the electricity emission factor is 0.537 t-CO_2e/MWh).

[7] Amount of emissions per net sales. 1NZ$ = 87 yen (August 2023).

emission units the government possesses as the CCR are in the form that adds to the emissions cap and differs from the emission units provided to ordinary auctions. If the CCR is triggered, it is designed to ensure that the NZ ETS emissions cap and the NZ ETS emissions amount substantially match by securing emission units through domestic emissions reductions and overseas offset credits following the amount sold.

The government sets the confidential reserve price independently from the former reserve price, keeping it undisclosed before and after the bidding. Regulations mandate that the Minister for Climate Change decides[8] the confidential reserve price level before each auction, considering the market price of emission units. This design aims to align the auction prices with those in secondary markets, preventing significant divergence.

Figure 4 shows the clearing prices of the emission units auctions started in 2021, the trigger prices of the CCR, and the reserve prices. Furthermore, the government decided[9] that starting from December 2023, the trigger price of the CCR will be divided into two tiers, and the reserve price will also rise. This revision is based on a recommendation of the Climate Change Committee and aims to induce the level of emission rights prices necessary for the achievement of the carbon-neutral target in 2050.

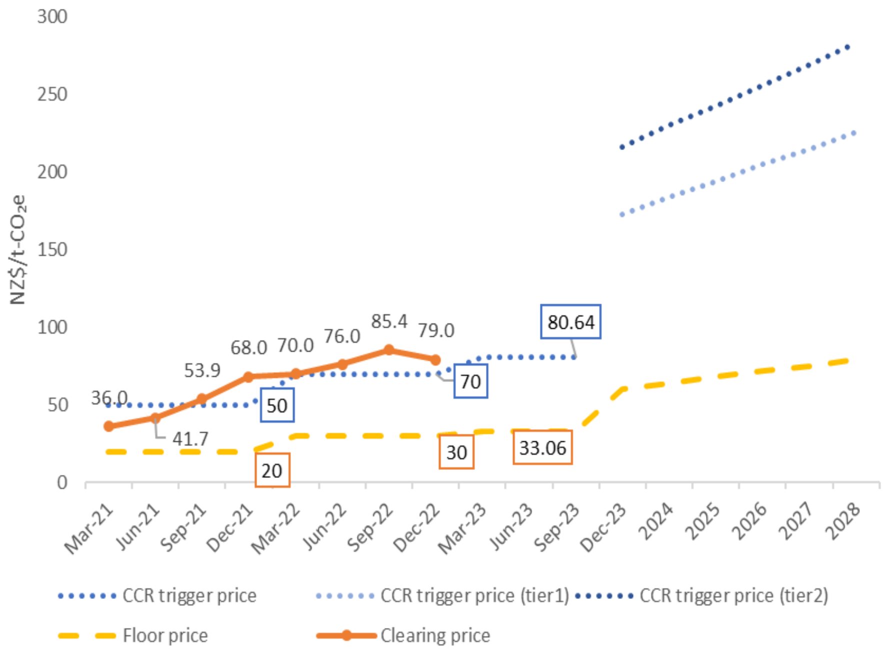


Figure 4: NZ ETS auction contracted prices, price caps, and reserve prices

(Source) the auction contracted prices based on the New Zealand ETS Auctions website and the price caps and reserve prices based on New Zealand government materials

2.3. Offset credits

As shown in Figure 2, until 2015, it was possible to use offset credits based on the Kyoto Protocol, but as of 2023, the transfer of offset credits from overseas is not allowed, and the scheme is confined to New Zealand only.

Furthermore, the Permanent Forest Sink Initiative (PFSI), which until now has issued credits using afforestation from 1989 onward as emission units (Forestry NZUs) of the NZ ETS, was introduced in 2006, but due to the 2020 NZ ETS scheme revision, it has been integrated into the NZ ETS as permanent forestry from 2023.

[8] Climate Change (Auctions, Limits, and Price Controls for Units) Regulations 2020

[9] Annual updates to the NZ ETS limits and price control settings for units 2023 https://consult.environment.govt.nz/climate/annual-updates-nz-ets-unit-settings-2023/

2.4. MRV

Operators must report their emissions for January to December of the previous year by March 31 every year and submit the same amount of emission units to the register by May 31.

A default emission factor calculated by the government based on the average emissions of each sector is provided for the emissions calculation. Third-person verification is not mandatory, but ETS operators must store the related materials used in their emissions reports for the past seven years, and the government has the authority to audit the materials as necessary. Each year, the Environmental Protection Authority (NZ EPA) randomly selects operators to conduct internal and third-person verifications of the accuracy of their applications for free allocations and emissions reports. The regulations include penalties such as public disclosure of non-compliant companies and fines for failures to surrender necessary emission units or inaccuracies in emissions reports. These penalties underwent strengthening in the 2020 revision.

Operators mining or burning fossil fuels can use a unique emission factor. When using a unique emission factor, the participants must calculate it themselves, receive third-person verification, and then apply it to the government by January 31 every year.

2.5. Relation with other policies

The revenue from the emission rights auctions begun in 2021 was transferred to the Climate Emergency Response Fund (worth NZ$45 billion) established in the same year and is being utilized for emissions reduction and adaptation measures.

The auction revenue came to NZ$1.3 billion in 2021 and NZ$2 billion in 2022, but in 2023, there were no bidders, so there was no revenue.

3. Implications for GX ETS

The NZ ETS, which started in 2008, is an ETS that includes absorption activities using afforestation in the scheme and has characteristics different from the ETSs of other countries and regions based on the industrial and power generation sectors. Furthermore, until 2015, it was a scheme that mainly made international offset credits usable. However, due to the recent scheme revisions, including the transition to auctions and the reduction of free allocations in stages, it has again been positioned as a significant tool for achieving carbon neutrality by 2050.

These experiences can provide implications for the detailed scheme design of the GX ETS from three perspectives.

Firstly, the ETS covers the forest sink from afforestation, providing a reference for future emissions reduction and atmospheric removal activities in the GX ETS. Domestically, the existing methodology for forestry in the J-Credit Scheme is applicable and could be instrumental in shaping the handling of the future ETS.

Next is the transition from a scheme centered on offset credits to auctions. The background is the international transition trend from the Kyoto Protocol to the Paris Agreement. However, the change to a scheme that restricts the use of offset credits as a national scheme sells emission units at a fixed price and transitions to auctions serves as a reference for one method of transitioning to emission rights auctions for power generation operators from FY2033 as planned by the GX ETS.

Finally, the characteristic cap and reserve price are set in the NZ ETS. It is planned that the GX ETS will also set upper and lower price corridors to encourage emissions reductions, and knowing how those levels were set in NZ ETS is helpful in discussions of the scheme design going forward.

References

1) Leining, Catherine (2021). "Future Options for Industrial Free Allocation in the NZ ETS." Motu Working Paper 21-13. Wellington: Motu Economic and Public Policy Research https://motu-www.motu.org.nz/wpapers/21_13.pdf
2) Leining, Catherine (2022) "A Guide to the New Zealand Emissions Trading Scheme: 2022 Update" Motu Economic and Public Policy Research https://www.motu.nz/assets/Documents/our-research/environment/climate-change-mitigation/emissions-trading/A-Guide-to-the-New-Zealand-Emissions-Trading-System-2022-Update-Motu-Research.pdf
3) Climate Change Response Act 2002 https://legislation.govt.nz/act/public/2002/0040/latest/whole.html
4) Climate Change (Eligible Industrial Activities) Regulations 2010 https://www.legislation.govt.nz/regulation/public/2010/0189/latest/whole.html#DLM3075101
5) Climate Change (Auctions, Limits, and Price Controls for Units) Regulations 2020 https://www.legislation.govt.nz/regulation/public/2020/0264/latest/whole.html#LMS463952
6) Environmental Protection Authority "Emissions Trading Scheme" https://www.epa.govt.nz/industry-areas/emissions-trading-scheme/
7) Ministry for the Environment "New Zealand Emissions Trading Scheme" https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/ets/?limit_27838=9&limit_27365=8
8) Ministry for the Environment "Annual updates to the NZ ETS limits and price control settings for units 2023" https://consult.environment.govt.nz/climate/annual-updates-nz-ets-unit-settings-2023/
9) NZ ETS Auctions https://www.etsauctions.govt.nz/
10) NZ Treasury "The Climate Emergency Response Fund" https://www.treasury.govt.nz/information-and-services/nz-economy/climate-change/climate-emergency-response-fund

Appendix: Overview of the New Zealand Emissions Trading Scheme (NZ ETS)

Overview	Name	New Zealand Emissions Trading Scheme
	Legal basis (name of the law)	The Climate Change Response Act 2002 and the related laws
	Overview	The regulations cover this scheme under which forestry, energy (fixed emissions sources), industrial processes, transport (liquid fossil fuels), etc. The obligation to report emissions is imposed on all sectors, including agriculture.
	Supervisory agencies	Ministry for the Environment, Environmental Protection Authority, Ministry for Primary Industries (about forestry)
	scheme started	January 2008
	Period covered by the trading	Regarding the forestry sector, five years has been established (selection of one year is also allowed), but the period is one year for the other sectors covered by the regulations.
Target	Unit	Each owner and operator of forestry
	Main requirements for eligibility	2008 onward: forestry 2010 onward: energy (fixed emissions sources), industrial processes (iron and steel, aluminum, etc.), transport (liquid fossil fuels) 2013 onward: waste, synthetic gases
	Covered gases	CO_2, CH_4, N_2O, SF_6, HFCs, PFCs
	Emission point (direct or indirect)	Direct emissions
	Coverage	50% of all emissions[10]
	Handling of supplied/purchased heat	-
Target-setting method	Allocation method	● Forestry ➢ A one-time-only free allocation was distributed to owners of forestry from before 1990. ➢ Possessors of forestry registered after 1989 are allocated an emission quota by participating voluntarily. ● Industrial processes ➢ A free allocation is distributed to maintain international competitiveness concerning industrial and trade activities with a high emission intensity. ➢ A free allocation ratio of 90% or 60% of the baseline is applied based on the emission intensity and the content of the trade activities. It has been decided to reduce the free allocation amount in stages from 2021. ● Energy/transport/waste ➢ Sold allocations using auctions
Flexibility measures	Banking and borrowing	For banking, excluding the emission quota purchased using the fixed price option is possible. For borrowing, this is not allowed.
	Utilization of other credits	Until June 1, 2015, international credits (CERs, ERUs, RMUs) were allowed without restrictions, but their use has not been allowed since then.
	Price countermeasures (setting of a price cap and reserve price, the market surveillance mechanism)	A reserve price was introduced when the scheme started. 2020: the level of the fixed price option was revised from NZ$25/t-$CO_2$e to NZ$35/t-CO2e 2021: a new price cap (cost containment reserve) and confidential reserve price were introduced instead of the fixed price option 2023: the levels of the price cap and reserve price were revised

10 https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/ets/coverage-of-the-nz-ets/

	Burden mitigation and leakage countermeasures	Amortization of an emission quota of one t-CO_2e concerning emissions of two t-CO_2e in the non-forestry sector was allowed, but the burden mitigation measures ended as of January 2019
	Prices (trading price and auction price), auction volume, market trading volume, breakdown of the market trading participants)	The average price in the trading market in 2022 was NZ$77.6/t-$CO_2$e.
	Distribution volume	ND
	Trading format	Exchange trading and negotiated trading
Market	Links to other systems (status of consideration)	New Zealand is considering but has not realized collaboration with the emissions trading schemes of other countries.
	Register/MRV method	A register managed by the government
	Background to introduction	Initially, a carbon tax was planned, but support for introducing a carbon tax could not be obtained from the citizens. Finally, the emissions trading scheme was introduced in 2008. The agriculture sector, New Zealand's largest source of emissions, was not covered by the regulations, and only an obligation to report emissions was imposed on that sector
	Effect (emissions reduction effect)	The evaluation of the government is that companies have purchased a large number of international credits through the emissions trading scheme and, as a result, have contributed to the achievement of New Zealand's targets under the Kyoto Protocol, while on the other hand, it has also evaluated that the extent to which this has contributed to the reduction of emissions from the BAU level is unclear.
Reporting method		Generally, reports are to be made by March 31 of the year following the covered year. If the default value is used, third-person verification is unnecessary.
Penal provisions	Compliance cost (on the companies' side), administrative cost (on the regulatory authority's side)	In the case that compliance cannot be achieved, there is a penalty of three times the market price per ton for the excess amount. There is a fine of a maximum of NZ$50,000 for false reports, etc.
Effect, recent trends, other	Uses for revenue	The auction proceeds are utilized as a Climate Emergency Response Fund
	Recent trends	The cap and reserve price from 2023 onward will be decided and applied in stages from December.

Output Based Pricing System (OBPS) of the Canadian Federal Government

Kiyoshi Komatsu *, Tohru Shimizu **

1. Overview of climate change policies

It is necessary to note three points regarding the climate change policies of Canada: the uneven distribution of energy resources, the two major political parties that advocate diametrically opposed climate change policies, and the strength of the authority of the provincial and territorial governments.

Firstly, looking at the federal level, there are abundant fossil fuels such as shale gas, etc. and abundant renewable energy such as hydropower, etc., but the amount of these available differs greatly depending on the province and territory and this is an element which influences the policies of Canada overall.

Next, under the two-party system in Canada the conservative parties and the Liberal Party take diametrically-opposed policies every time there is a change of administration. For example, preparations for the introduction of emissions trading (ETS) were advanced under the Liberal Party administration in the early 2000s, but the Harper administration of the Conservative Party, which won the general election in 2006, canceled the introduction of the ETS.

Subsequently, in 2011 the administration announced Canada's withdrawal from the Kyoto Protocol and officially withdrew in the following year, but in the 2015 general election the Liberal Party won, the Trudeau administration was inaugurated, and consideration of the introduction of carbon pricing at the federal level was advanced. Then in June 2018, the Greenhouse Gas Pollution Pricing Act (GGPPA) was passed in the parliament, and the introduction of carbon pricing at the federal level was decided.

On the other hand, Saskatchewan, which has taken the position of opposing the introduction of carbon pricing, is dependent on coal-fired power plants, and has expressed concerns about the large economic burden due to carbon pricing. Finally, the Supreme Court recognized the position of the federal government and the GGPPA was implemented.

The GGPPA is broadly comprised of two pillars. These are a fuel charge with the transport sector, etc. covered by the regulations, and an ETS called the Output Based Pricing System (OBPS) targeting the industry sector. However, in Canada the authority of the provincial and territorial governments is strong and implementation of the provinces' and territories' own carbon pricing is allowed as long as the provinces and territories satisfy the predetermined standards stipulated by the federal government. For example, before the inauguration of the Trudeau administration, Quebec and British Columbia had introduced their own carbon tax or ETS.

In this paper, we discuss the current basic principles of carbon pricing for the Canadian federal government overall and the OBPS covering the industry sector introduced based on those principles.

2. Overall picture of the carbon pricing system

The Pan-Canadian Approach to Pricing Carbon Pollution formulated basic principles on carbon pricing applied by the federal government of Canada, as shown in Table 1, in 2016. Based on the principles, the GGPPA bill that establishes more detailed systems was submitted to the federal parliament in January 2018, and it passed in the parliament in June of the same year. A principle in the Approach requires that the federal government respect existing climate change policies in the provincial and territorial governments, and when the provincial and territorial governments have already implemented the policies that meet the requirements (benchmarks) in the Approach, the federal government must allow them to continue the policies under the GGPPA. On the other side, where the province and territorial government fail to meet the requirement in the Approach (in the case that they have a system but it does not satisfy the standards or in the case that they do not have a system at all), federal government apply federal backstop (a charge and/or OBPS) to these provinces and territories.

* Executive Analyst, Climate Change Group, Climate Change and Energy Efficiency Unit, IEEJ
** Senior Researcher, Climate Change Group, Climate Change and Energy Efficiency Unit, IEEJ

Table 1: Overview of Pan-Canadian Carbon Pricing

Principles	・ Carbon pricing should be implemented flexibly recognizing the existing initiatives of each province and territory. ・ Carbon pricing should cover a broad set of economic activities. ・ Carbon pricing should be introduced in a timely manner which keeps the negative impact on assets to a minimum and maximizes the amount of emissions reduction. ・ Carbon price increases should occur in a predictable and gradual way to limit economic impacts ・ Carbon pricing policies should minimize international competitiveness impacts and carbon leakage. ・ The proceeds shall be utilized to avoid a disproportionate burden on socially vulnerable people such as the poor and indigenous peoples, etc.
Major benchmarks	▪ Carbon pricing will be applied to common sectors covered by the regulations (it is necessary to cover nearly all of the economic sectors). ▪ An explicit price setting system (carbon tax) or ETS should be introduced. ▪ Carbon tax: in 2018 the price per t-CO_2e should be set at CA$10 (CA$1 = 107.6 yen), subsequently, it should be raised by CA$10 per year to CA$50 in 2022. ▪ In the case of an ETS: targets for 2030 should be equal to or greater than those of the federal government overall, and should be at a level at which it is possible to achieve an amount of emissions reduction equal to the carbon tax by 2022.

(Source) Canadian government, Pan-Canadian Approach to Pricing Carbon Pollution (October 3, 2016 announcement) [1]

After the GGPPA bill was passed, the federal government asked each provincial and territorial government to submit a carbon pricing plan by September 1, 2018, and in October it evaluated the carbon pricing implemented in each province and territory. As a result, the provinces and territories to which federal backstop would be applied from January 2019 were decided. The status of the application for each province and territory is shown in Table 2.

In British Columbia and Quebec, which had introduced carbon pricing before the federal government, application of the provinces' own systems was allowed, while Saskatchewan, Ontario, Alberta opposed carbon pricing and fought with the federal government all the way to the Supreme Court, but in the end, the federal backstop was applied to them. The other provinces and territories of Prince Edward Island, Yukon, and Nunavut chose to apply the federal backstop. Furthermore, the method of application differs depending on the province and territory, and there are various cases on the application of the federal backstop; cases in which both the fuel charge and the OPBS are applied and cases in which only one of them is applied.

[1] Refer to the following website. https://www.canada.ca/en/environment-climate-change/news/2016/10/canadian-approach-pricing-carbon-pollution.html

Table 2: Provinces and territories applied Federal backstop
(Provinces and Territories to which the Fuel Charge and OPBS are Applied)

Provinces and territories to which the fuel charge is applied		Provinces and territories to which the OPBS is applied	
When application commenced	Province or territory	When application commenced	Province or territory
April 1, 2019	Ontario New Brunswick[2] Manitoba Saskatchewan	January 1,2019	Ontario (excluded from application from January 2022) New Brunswick (excluded from application from January 2021) Prince Edward Island Manitoba Saskatchewan (excluded from application from January 2023)
July 1, 2019	Yukon Nunavut	July 1, 2019	Yukon Nunavut
January 1, 2020	Alberta		

(Source) Prepared by The Institute of Energy Economics, Japan (IEEJ) based on GREENHOUSE GAS POLLUTION PRICING ACT ANNUAL REPORT FOR 2021

Moreover, there are provinces to which the OBPS was applied initially, but they were subsequently excluded from its application (Ontario, New Brunswick, Saskatchewan). These provinces each introduced their own ETS systems covering the industry sector in each jurisdiction, and the federal government recognized that these systems meet requirements, so the OBPS has no longer applied to them.

3. ETS system design

3.1. Outline of system

The OBPS makes it mandatory[3] for the facilities covered by the regulations to calculate the emissions limit by multiplying the production volume every year by the Output Based Standard (OBS). Then, in the case that the actual emissions exceed these emissions limits, it is mandatory[4] to pay a charge or submit offset credits which are allowed for the use of compliance in order to compensate for the excess amount. On compensation, the use of offset credits has some restrictions; regulated facilities are allowed to use the offset credits for a maximum of 75% of the excess emissions. For that reason, it is necessary to pay the charge of at least 25%. The charge will rise every year. In 2019, at the beginning of the year of OPBS, the charge was at CA$20 per ton, and in the subsequent years the charge rose by CA$10 each year until 2022, but from 2023 onward this changed to CA$15 every year.

On the other hand, in the case that the emissions fall below the emissions cap calculated using the above method, surplus credits that can be sold to other companies are issued by the government.

[2] Regarding New Brunswick, the province's own fuel charge was implemented from April 1, 2020, so application of the federal backstop was stopped.
[3] Refer to sections 36 to 38 of the Output-Based Pricing System Regulations (SOR/2019-266).
https://laws-lois.justice.gc.ca/eng/regulations/SOR-2019-266/page-5.html#h-1184433
[4] Refer to section 54 through section 69 of the previously cited materials (Note 3).
https://laws-lois.justice.gc.ca/eng/regulations/SOR-2019-266/page-8.html#docCont

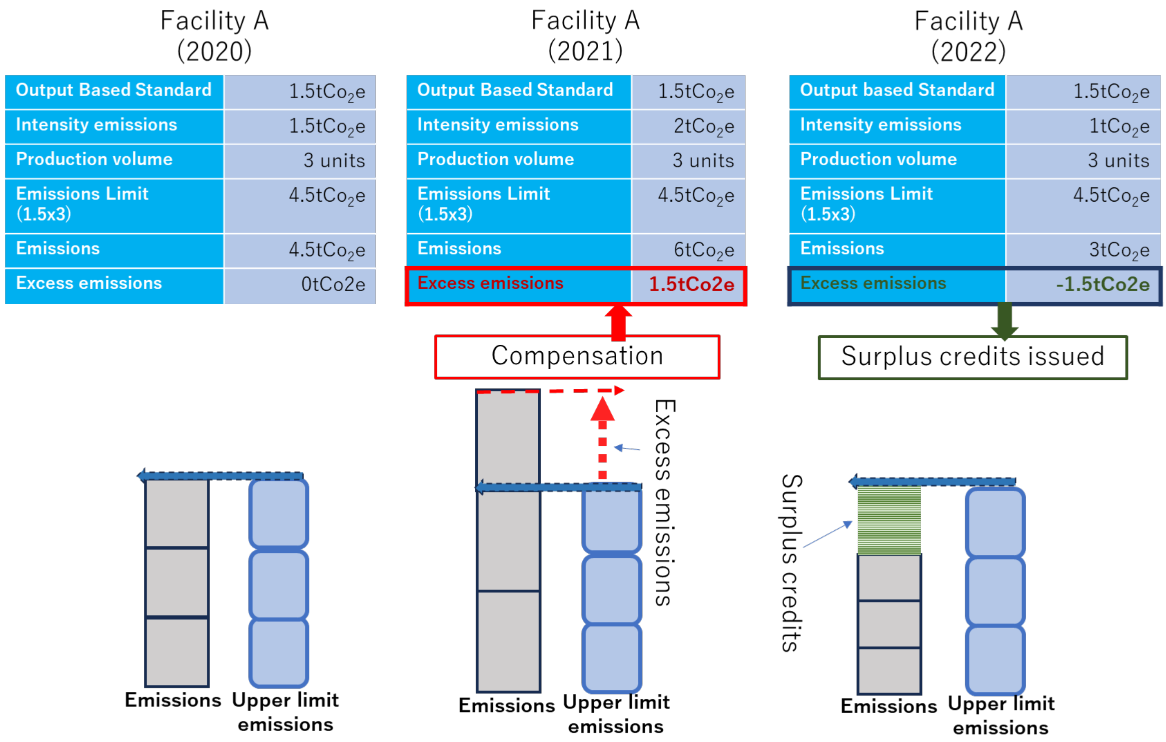


Figure 1: Setting of emissions limit and issuance of surplus credits in the OBPS

(Source) Prepared by The Institute of Energy Economics, Japan (IEEJ) based on various materials

The OPBS has unique characteristics compared to the systems of other countries. Firstly, there is the fact that it does not regulate the total amount of emissions; it regulates based on CO_2 intensity. Table 3 shows the status of emissions in the regulated facilities by the OPBS. In 2019 total emissions were 62.29 million t-CO_2e, with excess emissions of 8.42 million t-CO_2e, and in 2020 total emissions decreased to 56.50 million t-CO_2e, but excess emissions increased to 8.52 million t-CO_2e. It is likely that in this period production volume decreased and therefore total emissions also decreased, but CO_2 intensity did not improve, so excess emissions increased.

Table 3: OPBS Implementation Status [5]

Year	Total emissions reported (CO_2e Mt)	Excess emissions (CO_2e Mt)	Surplus credits issued (CO_2e Mt)	Compensation measures	
				Charge payment (CO_2e Mt)	Surplus credits submitted (CO_2e Mt)
2019	62.29	8.429	0.909	8.180 (97%)	0.249 (3%)
2020	56.5	8.526	1.102	7.786 (91%)	0.741 (9%)

(Source) Prepared by The Institute of Energy Economics, Japan (IEEJ) based on the Greenhouse Gas Pollution Pricing Act: Annual report for 2021

The other point is that the OPBS does not distribute in advance the emission quota to the facilities covered by the regulations; only surplus credits are issued in the case that the emissions of the regulated facilities fall below the emissions limit. As shown in Table 3, surplus credits were issued in 2019 and 2020. It is highly likely that they were used in compensation for excess emissions.

5 Refer to the Greenhouse Gas Pollution Pricing Act: Annual report for 2021.
https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/greenhouse-gas-annual-report-2021.html#toc23

Furthermore, it is possible that there could be some transactions of surplus credits among companies, but there is no publicly released information about it. The regulated facilities could transact surplus credits with negotiating others as the OTC transactions, and in this type, there is no publicly available information on price and volumes.

3.2. Allocation methods

In the OPBS, emission quotas are never distributed from the regulatory authority, free or auction. In the case that emissions reported from the regulated facilities fall below the emissions limit, the Minister of Environment and Climate Change of the federal government issues[6] surplus credits with respect to the difference from the emissions limit.

Regarding the CO_2 intensity emissions standards necessary for calculating the emissions limit, in 2018 the Canadian federal government presented[7] the method of calculating the CO_2 intensity, the Output Based Standard(OBS) in each industry sector or facility explaining the basic approach of the OBPS. According to the explanation, the OBS is developed by multiplying emissions intensity in each sector by an emissions reduction factor. The emissions reduction factor is determined for each sector by considering situations in the sector concerned, in particular international competition. Based on this approach, OBS for industry sectors, business types, and products were provided in the OBPS.[8]

For industrial sectors facing international competition, OBS is calculated using modified emissions reduction factors. For cement, production of steel, lime, nitrogen fertilizer, a factor of 90% is applied and, a factor of 95% is applied to white cement, dolomitic lime, specialty lime, production of steel in an electric arc furnace. For other sectors, an emissions reduction factor of 80% is applied.

In the above original proposal in 2018, the Canadian federal government proposed[9] CO_2 intensity emissions standards calculated by multiplying Canada's production-weighted national average of CO_2 intensity by an emissions reduction factor of 70%. However, the original proposal was adjusted taking into account a variety of factors (the treatment of facilities with the smallest CO_2 intensity, the distribution of CO_2 intensity within sectors, sectors facing international competition, etc.) and subsequently, room for adjustment was left.

In order to adjust the original proposal, a process for consultation with Canada's domestic stakeholders (the provincial and territorial governments, indigenous peoples, the industrial world, etc.) was held. In parallel with this, technical review work was carried out in the federal government. After completing this process, the federal government of Canada decided that the impact on industrial sectors facing international competition in the original proposal should be taken into consideration, and reviews of the risks to international competitiveness and to carbon leakage were carried out.[10]

As a result of these reviews, the industrial sectors, business types, and products facing international competition were specified and emissions reduction factors of 95% and 90% were applied as emissions reduction factors. Moreover, the other industries' emissions reduction factor was also changed to 80% from an initial 70%.[11]

3.3. Availability of offset credits

In the above OPBS, a maximum of 75% of excess emissions are allowed to be used to compensate for excess emissions using the submission of offset credits. There are two kinds of offset credits usable for compensation: the surplus credits and the "recognized credits" which are credits issued under (i) the offset mechanism of the federal government or (ii) the recognized

---

[6] Refer to section 59 of the previously cited materials (Note 3) for the calculation method.
https://laws-lois.justice.gc.ca/eng/regulations/SOR-2019-266/page-8.html#h-1184777

[7] "Carbon pricing: regulatory framework for the output-based pricing system" (January 31, 2018 announcement)
https://www.canada.ca/en/services/environment/weather/climatechange/climate-action/pricing-carbon-pollution/output-based-pricing-system.html

[8] There are two types of CO_2 intensity emissions standards: the case in which they are stipulated by the government, and the case in which they are established by calculating the CO_2 intensity every year for each facility and multiplying it by a predetermined emissions reduction factor. Refer to sections 36 to 43, Schedule 1 of the previously cited materials (Note 3) for the CO_2 intensity emissions standards for each specific industry sector, business type, and product.
https://laws-lois.justice.gc.ca/eng/regulations/SOR-2019-266/page-11.html#h-1185036

[9] Refer to the previously cited materials (Note 8)

[10] Refer to the following materials regarding the review process for taking into consideration industry sectors facing international competition.
Update on the output-based pricing system: technical backgrounder (July 27, 2018 announcement)
https://www.canada.ca/en/services/environment/weather/climatechange/climate-action/pricing-carbon-pollution/output-based-pricing-system-technical-backgrounder.html

[11] Refer to the previously cited materials (Note 11)

offset mechanisms of the provincial and territorial governments.

(i) The offset mechanism established by the federal government was officially announced in the federal government gazette on June 8, 2022. The Canadian Greenhouse Gas Offset Credit System Regulations (hereinafter referred to as the "Offset Credit System Regulations") stipulate the scope covered by the regulations and the eligibility requirements for implementing entities of the projects and decide the credit issuance period, etc.

In parallel with preparation for the launch of the system in 2021, the preparation work for the method of calculating the amount of emissions reduction in the emissions reduction project (the offset protocol) was also carried out. In February 2023 the offset protocol on landfill methane recovery and destruction and GHG emissions reductions in refrigeration systems were approved as official ones. Moreover, currently, the protocols for improvement of forestry management, improvement of the carbon absorption of soil, etc., improvement of the feed system for livestock, direct air carbon capture and storage (DACCS), and the Enhanced Oil Recovery (EOR) method have been developed.

(ii) The offset mechanisms operated by the provincial and territorial governments can also be used as "recognized credits" if they meet standards set by the federal government. This covers offset credits derived from the amount of emissions reduction and removal measured using the protocol for calculating the amount of emissions reduction and removal (the specific method for calculating the amount of emissions reduction and removal) applied under an offset mechanism that has been reviewed from the Minister of Environment and Climate Change and the minister determined eligible for use of OPBS.

Currently, the protocols that have been reviewed by the Minister of Environment and Climate Change and have become "recognized credits" are the aerobic composting protocol, the aerobic landfill bioreactor protocol, the protocol for emission reductions from pneumatic devices, the protocol improving the method of feeding cattle to reduce methane emissions derived from their gaseous regurgitation, the protocol to reduce methane emissions derived from manure through the efficient feeding of cattle, etc. implemented in the offset mechanism of Alberta.

In this way, the OPBS allows the use of offset credits from the mechanism of the federal government and the "recognized credits" to compensate for excess emissions. However, according to the latest report announced by the Canadian federal government, the use of these two offset credits was not reported in either 2019 or 2020.[12]

3.4. MRV of the emissions

The facilities covered by the regulations are required[13] to report their emissions every year in accordance with the OBPS by June 1 of the following year. The OPBS has some provisions on MRV, quantification method, and allows the use of GHGRP that is established by the federal government of Canada as well as the WCI method that is used in the Western Climate Initiative (WCI), a climate change initiative in which California, the United States, and Quebec, Canada, participate. In addition, the OPBS allows the use IPCC of guidelines when the methods mentioned above don't cover industry sectors.

Facilities covered by the regulations must measure their emissions based on one of these methods, have the results verified by a third-party verification agency and then submit them to the federal government.

3.5. Relationship to other policies

The revenue from the carbon pricing system of Canada is returned to the general public or used in investments for climate change actions. The plan for strengthening the climate change policies for Canada was published in December 2020 (A Healthy Environment and a Healthy Economy), and reported that the charge levied by the OBPS would be invested in industries in the provinces and territories for the introduction of cleaner technologies and activities for emissions reduction. Two systems were established as frameworks for investment: the Decarbonization Incentive Program (DIP) which makes investments in industry and manufacturing and the Future Electricity Fund (FEF) which makes investments in the electricity sector. Under the OBPS, charges were levied as compensation from the companies covered by the regulations in 2019 (CA$164 million) and 2020

[12] Refer to the previously cited materials (Note 5).
https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/greenhouse-gas-annual-report-2021.html#toc23

[13] Refer to section 13 of the previously cited materials (Note 2).
https://laws-lois.justice.gc.ca/eng/regulations/SOR-2019-266/page-3.html#docCont

(CA$236 million), coming to a total of approximately CA$400 million. Investments have been made in the industrial sectors of each province and territory through the Decarbonization Incentive Program (DIP) and the Future Electricity Fund (FEF) taking into account the status of the number of facilities covered by the regulations in each province and territory (including facilities participating voluntarily), and the amount usable for investment in each province and territory is published by the federal government of Canada.

Table 4: Usable Investment Amounts in the DIP and the FEF

Name of province	DIP Amount of funds which can be invested (million)		FEF Amount of funds which can be invested (million)	
	2019	2020	2019	2020
Manitoba	CA$ 5.10	CA$ 7.00	CA$ 0.30	CA$ 0.20
New Brunswick	CA$ 2.70	CA$ 3.10	CA$ 5.90	CA$ 14.20
Ontario	CA$ 68.10	CA$ 97.80	CA$ 17.00	CA$ 19.90
Saskatchewan	CA$ 6.90	CA$ 6.40	CA$ 56.30	CA$ 84.90

(Source) Prepared by The Institute of Energy Economics, Japan (IEEJ) based on the Greenhouse Gas Pollution Pricing Act: Annual report for 2021

4. Implications for GX ETS

Canada possesses abundant energy resources including both fossil fuels and renewable energy domestically, is not dependent on imports from overseas, and has a different political and economic background from Japan.

On the other hand, its ETS which was introduced in the form of the OBPS allows the issuance of surplus credits in the case that emissions fall below the set emissions cap, and this point is the part that is similar to the GX ETS. However, the GX ETS consists of voluntary target setting whereas the OBPS essentially consists of regulations based on CO_2 intensity, so we can conclude that it serves as a reference example for the second phase of the GX ETS in the fact that it uses standards based on intensity rather than the total amount of emissions and the fact that it has formulated a predetermined guidance.

Furthermore, the revenue from the levied charge came to a total amount of CA$400 million (approximately 42 billion yen in Japanese yen (assuming CA$1 equals 106 yen)) by 2020 and this has been utilized in investment for decarbonization in the industry sector. The GX ETS is different in that 20 trillion yen will be dispersed to technology development, etc. as prior investment and subsequently refunded using carbon pricing but similar in that the revenue from carbon pricing will be utilized in further emissions reduction.

References

1) Government of Canada “A Healthy Environment and a Healthy Economy”
https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/healthy-environment-healthy-economy.html
2) Government of Canada “Greenhouse Gas Pollution Pricing Act: Annual report for 2021”
https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/greenhouse-gas-annual-report-2021.html

Appendix: Overview of the OPBS [14]

System commencement year	2019/1/1
Period of system	One year (calendar year)
Targets and objectives	Sets intensity targets for each sector covered by the regulations (when setting the target values, preferential measures for industries, etc. facing international competition are taken, and improvement target rates are set which get stricter in stages, from 95%, to 90%, to 80%).
Overview	This is a system applied to industry sectors (iron and steel, cement, chemicals, mining, chemical fertilizers, pulp) as a regression prevention measure of the federal government in the case that the provincial and territorial governments have taken inadequate or no carbon pricing initiatives. It sets intensity targets rather than regulations on the total amount.
Penal provisions	The amount in 2019, the year in which the regulations were commenced, was CA$20 per ton. Since 2019 it has risen by CA$10 every year and from 2023 onward it will rise by CA$15 every year.
Unit	Facilities
Main requirements for eligibility	Facilities of industry sectors (iron and steel, cement, chemicals, mining, chemical fertilizers, pulp, power generation, etc.) in regions where the federal backstop has been applied, which are facilities with annual emissions of 50,000 tons or more.
Covered gases	CO_2, CH_4, N_2O, SF_6, NF_3, HFCs, PFCs
Coverage	Provinces and territories that have not satisfied the benchmarks stipulated by the federal government and provinces and territories that seek application of the OPBS themselves (refer to the main text regarding the provinces and territories in which the OPBS is applied).
Allocation method	The emissions for every year that are permitted for the facilities covered by the regulations are calculated based on the benchmark intensity emissions, and if they fall below the emissions of the facilities covered by the regulations, emissions credits are issued, and it is possible to sell them to other facilities covered by the regulations.
Burden mitigation and leakage countermeasures	The intensity benchmark (Output Based Standard, OBS) is basically 80% of the average value of each industry, but alleviation measures for industries facing international competition (when setting the target values, preferential measures for industries, etc. facing international competition are taken, and improvement target rates are set which get stricter in stages, from 95% to 90%).
Banking and borrowing	Banking is allowed for surplus credits.
Utilization of other credits	Use of the offset credits recognized by the federal government is possible
Countermeasures against rapid rises in the price/ quantitative measures	None
Price	Unclear
Trading volume	Unclear
Trading format and exchange	No information.

(Source) Prepared by The Institute of Energy Economics, Japan (IEEJ) based on various materials

[14] Prepared based on the Output-Based Pricing System Regulations (SOR/2019-266).
Refer to https://laws-lois.justice.gc.ca/eng/regulations/SOR-2019-266/index.html.

IEEJ Energy Journal　Vol. 19, No. 1　2024

Editor: Yoshihiko Omori

Publisher: The Institute of Energy Economics, Japan
Inui Bldg., Kachidoki, 13-1,
Kachidoki 1-chome, Chuo-ku, Tokyo
104-0054, Japan
e-mail: report@tky.ieej.or.jp

Please contact the editor for inquiry
e-mail: yoshihiko.omori@tky.ieej.or.jp

The Institute of Energy Economics, Japan