Energy and Climate Management, 2025, 1(4): 9400025
https://doi.org/10.26599/ECM.2025.9400025

Review

A review of the operational results of the K-ETS (2015–2024)

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Received: 5 July 2025; Revised: 1 September 2025; Accepted: 11 December 2025

ABSTRACT

Republic of Korea launched its national emissions trading system (K-ETS) in 2015 and is currently in Phase 3 of implementation. As one of the most prominent examples of a successfully established national ETS, the K-ETS covers 73.5% of the country's total greenhouse gas (GHG) emissions during Phase 3, playing a pivotal role in achieving national mitigation goals. This study reviews the institutional development of the K-ETS over the past decade and assesses the performance and limitations of its key components—allocation, trading, and compliance—based on operational data. It also provides a quantitative assessment of emissions reporting and verification procedures, the use of Korean Credit Unit (KCU), and the application of flexibility mechanisms such as banking and borrowing. The analysis highlights several institutional improvements, including the expansion of auctioned allocations, adoption of the benchmarking (BM) method, and introduction of market facilitators. These reforms have contributed to a significant increase in market activity, driven by a broader range of participants, greater use of flexibility mechanisms, and influence of policy events. Based on the findings, the paper proposes policy directions to enhance market liquidity, institutional credibility, and mitigation effectiveness. The study offers valuable insights for designing the forthcoming Phase 4 of the K-ETS and supporting Republic of Korea's carbon neutrality target for 2050.

KEYWORDS

K-ETS, institutional operation, auctioned allocation, mitigation effectiveness, flexibility mechanism, market liquidity.

1 Background and institutional development

The emissions trading system (ETS) is a market-based policy instrument designed to reduce GHG emissions. Under this system, the government allocates annual emission allowances to entities whose emissions exceed a specified threshold, authorizing them to emit only within the assigned cap. Regulated entities may trade surplus allowances or acquire additional ones through auctions or the market, thereby achieving emission reductions more cost-effectively than through conventional command-and-control approaches[1-8].

As presented in Figure 1, Republic of Korea enacted the Framework Act on Low Carbon, Green Growth, laying the legal foundation for the introduction of the K-ETS in 2010. This was followed in 2012 by the implementation of the GHG and Energy Target Management System, which facilitated emissions data management for major sources and raised awareness of mitigation responsibilities—effectively serving as a pilot phase for the K-ETS. In 2015, the national-level K-ETS was formally launched, mandatingparticipation from entities that emit above a designated threshold[9].

Given the mandatory nature of the system, substantial efforts were undertaken during the design phase to solicit stakeholder input and reflect their views. The government set the stabilization of the system and the accumulation of operational experience as primary objectives for Phase 1 (2015–2017). During this phase, early reduction efforts were credited, and 100% of allowances were allocated free of charge. Most allowances were distributed based on the Grandfathering (GF) method, while the benchmarking (BM) method was applied to three sectors: aviation, refining, and cement. To provide flexibility in compliance, the K-ETS incorporated mechanisms such as offset credits, banking and borrowing[10].

During Phase 2 (2018–2020), the government set a key objective of achieving meaningful GHG reductions through the K-ETS. To support this goal, the allocation structure was modified to include 3% auctioned allowances and 97% free allocations. In addition, the overall reduction target was strengthened compared to Phase 1, ensuring better alignment with Republic of Korea's national mitigation commitments. The BM allocation approach, initially applied to three sectors—refining, aviation, and cement—was expanded to four additional sectors: power generation, district heating, industrial complexes, and waste management, bringing the total to seven. To alleviate liquidity shortages in the trading market, the government established new eligibility criteria for banking (carry-over of allowances) and institutionalized the participation of public financial institutions as market makers. These measures aimed to stimulate market activity and improve overall market functionality[11,12].

Starting from Phase 3 (2021–2025), the government extended the compliance period to five years to enhance the long-term stability of the K-ETS. This phase sets institutional priorities on ensuring the effective implementation of GHG reduction efforts and strengthening overall market functionality. Key reforms included increasing the share of auctioned allowances from 3% to 10%, expanding the scope of entities and sectors eligible for BM allocations, and broadening the participation of public actors such as market makers and financial institutions to stimulate market activity. Following the announcement of Republic of Korea's updated 2030 mitigation target in the First National Carbon

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Neutrality and Green Growth Basic Plan (2023), the government recalculated the national emissions budget and revised the allocation plan accordingly. More recently, the K-ETS has seen further institutional refinements through amendments to relevant legislation and guidelines. These include the establishment of eligibility criteria for voluntary participants, differentiated rules for allowance cancellation, revised criteria for allowance banking, expanded roles for market makers, and the institutionalization of consignment trading mechanisms[13,14]. Table 1 is the summary of Operational direction by phase in the master plan.

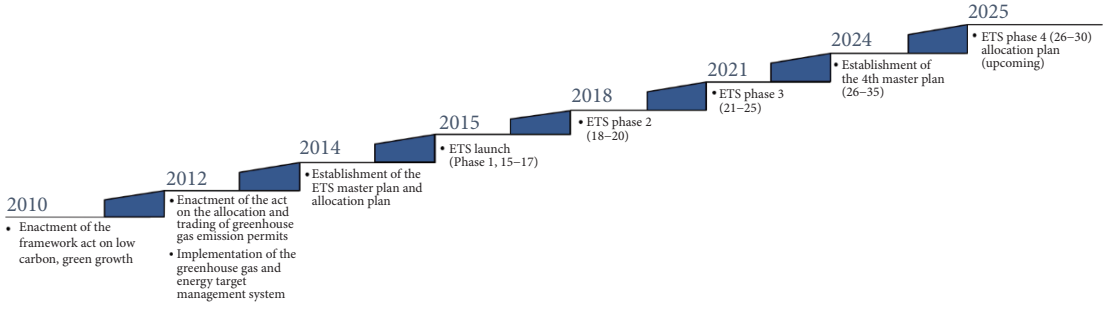

Fig. 1 Policy developments and trends in the K-ETS. Note: Internal data from the Greenhouse Gas Inventory and Research Center (GIR).

Table 1 Operational direction by phase in the master plan.

Type	Phase I (2015–2017)	Phase II (2018–2020)	Phase III (2021–2025)
Main objectives	· Acquire experience and stabilize the K-ETS	· Substantially reduce GHG emissions	· Promote effective reductions
Operations	· Improve flexibility e.g., the ratio of offset credits, etc. · Establish necessary infrastructure for accurate Monitoring, Reporting, and Verification (MRV)	· Expand the applicable scope and raise the targets · Develop various standards, e.g., emissions reporting, verification, etc.	· Reinforce the cap based on the Roadmap · Expand market functions by strengthening the functions of market makers, introducing derivatives in the exchange, etc.
Allocation	· Allocate all emission permits free-of-charge · Apply lessons learned from the GHG and Energy Target Management System	· Introduce auctions · Develop allocation methods, e.g., benchmarking, etc.	· Improve the criteria for selecting sub-sectors eligible for free allocation and expand the ratio of auctions · Expand the use of benchmarking for allocation

Note: Data from 2024 Korean Emissions Trading System Report (Greenhouse Gas Inventory and Research Center, GIR).

2 System operation process

The operation of the K-ETS follows four main procedural stages: allocation, verification, trading, and submission. Allocation refers to the advance distribution of emission allowances to regulated entities before the start of each compliance phase. According to K-ETS guidelines, preliminary allocations must be communicated to each entity at least two months prior to the beginning of the compliance year.

During the compliance year (January 1 to December 31), each regulated entity must compile its data on actual GHG emissions and energy consumption, and submit this in the form of a GHG Emissions and Energy Consumption Report (hereinafter "the Report"). The Report must be verified by an accredited third-party verifier, and both the verified Report and the verification statement must be submitted to the government. The competent authority then reviews the documentation and formally certifies the reported emissions.

Entities subject to allocation must surrender emission allowances equal to their verified GHG emissions within eight months after the end of the compliance year. If an entity has a shortfall in allowances, it may make up the shortfall by purchasing allowances on the market, borrowing from future allocations, or using banked allowances prior to the surrender deadline. Conversely, if an entity holds surplus allowances, it may sell the excess through market transactions. Entities in sectors subject to auction-based allocation may also acquire additional allowances through auction participation. The timeline of key regulatory obligations and annual procedural milestones is presented in Figure 2.

2.1 Allocation

2.1.1 Preliminary and final allocation

Entities designated as allocation targets under the ETS are required to submit an allocation application to the government at least four months prior to the start of the compliance period. This application estimates the volume of allowances the entity expects to receive for the entire period. The allocation application is submitted once in the year immediately preceding the compliance period, not annually.

Based on the submitted data and the national emissions budget, the government determines the preliminary allocation for each entity and notifies them accordingly. Table 2 shows the status of allowance under the K-ETS. In 2015, the first compliance year, 546.8 million tons of allowances were preliminarily allocated, with a 2% annual reduction applied throughout Phase 1 (2015–2017).

In Phase 2 (2018–2020), the government announced two separate allocation plans. The emissions budget set in the first stage applied solely to 2018, while the allowances for 2019–2020 were finalized in the second stage. In Phase 3 (2021–2025), preliminary allocations were distributed equally across each compliance year, segmented into two sub-periods: 2021–2023 and 2024–2025. For the years 2021 to 2023, 567.4 million tons were allocated per year. No new entrants were present at the beginning of each compliance phase; therefore, no initial allocation was

Fig. 2 Schedule for the K-ETS. Note: Data from 2024 Korean Emissions Trading System Report (GIR).

Table 2 Status of allowance allocation under the K-ETS. (Unit: Mt)

Compliance year	Pre-Allocation ①	New entry	Additional allocation	Allocation revocation	Succession of Rights and Obligations		Early reduction credits	Free allocation	Auction	Final allocation
					Transfer	Acquisition				
2015	546.8	–	6.4	−13.1	−2.6	2.6	–	540.1	–	540.1
2016	534.8	3.3	11.8	−18.6	−4.1	4.1	29.4	560.7	–	560.7
2017	541.0	7.7	25.1	−10.3	−6.6	6.6	22.0	585.5	–	585.5
2018	567.5	–	27.0	−5.6	−6.4	6.4	–	588.9	4.6	593.5
2019	527.4	3.3	33.2	−9.1	−19.6	19.6	–	554.8	8.6	563.3
2020	530.7	9.0	38.0	−18.4	−33.4	33.4	–	559.3	3.2	562.5
2021	567.4	–	17.7	−15.0	−5.7	5.7	–	570.1	14.7	584.8
2022	567.4	3.3	29.6	−30.1	−88.9	88.9	–	570.1	12.6	582.7
2023	567.4	5.1	32.0	−31.3	−94.6	94.6	–	573.2	5.9	579.1

① Pre-allocation + Re-allocation + Adjustment allocation

Note: Complied by the Authors based on the Korean Emissions Trading System Report (2018–2024) (GIR).

made for them. While annual fluctuations were observed, no consistent trend emerged across the 10-year period[13,15].

During Phase 1 of the K-ETS, early reduction achievements were recognized to support the initial establishment of the system. However, emission reductions resulting from factors such as decreased production, facility shutdowns, or the relocation of facilities outside the organizational boundary or to other countries were excluded from recognition[13,15].

Since most emission allowances during Phase 1 were allocated using the GF method, entities that had implemented early mitigation efforts faced relative disadvantages in allocation. To address this, the government granted additional allowances to account for verified early reduction efforts undertaken prior to the launch of the system. This recognition of early reduction was limited to Phase 1 and was not continued in Phases 2 or 3.

In the first compliance year of each phase, entities receive their total annual preliminary allocation in a lump sum. Any changes that arise thereafter—such as capacity adjustments, facility closures, or organizational changes—are reflected through additional allocations, cancellations, or transfers of rights and obligations. The total allocation after these adjustments is referred to as the final allocation.

The final allocation consists of both auctioned and freely allocated allowances. It amounted to 540.1 million tons in 2015 and increased to 579.1 million tons in 2023, reflecting an average annual growth rate of 0.9%.

2.1.2 Ex-post adjustment in allocation

Following the preliminary allocation, final allowances may be adjusted through mechanisms such as supplementary allocation, cancellation, or the transfer of rights and obligations. These post-allocation adjustments are collectively referred to as ex-post adjustment in allocation.

Supplementary allocation is granted when a regulated entity's verified GHG emissions exceed its pre-allocated allowances for reasons recognized under the K-ETS framework. Such reasons include the commissioning or expansion of facilities, compliance with obligations under other legislative frameworks, or contributions to national GHG reduction targets[13].

Eligible cases for supplementary allocation include increased electricity generation due to constraints in the national power grid; expanded heat production to meet district energy supply obligations; additional aviation activities required to ensure flight safety; compliance with effluent quality standards in public wastewater treatment facilities; the expansion of public transportation systems to promote sustainable mobility; the adoption of environmentally friendly logistics for the transportation of large or heavy goods; and the substitution

of fossil fuels with combustible waste for energy recovery purposes.

Two main factors have contributed to the observed growth in supplementary allocations. First, in the power and industrial sectors, operational constraints and the commissioning of new facilities led to notable increases in emissions relative to previous years. Second, the expansion and modernization of high-efficiency installations—particularly those meeting Best Available Technology (BAT) criteria (that is, the top 10% in emission efficiency)—also drove the need for additional allowances.

Despite year-to-year variation, the overall trend in supplementary allocation has been upward, with an average annual increase of 22.4%. The total volume rose from 6.4 million tons in 2015 to 32.0 million tons in 2023[15].

Allocation cancellation refers to the revocation of all or part of the emission allowances—limited to free allocations—that have been preliminarily or additionally granted to an entity, under specific circumstances defined by the K-ETS. These circumstances include: (1) the full or partial closure of a facility during the compliance year; (2) significant emission reductions due to facility suspension or under-utilization, where verified GHG emissions fall below a specified benchmark; and (3) the receipt of allowances based on inaccurate or false information provided in the allocation or additional allocation application.

Allowances cancelled under these conditions are returned to the Emissions Allowance Reserve Account. The two most common reasons for cancellation were the closure of all or part of a business site and the verified emissions in a given year falling below 50% of the allocated amount. While annual cancellation volumes remained below 20 million tons until the compliance year 2021, they surged to 30.1 million tons in 2022 and further to 31.3 million tons in 2023.

The transfer of rights and obligations occurs when an allocated entity undergoes corporate restructuring—such as mergers, demergers, transfers, or leases of facilities—resulting in the transfer of emissions trading obligations to another entity. If the receiving entity was not previously designated as an allocated entity, it is deemed to have acquired such designation at the time of the transfer.

In the initial phase of K-ETS implementation, the volume of rights and obligations transferred was relatively limited. However, as participants became more accustomed to the system, both the frequency of such transfers and the volume of allowances involved grew markedly. During Phase 1, the annual average volume of transferred allowances was 4.4 million tons, whereas in the most recent compliance year (2023), this figure rose dramatically to 94.6 million tons.

2.1.3 Auctions

Republic of Korea introduced auctions in Phase 2 of the K-ETS. During Phase 1, 100% of allowances were distributed free of charge. In Phase 2, 3% of total allowances were subject to auction, and this share was further expanded to 10% in Phase 3. According to the national allocation plan for Phase 3[10,11,13], entities in 41 industrial sectors were designated as subject to auctions, 82.0 million tons—equivalent to 10% of total allowances—were reserved for auctioning. That is, under the Phase 3 design, entities subject to auctions were allocated only 90% of their allowances for free, while the remaining 10% had to be obtained through auctions[a].

The government typically announces the annual auction schedule—including monthly auction volumes and auction dates—either at the end of the preceding year or at the beginning of the auction year. However, from 2024 to June 2025, in response to evolving market conditions, it adopted a flexible disclosure approach, publishing monthly volumes five days before each auction in response to market dynamics to each scheduled auction.

For the 2023 compliance year, the government initially planned to auction 17.8 million tons of allowances. Monthly auctions for KAU23 were held from July 2023 to June 2024, excluding April 2024, resulting in a total of 11 auction events. The total volume successfully auctioned in 2023 was 5.9 million tons, representing 1.0% of that year's final allocation for that year[1].

2.2 Certification and submission

2.2.1 Certification and submission

Under the national allocation plan, entities subject to allocation are required to compile data on their GHG emissions and energy consumption for the relevant compliance year (January 1 to December 31). They must prepare and submit a GHG Emissions and Energy Consumption Report (hereinafter "the Report") within three months of the end of the compliance year.

Prior to submission, the Report must be verified by a government-accredited third-party verification body. Both the verified Report and the corresponding verification statement must be submitted to the government. The competent authority convenes a GHG Emissions Certification Committee, which reviews the submitted materials and finalizes the certified emissions within five months of the end of the compliance year. Upon certification, regulated entities must surrender a quantity of emission allowances equivalent to their certified emissions within eight months of the compliance year's end. This submission is conducted electronically via the Emissions Trading Registry System (ETRS).

Allowable credit types for submission—such as KAU[b], KCU[c], and KOC[d]—vary according to specific K-ETS regulations. Entities may also utilize borrowing and banking mechanisms, subject to eligibility and cap conditions.

During Phase 1, the number of regulated entities and their certified emissions increased by 2.1% in 2016 and 3.2% in 2017 relative to the previous year. However, these increases were lower than the growth rates in final allocations, which were 3.8% in 2016 and 4.4% in 2017, respectively.

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[a] Since auction participation is voluntary, there may be a gap between the total volume earmarked for auction (10%) and the actual volume awarded through successful bids.

[b] Korean Allowance Unit (KAU): emission permits allocated to covered entities

[c] Korean Credit Unit (KCU): emission permits converted from KOCs

[d] Korean Offset Credit (KOC): certified reduction credit from external offset projects obtained from the reduction, absorption, or removal of GHGs outside the scope of business operations monitored by the K-ETS in compliance with international standards

In Phases 2 and 3, the number of participants initially increased due to the expansion of coverage under the K-ETS. Nevertheless, certified emissions declined over time, even as the number of regulated entities continued to rise. For instance, during Phase 3, 687 entities reported 591 million tons of certified emissions in 2021, whereas 733 entities reported only 549.9 million tons in 2023. This decline in verified emissions is primarily attributed to reduced economic activity and industrial output following the global demand contraction in the aftermath of the COVID-19 pandemic[1-8].

2.2.2 *Flexibility mechanisms*

The K-ETS incorporates flexibility mechanisms to enhance cost-efficiency in compliance and broaden participation in emission reduction activities. These mechanisms allow regulated entities to meet their surrender obligations not only through allocated allowances but also via alternative instruments such as offset credits and temporal flexibility, including banking and borrowing.

A central element of the flexibility framework is the use of offset credits. Under this mechanism, regulated entities may convert certified GHG reduction achievements—formally referred to as Korea Offset Credits (KOC)—into KCU for compliance purposes. These KOCs must originate from mitigation activities implemented outside the organizational boundaries of the entity. The rationale for this mechanism is to incentivize emission reductions in uncapped sectors or sources, thereby achieving cost-effective and system-wide mitigation benefits[1].

The design and eligibility of offset credits have evolved over successive compliance phases. During Phase 1 (2015–2017), offset credits were permitted only for domestic external reduction activities. Their use was capped at 10% of each entity's surrender obligation[9]. In Phase 2 (2018–2020), while the overall usage cap of 10% remained unchanged, the scope of eligible credits was expanded to include international reductions—such as Certified Emission Reductions (CERs)—up to 50% of the offset quota, effectively allowing up to 5% of total submitted units to come from overseas sources[12]. In Phase 3 (2021–2025), the rules were tightened further: the use of offset credits, whether domestic or international, was limited to 5% of the total volume of emission allowances submitted[14].

These progressive adjustments to offset credit policy reflect the government's effort to balance compliance flexibility with the environmental integrity of the trading system. By limiting reliance on external credits over time, the system has aimed to strengthen domestic mitigation incentives and ensure the credibility and verifiability of submitted units.

Between 2015 and August 2024, a cumulative total of 52.0 million tons[e] of KOC were registered through both domestic and international external reduction projects, with domestic projects accounting for 38.5 million tons (74.1%) and international projects contributing 13.5 million tons (25.9%). However, from September 2023 to August 2024, newly registered KOC volumes declined markedly to 2.6 million tons—1.3 million tons each from domestic and international sources—representing a sharp decrease from 8.5 million tons recorded during the same period of the previous year. This downturn was particularly notable in international KOC registrations, which had shown a steady upward trajectory since their introduction in 2020 (1.0 → 5.4 → 5.9 million tons) before undergoing a significant contraction.

As of August 2024, a total of 1,432 external reduction projects had been certified, comprising 825 domestic and 607 international initiatives. Of the total KOC issued, 33.6 million tons[f] were converted into KCU by regulated entities for compliance purposes. In the 2023 compliance year, only 0.7 million tons (0.5 million domestic and 0.2 million international) were converted into KCU, signifying a substantial decline from the 8.1 million tons (7.4 million domestic and 0.7 million international) converted in 2022. Notably, KCU conversion volumes remained below 1 million tons annually throughout Phase 2 but surged to over 7 million tons in the early years of Phase 3, before returning to Phase 2 levels in recent years.

Banking criteria have been a key factor affecting liquidity and price formation in the emissions trading market and have undergone several revisions throughout the implementation of the K-ETS. During Phase 1, when the system was first introduced, there were no quantitative restrictions on the volume of allowances that could be carried over, although banking was permitted only to the following compliance year on an annual basis. However, in cases where the volume of carried-over allowances from Phase 1 was deemed excessive, the government subtracted the amount exceeding a certain threshold[g] from the Phase 2 allocation to curb excessive banking by firms[9].

In the early stage of Phase 2, no specific limit was imposed on the banking volume, consistent with the rules in Phase 1. Nevertheless, in June 2019, the government introduced a formal restriction on banking allowances, setting the banking limit at three times the net volume of allowances sold in 2017 and twice the net volume sold in 2018[11, 16-18].

At the beginning of Phase 3, this two-times net sales limit was maintained to alleviate market illiquidity and reduce short-term price volatility. However, to address supply-demand imbalances and ensure flexibility in mitigation efforts for regulated entities, the government relaxed the banking restrictions twice—first in December 2023, and again in December 2024[13,19,20]. Between 2016 and 2018, over 30 million tons of allowances were carried over annually. However, following the introduction of banking restrictions in 2019 as part of Phase 2 policy revisions, the banking volume dropped to 17.2 million tons. The trend subsequently reversed in Phase 3 due to regulatory relaxation. In 2023, proprietary trading by securities firms resulted in the banking of 2.1 million tons (by 10 institutions), while market makers accounted for 4.9 million tons in banking (by 8 institutions). Table 3 summarizes revison of the standards for the Banking of KAU· KCU23-25, and Table 4 shows the results of surrender from the compliance year 2015 to 2023..

Borrowing limits under the K-ETS have also varied across phases. In Phase 1, borrowing was capped at 20% of a company's

[e] 52.0 million tons = 22.5 million tons in Phase 1 (January 1, 2015 – August 9, 2018) + 10.3 million tons in Phase 2 (August 10, 2018 – August 9, 2021) + 19.3 million tons in Phase 3 (August 10, 2021 – August 31, 2024)

[f] 33.6 million tons converted to KCU = 15.4 million tons in Phase 1 + 1.5 million tons in Phase 2 + 16.7 million tons in Phase 3

[g] The deduction applies to the portion of banked allowances exceeding 10% of the average verified emissions during Phase 1 plus 20,000 tons.

Table 3 Revision of the standards for the Banking of KAU·KCU23-25.

	3rd Allocation plan (Sep. 2020)	1st Amended (Dec. 2023)	2nd Amended (Dec. 2024)
KAU21, KCU21	net sales × 2	net sales × 2	net sales × 2
KAU22, KCU22	net sales × 2	net sales × 2	net sales × 2
KAU23, KCU23	net sales × 1	net sales × 3	net sales × 3
KAU24, KCU24	net sales × 1	net sales × 3	net sales × 5
KAU25, KCU25	average annual net sales for Phase 3 × 1	net sales × 3	net sales × 5

Note: Data from Amended Allocation Plan for Phase III (2021–2025) (Ministry of Environment, December 2023).
Data from Amended Allocation Plan for Phase III (2021–2025) (Ministry of Environment, December 2024).

Table 4 Surrender results. (Unit: Mt)

Year	Certified		KOC → KCU	KAU traded①		Surrendered				Not surrendered	Not banked	Banking ('23→'24)		
	Emission	Entitiy②		Sold	Purchased	Total	KAU	KAU (Borrowed)	KCU			Total	KAU	KCU
2015	542.7	522	9.5	−4.8	4.8	542.6	524.0	9.8	8.8	−0.002	0.0	17.0	16.3	0.7
2016	554.3	560	2.6	−14.1	14.1	554.3	536.2	14.8	3.3	0.0	0.0	31.0	31.0	0.01
2017	571.9	591	3.3	−40.0	40.0	571.9	568.6	–	3.3	−0.03	0.0	37.7	37.7	0.005
2018	601.5	586	0.5	−28.5	28.5	601.5	595.8	5.2	0.5	−0.001	0.0	35.6	35.5	0.003
2019	587.9	610	0.3	−29.3	29.3	587.8	578.6	8.9	0.3	−0.03	0.01	17.2	17.2	0.003
2020	554.4	636	0.7	−37.7	37.7	554.4	553.7	–	0.7	−0.01	0.03	17.9	17.9	0.0
2021	591.0	687	7.9	−21.3	21.3	591.0	582.2	0.8	7.9	−0.05	0.03	20.9	20.9	0.0
2022	572.0	713	8.1	−31.7	31.7	572.0	563.7	0.7	7.6	0.00	0.01	39.3	38.9	0.5
2023	549.9	733	0.7	−33.1	33.1	549.9	548.4	0.5	1.1	–	0.0	70.0	69.9	0.1

① The entries are based on the trading volume registered in the ETRS
② Market makers and securities companies are not counted as covered entities.
Note: Data from ETRS Database (as of Sep. 2024).

required submission volume. During Phase 2, the single cap was retained but operationalized on a compliance-year basis to distribute demand more evenly across the market. Unlike banking, borrowing across planning phases was strictly prohibited; companies were not permitted to borrow from the first year of the subsequent planning phase[11,13,16,17,19,20].

In the 2024 compliance year, borrowing accounted for only 0.1% of the total submitted allowances, amounting to 0.5 million tons borrowed by 41 companies. While the number of borrowing entities remained relatively stable compared to the previous year (38 companies), the total volume borrowed decreased by 22.6% from 0.7 million tons in 2023[1].

3 Analysis of the emissions trading system and transaction performance

3.1 Trends in emissions trading-related systems

3.1.1 Expansion of the market maker system

The market maker system was introduced during Phase 2 of the K-ETS pursuant to Article 22-2 of the Act on the Allocation and Trading of GHG Emission Allowances. This mechanism was designed to ensure stable market operations and to stimulate emissions trading. Under the system, market makers are designated financial institutions that receive emission allowances on loan from the government's dedicated market maker reserve and are mandated to conduct transactions that enhance liquidity in the secondary market.

Initially, in the compliance years 2018 and 2019, only two financial institutions participated as market makers. However, the system has since expanded, with a total of eight financial institutions acting as market makers by 2023. In parallel with the expansion in participation, the volume of allowances available to each market maker has also been progressively increased to support greater market-making activity. Table 5 shows the expansion of market participants and changes in the trading method.

3.1.2 Introduction of third-party and commission-based trading

In September 2021, the Korean government authorized proprietary trading by securities firms within the K-ETS framework to invigorate the emissions trading market, stabilize carbon prices, and enhance market transparency. Building on this, the regulatory groundwork for the introduction of a formal brokerage trading system has been laid out, with full implementation scheduled for 2025.

This development has already broadened the range of eligible market participants, which was previously limited to compliance entities, market makers, and designated trading intermediaries. With the entry of securities firms, non-compliance entities and general corporations have gained access to the market. Furthermore, as stipulated in the 2025 amendment, the scope of participation is expected to expand further to include collective investment schemes, fund managers, banks, and insurance companies.

Table 5 Expansion of market participants and changes in the trading method.

Current provisions	Draft amendment
[Eligible market participants]	
Covered entities Market makers Emissions trade brokerage companies	Covered entities Market makers Emissions trade brokerage companies Collective investment entities (asset management companies) Fund managers Banks, insurance companies, etc.
[Emissions trading methods]	
Direct trading through the emission permit exchange	Direct trading through the emission permit exchange Brokerage-based trading through emissions trade brokerage companies

Note: Act on the Allocation and Trading of Greenhouse-Gas Emission Permits (Ministry of Environment, Office for Government Policy Coordination, and Ministry of Economy and Finance; partially amended on 7 February 2025).
Enforcement Decree of the Act on the Allocation and Trading of Greenhouse-Gas Emission Permits (Ministry of Environment, Office for Government Policy Coordination, and Ministry of Economy and Finance; partially amended on 7 February 2025).

Alongside the adoption of intermediary trading mechanisms, these regulatory changes are anticipated to promote a more active and liquid carbon market.

3.2 Analysis of emission allowance trading performance

3.2.1 Transaction performance trends

An analysis of the cumulative emissions trading performance from the first to the third planning periods (as of August 2024, the submission deadline for the 2023 compliance year) reveals that a total of 414.0 million tons were traded in both on- and off-exchange markets, with a total transaction value of KRW 7.9199 trillion. Among the different allowance types, Korean Allowance Unit (KAU) accounted for the highest share of transaction volume at 364.4 million tons (88.0%), followed by KOC at 45.2 million tons (10.9%) and KCU at 4.4 million tons (1.1%). Although annual trading volumes fluctuated over time, the overall trend has been upward, increasing from 5.7 million tons in 2015 to 89.9 million tons in 2023. As of August 2024, the transaction volume stood at 56.7 million tons, marking a slight decline of 6.3% compared to the same period of the previous year. Table 6 summarizes the trends in trading volume by emission permit.

Table 6 Trends in trading volume by emission permit. (Unit: Mt)

Phase	Year	KAU	KCU①	KOC	Total
I	2015	0.3	0.9	4.4	5.7
	2016	4.2	2.2	5.6	12.0
	2017	21.2	0.3	4.7	26.3
II	2018	44.8	–	2.7	47.5
	2019	33.5	–	4.6	38.1
	2020	40.3	–	3.8	44.0
III	2021	48.7	–	6.0	54.7
	2022	33.2	0.7	5.2	39.1
	2023	82.6	0.3	7.0	89.9
	2024②	55.5	–	1.2	56.7
Total		364.4	4.4	45.2	414.0

① No trading of KCU was recorded in 2018, 2019, 2020, 2021 and 2024.

② Including the period from January to August 2024.

Note: Complied by the Authors based on the Korean Emissions Trading System Report (2018–2024) (GIR).

Within on-exchange transactions—comprising competitive, negotiated, and auction trades—competitive transactions (i.e., third-party trades) accounted for 64.6% of the total volume between January 2015 and August 2024 and for 78.4% during the third planning period (January 2021 to August 2024), indicating that third-party trades were more active than negotiated trades between counterparties[9, 15, 21, 22].

Unlike KAUs and KCUs, KOCs are not eligible for compliance use and are open to participation from non-covered entities. Since June 2021, KOC instruments have been renamed[h], so their trades

[h] KOCs issued prior to the revision of the guidelines for KOC certification (2015–2021) were renamed KOC20–22

are subject to fixed trading periods. However, it is noteworthy that iKOC—representing offset credits from overseas certified reduction projects—has generally exhibited higher transaction volumes and prices than domestically sourced KOCs, except for vintages KOC21 through KOC26.

The trading volume of market makers varied across compliance years. For KAU23, market makers sold 7.0 million tons and purchased 4.7 million tons. Compared to KAU22, which recorded 6.7 million tons in sales and 9.6 million tons in purchases, the proportion of purchases decreased significantly. During the key trading period for KAU23 (September 2023 to August 2024), the share of market maker transactions in the exchange market was 29.4% for sales and 19.6% for purchases—both declining from the previous year. On a monthly basis, market maker sales were relatively high in September 2023 and January 2024. The lowest purchase volume was recorded in October 2023 (58,000 tons), while the highest monthly purchase volume occurred in December 2023 (775,700 tons), representing a peak share of 44.2%.

Securities firms began actively participating in the exchange market in late 2021, with 21 firms participating as of 2023. In the 2023 compliance year, KAU23 sales and purchases by securities firms amounted to 0.34 and 0.35 million tons, respectively—significantly lower than the KAU22 purchase volume of 2.5 million tons. From September 2023 to August 2024, securities firms accounted for 1.4% of sales and 1.5% of purchases in the on-exchange market (excluding auctions), reflecting a notable decline from the previous year (2.1% in sales and 11.5% in purchases). Monthly data also showed a distinct concentration of transactions in the latter half of the year.

The total annual transaction value increased from KRW 62.4 billion in 2015 to KRW 968.8 billion in 2023, indicating a gradual upward trend alongside institutional development. In particular, annual transaction values exceeded KRW 1 trillion in 2018, 2020, and 2021—periods marked by increased market demand and active trading. The trends in payments by emission permit are presented in Table 7.

Table 7 Trends in payments by emission permit. (Unit: KRW 100 million)

Phase	Year	KAU	KCU①	KOC	Total
I	2015	40	100	484	624
	2016	709	387	946	2,041
	2017	4,463	67	973	5,503
II	2018	9,944	–	565	10,509
	2019	9,688	–	1,143	10,831
	2020	12,364	–	1,021	13,385
III	2021	11,175	–	1,491	12,666
	2022	7,496	149	1,111	8,756
	2023	8,524	37	1,126	9,688
	2024②	5,047	–	150	5,197
Total		69,449	740	9,011	79,199

① No trading of KCU was recorded in 2018, 2019, 2020, 2021 and 2024.

② Including the period from January to August 2024.

Note: Complied by the authors based on the Korean Emissions Trading System Reportk (2018–2024) (GIR).

3.2.2 Institutional and external drivers of emissions trading volume: A qualitative review

The performance of the K-ETS is shaped by a multifaceted interaction of institutional, structural, and exogenous factors. Notable fluctuations in trading volume and value across compliance years reflect the compounded influence of system design, strategic behavior of market participants, and external shocks. Figure 3 shows the trends in trading price and volume for KAU15-KAU23 in the exchange market.

One of the primary factors influencing trading volume is the institutional schedule governing compliance activities. Under the K-ETS, compliance entities are required to submit their annual emissions report by the end of March and to surrender allowances equivalent to their verified emissions by the end of August (or by the end of June in earlier compliance years, such as 2022 and prior). These deadlines mark critical decision points at which entities assess their actual emissions and determine any allowance surpluses or shortfalls. As a result, trading activity tends to become highly concentrated in the period immediately preceding the surrender deadline—a trend that has been observed consistently across multiple years. This pattern of schedule-induced trading concentration can exert significant pressure on market liquidity and pricing within a short time window, contributing to increased price volatility in the emissions market.

Second, changes in government policy and external policy events serve as major drivers that shape market expectations and alter trading behaviors. For instance, in years when announcements were made regarding restrictions on banking allowances, implementation of market stabilization mechanisms, revisions to the national GHG reduction targets (NDC), or adjustments to sectoral allocation plans, notable fluctuations in trading volume were observed.

Third, exogenous factors—such as macroeconomic cycles and unforeseen events like the COVID-19 pandemic—also have a substantial impact on trading activity. During the 2020 pandemic, reduced industrial production led to lower emissions, which in turn significantly decreased demand for allowances and triggered a sharp decline in market prices. This illustrates how external shocks unrelated to internal supply-demand dynamics can disrupt market functioning. These unpredictable factors represent structural risks that can undermine the stability of the emissions trading market.

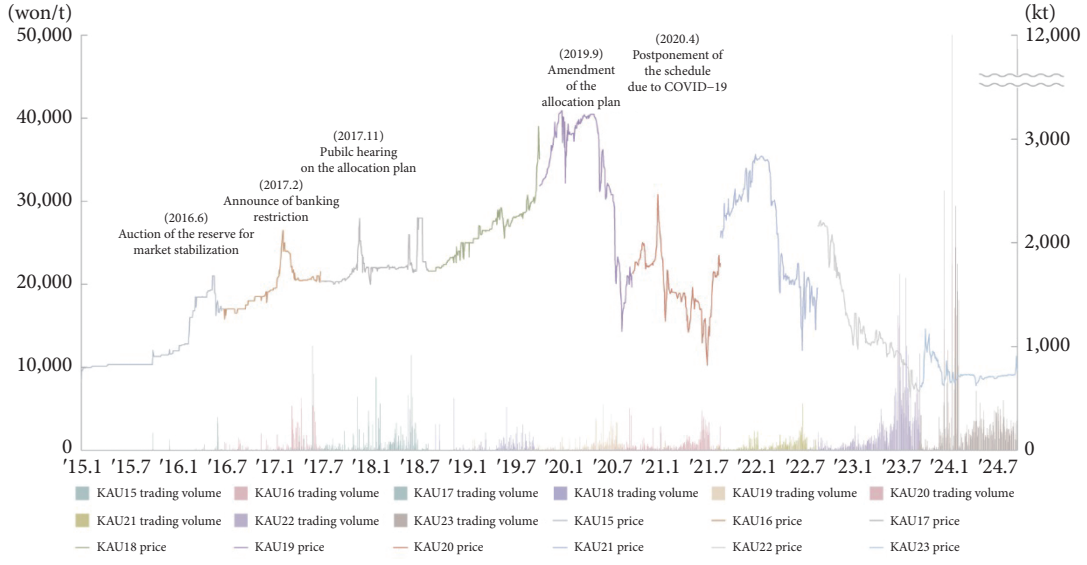

Fig. 3 Trading price and volume for KAU15-KAU23 in the exchange market. Note: For convenience, only the price and trading volume of the index emission permits for the corresponding periods are used. For example, although the trading of KAU21 began in 2020, the above graph is based the amount of KAU21 traded only in the 2021. Source: 2024 Korean Emissions Trading System Report.

Additionally, the composition of participating entities influences market performance. Thus, emissions trading outcomes are shaped by a complex interplay of institutional, structural, and exogenous variables, making it difficult to attribute market behavior to a single explanatory factor. To secure market liquidity and stabilize allowance prices, policy efforts should focus on diversifying trading participants, improving the predictability of trading conditions, offering advance notice of regulatory changes, and strengthening institutional coherence.

4 Future plans

In December 2024, the Korean government announced the Fourth Basic Plan for the K-ETS, outlining institutional reforms for the fourth plan period beginning in 2026. This aims to eliminate the oversupply of allowances and enhance mitigation incentives—such as surplus accumulation—while enhancing market-based incentives and aligning the emissions cap with South Korea's 2030 Nationally Determined Contribution (NDC). Key measures include the inclusion of MSR reserves in the total cap, expansion of BM-based allocation to over 75% of emissions, and tightened BM criteria. Additionally, market participation will be broadened by relaxing banking rules and introducing third-party access to both the spot and auction markets. The launch of the Korean Market Stability Reserve (K-MSR) is also expected to enhance price stability and reinforce market trust.

The government has announced that in the fourth planning phase, it will strengthen emissions allowance management by including MSR (Market Stability Reserve) volumes—previously excluded from the total cap—within the overall cap. Additionally, it will apply more stringent standards than in previous phases by differentiating the proportion of auctioned allowances by sector. The government also plans to expand the share of allowances allocated using the BM method to over 75% and to raise the BM standards, thereby encouraging companies to make greater investments in improving their emissions efficiency.

In addition, to stimulate activity in the emissions trading market, the government plans to relax banking restrictions for regulated entities, thereby supporting more flexible emissions management. Third-party participation in both the secondary market and allowance auctions will also be permitted, alongside the introduction of consignment trading. Moreover, a K-MSR will be introduced to address supply–demand imbalances, restore confidence in the emissions market, and promote greater trading activity. The adoption of consignment trading and the K-MSR are considered core components for activating the market function—an essential feature of the ETS. If implemented successfully, these measures are expected to facilitate cost-effective GHG reductions while enhancing the global competitiveness of regulated companies.

The Fourth Basic Plan also outlines the future direction of the Fifth Planning Phase (2031–2035). For Phase 5, the government will consider ways to strengthen the contribution of the K-ETS to national mitigation, including shifting from a multi-year allocation system to an annual allocation system. It also plans to review the potential expansion of BM- and auction-based allocation and the exclusion of indirect emissions from the cap.

5 Conclusion

Republic of Korea operates one of the world's few nationwide emissions trading systems (K-ETS). Over the past decade, the K-ETS has firmly taken root as a core policy tool for reducing GHG emissions, supported by continuous stakeholder engagement, systematic market monitoring, institutional research, and capacity building of key participants to ensure effective system implementation.

At the outset of the system, all allowances were allocated free of charge. However, as the phases progressed, the government introduced auctioning and gradually increased the share of paid allocation to support a smooth institutional transition. In parallel, it shifted from a GF approach to a BM approach, thereby reducing opposition from regulated entities and incentivizing improvements in emission efficiency. To enhance market liquidity, several institutional measures were introduced, including the market maker system, proprietary trading by securities firms, and adjustments to banking limits. In addition, the government

has built and continually improved the core infrastructure systems underpinning K-ETS operations, including the National Greenhouse Gas Management System (NGMS), the Emissions Trading Registry System (ETRS), and the Offset Registry System (ORS), thereby enabling more efficient system operation.

Through ten years of implementation, public and stakeholder understanding of the necessity, purpose, and operational framework of the emissions trading system has expanded across a broad range of stakeholders, providing a stronger foundation for its continued effective operation.

A notable concern in recent years has been the persistent oversupply of emission allowances, which has exerted downward pressure on allowance prices and raised questions about the system's effectiveness in driving genuine emission reductions. Nevertheless, empirical observations suggest that the K-ETS has helped raise awareness of climate responsibilities across industries. Survey data from regulated entities indicate a generally positive perception of the system, with many firms reporting increased investments in low-carbon technologies and the deployment of dedicated internal teams for emissions management.

The Republic of Korea's government plans to release the Fourth Allocation Plan in the second half of 2025, which will provide detailed implementation guidelines for Phase 4. Building upon the strategic direction outlined in the Basic Plan, the forthcoming allocation plan will specify quantitative targets and operational measures concerning the total cap, BM stringency, proportion of auctioned allowances, and trading enhancement strategies. As such, this plan will serve as a critical milestone in determining the long-term success of the K-ETS. Building upon ten years of operational experience, there is growing optimism that the phase 4 of the K-ETS will feature a more mature and sophisticated system—capable of simultaneously supporting industrial competitiveness and expanding mitigation efforts.

Acknowledgements

None.

Author contribution statement

Jung-ae Park contributed to drafting the trading section and was responsible for the overall review and editing of the manuscript. Young-hyun Lee conducted data collection for the trading section and performed data analysis, statistical processing, and visualization. Yong-cheol Park drafted the sections related to institutional design and allocation and carried out data analysis, statistical processing, and visualization for these parts of the study. Hyung-wook Choi, as the corresponding author, supervised the overall research process and coordinated the study.

Data availability

Not applicable.

Use of AI statement

None.

Declaration of competing interest

The author(s) have no competing interests to declare that are relevant to the content of this article.

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