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South Korea has set ambitious greenhouse gas (GHG) emission reduction targets. However, the country currently confronts a decline in the price of emission permits. This downward trend could obstruct the successful realization of GHG objectives through market mechanisms. The current emissions trading scheme (ETS) restricts banking of excess emission allowances, which has been identified as the main reason of the ongoing price decline. Consequently, this restriction hinders the adequate reflection of updated targets within the emissions trading market. To address this issue and avert potential shocks from a substantial reduction in emission allowance supply during Phase IV, it is necessary to relax the banking restrictions. At the same time, to proactively manage potential price escalations resulting from eased restrictions on permit banking, supplementary measures are required. These measures could include the introduction of explicit market stability mechanisms utilizing allowance reserves and the expansion of allowance supply channels.

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Approaches to Enhance the Market Functionality of the K-ETS

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I. Introduction

Amidst the growing global awareness of the climate change crisis, nations worldwide are proactively reassessing their commitments to mitigating greenhouse gas (GHG) emissions. South Korea, in alignment with this collective effort, made a significant declaration by pledging ‘2050 Carbon Neutrality’ in December 2020. Subsequently, in October 2021, the nation unveiled its comprehensive ‘2050 Carbon Neutrality Roadmap,’ outlining the trajectory to achieve this ambitious goal. In support of these initiatives, South Korea also augmented its National Greenhouse Gas Reduction Target (Nationally Determined Contributions, NDCs) for 2030. This plan provided detailed, sector-specific and yearly reduction targets, along with strategies for implementation up to 2030. The updated GHG reduction goals have been widely recognized as ambitious and challenging to achieve.¹⁾

To expedite the transition to a low-carbon economy and achieve more ambitious mitigation goals, a broad spectrum of systems and policies are being implemented and scrutinized. Among these, the Emissions Trading Scheme (ETS) is considered as one of the most significant policy instrument that incentivizes greenhouse gas (GHG) reduction through economic incentives. Despite the considerable escalation in domestic GHG reduction commitments, there has been a noticeable decline in the price of emission allowances, signaling potential inconsistencies in the pricing mechanism’s effectiveness. This study aims to assess the current state of the Korea ETS (henceforth, K-ETS) and forwards propositions to improve market efficiency, thereby facilitating the achievement of GHG reduction targets.

II. Present Condition of K-ETS

In 2015, South Korea introduced the Emissions Trading Scheme (ETS) as a cost-effective approach to attain its national greenhouse gas (GHG) reduction targets and minimize the financial impact on businesses and the broader economy. Over the years, the ETS has demonstrated consistent growth, attracting an increasing number of participants and expanding its coverage of emissions. During Phase III (2021~2025), the ETS covers approximately 73.5% of national emissions (Ministry of Environment, Sept. 2020). The participating entities in the ETS

* Summarized and adapted from Yoon, Yeochang, “How to Improve Emissions Trading System (ETS) Operations for a Transition to Low Carbon Economy,” in Yong Hyeon Yang ed., *Strategy for Transition to Low Carbon Economy and Policy Challenges*, Korea Development Institute, 2023 (forthcoming) (in Korean).

1) South Korea has committed to an annual GHG emission reduction rate of 4.17% from the baseline year 2018 to the target year 2030, markedly faster than the EU’s 1.98%, the US’s 2.19%, and Japan’s 2.56%.

can be broadly categorized into two groups: those receiving full free allowances and those purchasing a portion of allowances. Free permits (or, allowances) are allocated to firms at a high risk of carbon leakage and facing substantial cost burdens, preserving their market competitiveness. Conversely, some participants must purchase a certain percentage of emission allowances through auctions in the emissions trading market. Phase I (2015~2017) offered 100% free allowance, followed in Phase II (2018~2020) which introduced 3% of auctioned allowances. In Phase III (2021~2025), auctioned allocations are set to rise to 10%. Moreover, starting from 2019, monthly emission permit auctions was added to spot market, providing participants with more opportunities to acquire emission permits.

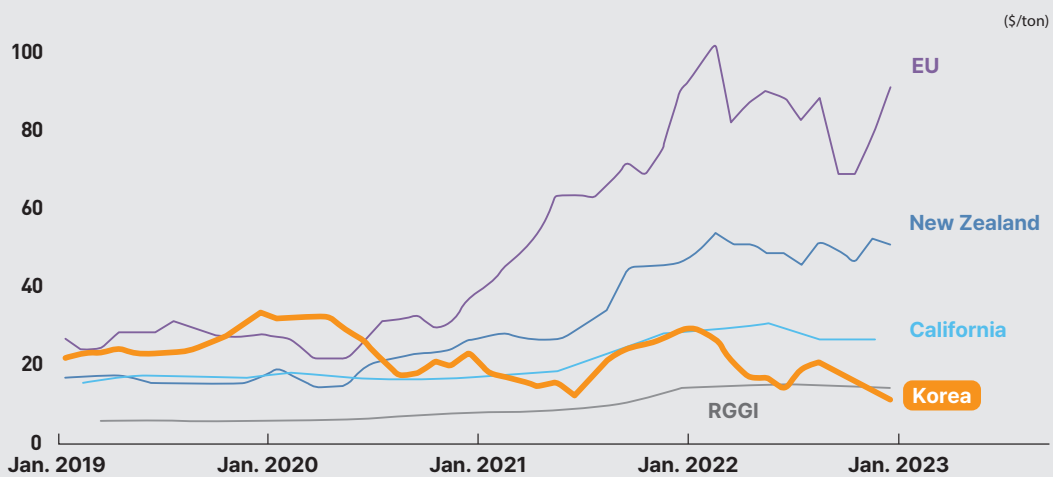
ETS participants play a crucial role in South Korea's efforts to achieve its greenhouse gas (GHG) reduction targets in a cost-effective manner. By comparing the cost of implementing further GHG reductions with the price of emission allowances, participating entities can make informed decisions to optimize their approach.²⁾ If the cost of additional GHG reductions exceeds the ETS price, entities are encouraged to acquire emission allowances, thus offsetting their emissions economically. On the other hand, if the cost of additional reductions is lower than the ETS price, entities are incentivized to invest in direct GHG reduction initiatives. The revenue derived from auctioning emission permits is funneled into the Climate Action Fund which supports carbon neutrality initiatives. The Fund operates as a mechanism to stimulate entities to decrease GHG emissions, establish a GHG reduction foundation, and provide support for emission reduction activities. Hence, maintaining an appropriate ETS price is crucial to effectively stimulate entities to reduce emissions and attain reduction targets.³⁾

South Korea has ambitious GHG reduction targets, but the demand and prices for emission permits are lagging, both displaying a decline.

Despite a substantial rise in GHG reduction targets, the K-ETS price has continuously decreased, which is typically not seen with increased demand. The K-ETS price was higher than other ETSs during late 2019 and early 2020. While other emissions trading schemes have significantly increased since 2020, the K-ETS price has dropped since 2020 (Figure 1).

2) Once the total supply of emission allowances set by the NDC is allocated, the pricing of these allowances is formed based on the participants' mitigation costs and prevailing external economic conditions.

3) Participants in the ETS who join K-RE100 can have their GHG reduction efforts recognized through direct PPA, third-party PPA, and certificate purchases among the six procurement options, excluding the green premium. If the price of emission allowances stays low, the benefit from this recognition could diminish, thereby reducing the incentive to participate in K-RE100.

Figure 1. Monthly Emission Allowance Price Trends – Korea vs. International

Note: RGGI is a market-based cap-and-trade system engaged by 12 Northeastern U.S. states, targeting emissions from the electricity generation sector.

Source: Author's calculation based on ICAP (<https://icapcarbonaction.com/en/ets-prices>).

The pricing mechanism of the K-ETS is currently underperforming, consequently compromising market efficiency.

The emission permit prices, failing to reflect the updated GHG reduction target, remain consistently low. This discourages participants from investing in GHG reduction facilities and technologies, as they find it more beneficial to purchase emission permits instead. This results in a shrinkage of the Climate Action Fund, which relies on the revenue from emission permit auctions. The fall in emission permit prices, particularly amidst substantial increases in GHG reduction targets, signals a failure to adequately incorporate future expectations into the current market, thereby revealing a lack of proper functionality of the price mechanism within the ETS and ultimately undermining overall market efficiency.

III. Banking Restrictions Need to Be Relaxed

In its current framework, the K-ETS imposes restrictions on the banking of unused emission permit in order to stimulate the trading market.

The banking restrictions impede the price function and overall efficiency of the scheme.

To brace for potential reductions in allowance supply in the future, it is crucial to relax the banking restrictions.

In most cap-and-trade programs, participants are permitted to bank excess emission permits for the following year after surrendering an amount equivalent to their greenhouse gas (GHG) emissions. This encourages efficient utilization of surplus permits in the future. However, the K-ETS has encountered challenges in terms of liquidity in the spot market. Participants often choose to retain their emission permits as a risk mitigation measure, leading to limited permit trading activity. As the deadline for surrendering emission permits approaches each year, participants consistently express concerns about the difficulties of acquiring additional permits (Yu and Lee, 2020). To address these issues and promote market stability, the government began implementing constraints on banking emission permits based on the allocated emission allowances from 2017. In 2019, this regulation was adjusted to allow for emission permit banking relative to the volume of permits traded in the market, with an increasingly stringent approach.⁴⁾

These banking restrictions were designed to incentivise trading activity, and have contributed substantially to the downward pressure on emission permit prices (Bae *et al.*, 2022). Additionally, these restrictions discourage participants from banking surplus allowances for the following years, which reduces the incentive to demand more emission permits. As a consequence, despite the increase in GHG reduction goals, the ETS price may not increase since the current demand fails to align with incentive expectations. The persistently low permit prices, combined with the lack of effective price signals in the ETS, have led entities that were successful in achieving early emission reductions to scale back their efforts and opt to utilize their emission permits instead. This undermines the intended purpose of the ETS, as entities may be disincentivized from further reducing their emissions, hindering the progress towards meeting GHG reduction targets.

The increased GHG reduction targets for 2030 were not taken into account when devising the total allowance supply in the Phase III, which was planned in 2020. As a result, the forthcoming Phase IV, scheduled for 2026, is expected to experience a substantial contraction in permit supply as it incorporates the updated targets. Participants could disperse the supply shock by banking over multiple years. However, if the banking restrictions remain in place, the impact of the supply shock is likely to be concentrated within a short duration,

4) In Phase III, allowance banking is restricted to twice the net selling amount in 2021~22 and 2022~23, and only the net selling amount in 2023~24 and 2024~25.

starting in 2026, which marks the first year of Phase IV. This would induce heightened market volatility and impose a more significant burden on entities endeavoring to reduce their GHG emissions. Consequently, there is an urgent need to promptly relax the banking restrictions so that the increased GHG reduction goal can be effectively reflected in the ETS market.⁵⁾

Table 1. Types of Banking Restrictions in Major ETSS

K-ETS	EU ETS	New Zealand ETS	RGGI	California
Quantitative restriction based on the net selling amount	No limit	No limit	No limit	Holding limit

Note: 1) RGGI is a market-based cap-and-trade system engaged by 12 Northeastern U.S. states, targeting emissions from the electricity generation sector.

2) California ETS limits rollover through a holding limit quantity.

Source: Author's calculation based on ICAP, *Emissions Trading Worldwide – Status Report 2021*, 2021.

IV. Adoption of Supplementary Measures Concurrent with the Easing of Banking Restrictions

The quantity of emission allowances traded on the spot market has consistently increased throughout the Phase II and Phase III, indicating improved trading conditions since the implementation of banking restrictions in 2017. Still, relative to the EU ETS, the trading activity in the K-ETS remains substantially lower, thus raising concerns.⁶⁾

Given the expected long-term increase in allowance prices, the relaxation of banking restrictions may risk amplifying demand for emission permits, leading to a swift decrease in supply and trading volume. Market participants, particularly those with a higher propensity to hedge against uncertain GHG reduction costs and shifts in allowance supply, might be further encouraged to secure emission permits through banking. In the current scenario where allowance prices are low but predicted to rise in the future, a relaxation in banking restrictions is likely to trigger a short-term increase in demand and prices for emission allowances, accompanied by a reduction in supply.

5) The price of emission allowances began showing seasonality due to institutional features after banking criteria were adjusted to net selling amount. Starting each March, when participants verify their emissions by filling out a statement, demand uncertainty for emission allowances vanishes. Concurrently, to carry over excess surplus permits for the subsequent year, participants have an incentive to sell permits intensively until June, the emission permit submission deadline, to secure banked allowances. The concentration of sales during this period post-2020 led to decreasing allowance prices and increased market volatility. On November 24, 2022, the Emissions Trading Advancement Council moved the deadline for applying and submitting emission allowance banking to August 10 to lessen price volatility. However, the banking restrictions, based on the net selling amount, has not been substantially revised for improvement.

6) In 2021, the ratio of certified emissions to trading volumes remains very low at 0.08 for the K-ETS (based on KAU), in stark contrast to the EU ETS's 9.15.

Relaxing the banking restrictions could result in a short-term surge in demand and prices for emission permits. Therefore, alongside a gradual relaxation of banking restrictions, complementary measures should be implemented.

A potential issue arises from the possibility of participants experiencing difficulty in procuring allowances when needed or during periods of unpredictable market operations. This situation may create an undue incentive for participants to secure and retain residual permits for future use, essentially as precautionary savings. This highlights why the relaxation of banking restrictions should be implemented gradually, while concurrently instituting additional complementary measures. To address potential supply deficiencies in the trading market after easing banking restrictions, policies should be explored to expand supply channels and improve the long-term predictability of market operations. Firstly, an explicit market stabilization mechanism should be established, capable of providing a reserve of allowances in instances where permit prices surge excessively. The eligibility criteria for auction participants should be expanded to ensure a steady supply of emission permits. Additionally, it is crucial to enhance the predictability of emissions market operations by outlining a comprehensive long-term plan for the total emission allowance supply.

1. An Explicit Market Stabilization System

To mitigate potential market volatility that might result from the easing of banking restrictions, the establishment of an explicit, efficient market stabilization mechanism is of utmost importance. The current market stabilization instruments of the K-ETS are overly intricate concerning their application conditions and methods, casting doubt on their effectiveness. Additionally, their actual implementation often remains unpredictable, causing concerns about market uncertainty that could exacerbate the inclination towards banking.

The EU ETS's Market Stability Reserve (MSR) serves as the primary market stabilization scheme in the cap-and-trade market, adjusting the supply of emission allowances based on the observed volume of permits traded in the market.⁷⁾ The primary focus of this system is on stabilizing the trading volume rather than the price of emission allowances, so the MSR's direct impact on price stabilization may not be substantial. Furthermore, considering that the trading volume is calculated based on the cumulative supply and demand in the market, a time lag in the calculation process might lead to non-functioning of market stability mechanisms amidst escalating price volatility.

7) When the market has excess allowances, a certain amount is removed from the following year's auction. Conversely, when there's a shortage, a planned allowance reserve is supplied to the market.

By implementing an explicit market stabilization scheme utilizing reserves, emissions prices can be stabilized and market efficiency can be enhanced.

Hence, it becomes imperative to consider implementing a market stabilization system that adjusts the overall supply of emission allowances contingent on their prices, as demonstrated by successful practices in the New Zealand ETS, RGGI, California ETS, among others. In such a system, the total allowance supply fluctuates in response to the price of emission permits. For instance, by setting predetermined price thresholds and a reserve quantity of allowances, the planned reserve can be introduced into the market when the permit price surpasses a certain level. Conversely, if the price falls below the lower limit, the auction may be cancelled, or the government can proactively purchase emission allowances from the market to bank as a reserve. This approach, by modulating the supply based on price fluctuations, aims to promote a stable price range for emission permits, thereby averting excessive highs or lows. Given the ETS's inherent characteristics, where the government predetermines the total supply, the market stabilization system can be viewed as a mechanism that adjusts the allowance supply to resemble an upward-sloping supply curve,⁸⁾ rather than a fixed quantity. This methodology can not only achieve its primary goal of market stabilization but also enhance overall market efficiency.⁹⁾

Within the ETS framework, a single-price multi-unit auction and a trading market concurrently operate. A critical challenge of the multi-unit auction is that participants might submit bids under the true value of their allowances, which could depress auction prices.¹⁰⁾ This not only erodes auction revenue but also undermines the function of price discovery.¹¹⁾ Subsequently, the suppressed auction prices may reverberate back to the trading market.¹²⁾ The effect may be amplified when the supply is fixed in the multi-unit auction, enabling strategic low bidding while the allowance volume remains constant. However, if allowance supply correlates with the prevailing price,

8) The supply curve of a market stabilization system, utilizing allowance reserve, is depicted in Figure 2, where the total allowance supply rises with the price (upward-sloping curve). Meanwhile, the current K-ETS operates with a vertical supply curve, where supply remains steady regardless of allowance price fluctuations.

9) Not only is the demand highly price-sensitive, but the supply of emission permits is also highly price-sensitive, making it much easier to achieve market efficiency through the market function of the ETS.

10) In single-unit auctions, a second-price sealed-bid auction allows bidders to bid their true value, where the winning bidder pays the second-highest bid. This separates the winning bidder from the winning price. As Milgrom (1989) demonstrated, in multi-unit auctions where price and quantity are bid simultaneously, separating the bidder from the winning price is challenging. Bidders are therefore motivated to bid at a significant discount to their true value, resulting in much lower winning bids.

11) As per Yoon (2023), the bias of the difference between the auction price and the trading price in the K-ETS is 5.28% from January 2021 to September 2022, which is significantly larger than the EU ETS's -0.45% and New Zealand ETS's -0.97%.

12) Within the K-ETS, the trading price begins to fall from the auction day, indicating that the auction market's bias might be transferred to the trading market.

strategic underbidding could constrict supply and undercut individual participants' profits. Thus, presenting an ascending supply curve in relation to price may encourage participants to bid closer to their allowances' actual value. This method shows potential to optimize the effectiveness of emissions auctions and trading markets.

In a market stability mechanism underpinned by a price-based reserve plan, the price tier and the allowance reserve size can be preset, taking into account domestic institutional conditions. Major ETS systems employing a price-based market stability mechanism exhibit varied price tiers and supply curves, reflecting their unique domestic conditions. As shown in Figure 2, the number and variety of price tiers escalate in the sequence from New Zealand ETS to RGGI, and then to California ETS.¹³⁾

In the process of integrating such a price-informed system into the K-ETS, it is advisable to prioritize a simplified price tier system. While banking is meant to foster market flexibility, market stability reserves are designed to stabilize prices. Although their functions diverge, both mechanisms could collectively contribute to an upward shift in the price of emission allowances under the current K-ETS context. Importantly, as for the market stability scheme more price tiers could incite temporary price peaks influenced by loosened banking restrictions.¹⁴⁾ In this regard, it would be necessary to initially adopt a two-tier pricing model, comprising a reserve supply price and a bottom price, similar to the model implemented by the New Zealand ETS. In this system, the allocation of allowance reserves is triggered once permit prices reach the reserve supply price. The reserves are strategically distributed in pre-set amounts to preserve the fundamental objective of the ETS - emission reduction. The bottom price, on the other hand, modulates the supply to prevent the price of allowances from plummeting below a pre-determined threshold.

Furthermore, it is crucial to ensure a substantial gap between price

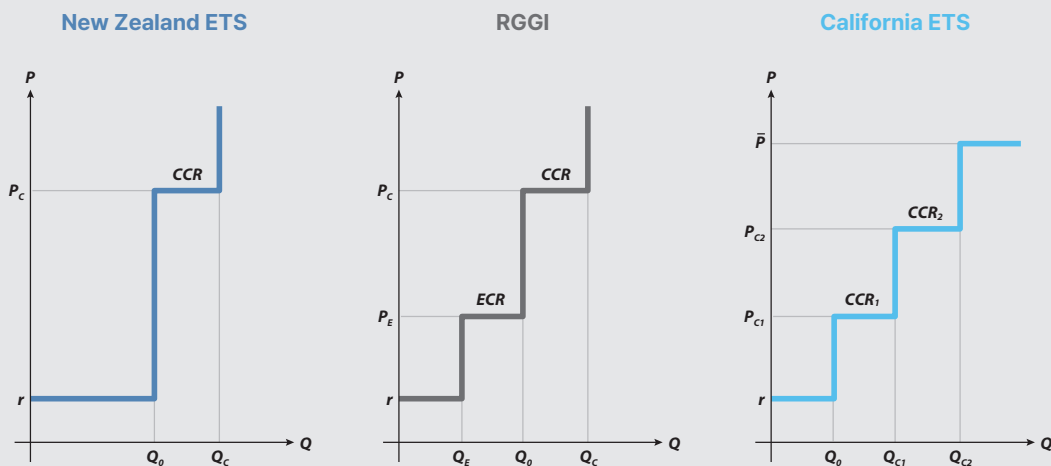
13) Fundamentally, Q_0 is the reference supply quantity for each ETS. For the New Zealand ETS, the allowance reserve price is set such that when the price of emission allowances reaches P_C , the Cost Containment Reserve (CCR) equivalent to $Q_C - Q_0$ is supplied. The price of emission allowances is adjusted to ensure that the supply does not drop below the bottom price, r . For RGGI, in addition to the New Zealand ETS's method, it has price tiers in which the Emission Containment Reserves (ECRs) decreases by $Q_C - Q_E$, when the price of emission allowances reaches P_E . For the California ETS, in addition to the bottom price and the two price tiers of allowance reserve, it has a price ceiling that controls the allowance supply to prevent the price of emission allowances from exceeding \bar{P} . Notably, as the number of price tiers increases, the supply curve tends to form an upward slope.

14) As previously noted, the market stability mechanism's supply curve lessens the chances of participants bidding beneath their true value at the auction. Specifically, as the number of price tiers in the market stability mechanism boosts supply flexibility, participants strategically lower their bids, causing a supply decrease. In other words, the more price tiers in the market stability mechanism, the higher the likelihood of higher winning bids in the domestic auction.

As for the price tiers in the market stabilization scheme, they should ideally consist of two straightforward tiers with a considerable disparity between them.

tiers. A low-set allowance reserve price might encourage even efficient participants to procure emission permits at the reserve price, bypassing the need for investments in abatement initiatives. Additionally, closely spaced price tiers could lead to the convergence of the price of emission allowances towards a particular tier, regardless of the prevailing market conditions (Friesen *et al.*, 2022).

Figure 2. Price Tiers of Market Stability Mechanism of Major ETSs



Note: New Zealand ETS, RGGI, and California ETS amended their price tiers over 2020–21.

Source: Author's calculation based on New Zealand Ministry for the Environment (2022), RGGI (2021), and California Air Resources Board (2022).

Eligibility for participation in emissions auctions, currently confined to entities subject to auctioned allocation, must be expanded to secure a consistent supply of emission permits.

2. Expanded Eligibility for Auction Participants

The share of auctioned allocations within the K-ETS is steadily escalating, distinguishing it from other global ETSs as it restricts domestic emissions auctions to those subject to auctioned allocation. The emission allowance auctions act as the primary conduit for securing emission permits, especially during periods marked by liquidity challenges in the allowance supply within the trading market. Additionally, the allowance reserve of the market stability scheme is supplied via these auctions. Given these factors, there is an emerging need to broaden the spectrum of emission allowance auction participants, which is currently confined to entities obtaining allowances for a fee. Such an expansion is vital to counteract potential supply deficits in the trading market.

Simultaneously, as part of the broader increase in auctioned allowances within the ETS, there are ongoing deliberations about differentiated increases in the ratio of auctioned allowances

targeted at the power generation sector (Kim, 2020). However, power generation entities already maintain a significant footprint in emissions auctions. Thus, augmenting the portion of purchased allowances allocated to this sector could lead to an undue concentration of power generation entities within the auction market. To neutralize this overrepresentation, it is crucial to extend the pool of auction participants.

Meanwhile, as part of the overall expansion of auctioned allowances within the ETS, there is ongoing discussion regarding the proposal to increase the allocation of auctioned allowances specifically for the power generation sector (Kim, 2020). However, power generating entities already have a substantial presence in emissions auctions, so increasing the share of auctioned allowances allocated to this sector may result in an excessive concentration of power generation entities in the auction market. To counterbalance this concentration, it is essential to expand the pool of auction participants.

Nevertheless, even with an expanded target for auction participation, small and medium-sized enterprises may still be reluctant in participation due to transaction costs, including managing human resources for auction participation. These burdens need to be alleviated by facilitating consignment trading through financial institutions and securities companies, thereby encouraging greater involvement from businesses of all sizes.

3. Enhanced Predictability for Market Operation of the ETS Market

Given the long-term nature of decisions to reduce GHG emissions, it's crucial to improve the predictability of the emissions trading market.

Informed decision-making for GHG emissions reduction requires a long-term outlook that encompasses investment in facilities, technology, and human resources. To drive early emission cuts and optimal dynamic decision-making among participants, long-term predictability of total allowance supply needs to be secured. Operational specifics can be addressed at each phase's onset, but prior announcement of the total supply reflecting NDC pathway can be released.

The EU ETS's decision on annual allowance supply is based on a linear reduction coefficient in which total allowance supply decreases by a certain percentage each year. The California ETS announces the annual supply until 2031 and offers a formula to calculate the total supply from 2032 to 2050. The New Zealand ETS yearly announces

the next five years' allowance supply. In contrast, the K-ETS reveals allocation plans shortly before each phase begins, offering little long-term predictability. In pursuant to the Paris Agreement, South Korea shall submit its NDC every five years for the upcoming decade. Thus, by pre-announcing the total supply that accounts for updated reduction targets, the long-term predictability of the market will be enhanced.

Additionally, the New Zealand ETS, RGGI, and California ETS, which all utilize price-based market stability measures, disclose the reference increase rate for each price tier. This serves as a price signal for emission allowances. Revealing long-term plans for allowance supply and tier prices of the market stability scheme is vital to equip market participants with sufficient information and enhance predictability. Additionally, to build market confidence in K-ETS's long-term plan, arbitrary interventions should be minimized and consistent market operations maintained.

V. Conclusion

This study explores the current state of K-ETS and proposes enhancements for its market functionality. Currently, the system grapples with the challenges of dwindling demand and prices for the permit, as the escalating GHG reduction targets aren't adequately mirrored in the allowance price, primarily due to the banking restrictions. These restrictions on carrying over excess allowances inhibit the inclusion of future expectations in the present allowance market, consequently lowering the incentive to secure additional allowances. To accurately mirror GHG reduction targets in the market and counteract supply shocks, a phased relaxation of the banking restrictions is necessary.

Such easing, however, could trigger short-term spikes in demand and prices, especially when permit prices are projected to increase. Hence, accompanying measures are needed to mitigate these impacts. One method is to implement a market stability mechanism that supplies extra allowance reserves based on pre-established price tiers. This mechanism not only balances the price and supply of allowances, but also improves overall market efficiency. Moreover, to counter potential market supply shortages, auction participation eligibility, presently restricted to entities that receive allowances for a fee, must be broadened. Lastly, to enhance the predictability of the market, the

long-term plan for total allowance supply, which reflects the reduction pathway, should be announced in advance. ■

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