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DEVELOPING EFFECTIVE BENCHMARK-BASED ALLOCATION FOR INDUSTRIAL SECTORS: THE CASE OF THE KOREAN ETS

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INTRODUCTION

Emissions trading systems (ETS) are increasingly being introduced as a way of cost-effectively reducing greenhouse gas (GHG) emissions to meet ambitious national climate change targets, including Nationally Determined Contributions and net-zero long-term goals under the Paris Agreement. A key concern for governments and industry, however, is how to protect industry's global competitiveness and prevent "carbon leakage", that is, the transfer of production to world regions with less ambitious climate policies that would lead to an increase in total emissions. To address this concern, ETS allowances are typically allocated for free to energy-intensive or trade-intensive industries at risk of carbon leakage.[1]

Different approaches to free allocation lead to different financial impacts on companies and rewards for low carbon action. Hence, this becomes a contentious and important topic. Benchmark (BM)-based allocation provides free allowances based on a company's level of production multiplied by an emissions intensity benchmark. Companies with high emissions intensity will get relatively fewer free allowances compared with their emissions and will have to buy allowances in the carbon market to make up for any deficit, whereas companies with low emissions intensity will get relatively more and can sell any surplus allowances. As such, this rewards companies with low emissions intensity, which are likely to have invested more in GHG reduction technologies. Grandfathering (GF), on the other hand, provides free allowances based on the level of historic emissions. This rewards companies with high historic emissions, which are likely to have invested less in GHG reduction technologies. Therefore, BM-based allocation is generally regarded as a more superior method than GF in terms of fairness. However, it is also considered more difficult to design and implement.

This policy paper shows how in the latest phase of Korea's ETS (K-ETS), BM-based allocation has been successfully implemented with some of the country's largest and most carbon leakage–exposed industrial sectors, including steel and petrochemicals. The lessons learned from this experience offer the following recommendations for jurisdictions planning to introduce effective free allocation systems:

- Use BM-based allocation as the free allocation method, and ensure key details are specified in the ETS legislation.
- Develop BM values for products associated with significant emissions.
- Determine a level of the BM value in a practical way, while seeking to be as ambitious as possible.
- Design the monitoring, reporting, and verification (MRV) system to reflect the boundaries of BM products from the beginning of the ETS.

The K-ETS covers more than 70% of Korea's total GHG emissions.

- Adopt a consistent and coordinated approach in the process of consulting with industry sectors and developing the BM-based allocation methodology.

1. BACKGROUND

The K-ETS is the first national ETS in East Asia and has been operating since 2015. It covers all entities emitting at least 125,000 tCO_2e per year or having an installation emitting at least 25,000 tCO_2e per year and six greenhouse gases.[2] The K-ETS covers more than 70% of Korea's total GHG emissions. It was preceded by the Target Management System (TMS), which was implemented in 2012 and provided valuable training in GHG emissions monitoring, reporting, and verification.[3]

The K-ETS has an absolute and declining cap based on the share of K-ETS entities' historic emissions compared with total national emissions, multiplied by the total national GHG emission targets in the relevant years. Following the announcement of Korea's net-zero GHG emission goal by 2050, medium-term targets are expected to be tightened to align with this goal, leading to a consequent tightening in the K-ETS cap.

The cap is composed of ex ante allocation amounts for existing facilities (free allocation and auctioning) and a reserve for new and expanded facilities.[4] The share of auctioning is gradually increasing under the K-ETS to strengthen the carbon price signal and provide funds for investment in low carbon technologies. 10% of the ex ante allocation will be auctioned in Phase 3, with the remainder (90%) being allocated for free. For the sectors deemed to be exposed to a significant risk of carbon leakage, 100% of ex ante allocation is allocated for free. The auctioning share is expected to increase further in Phase 4, with free allocation decreasing.

2. BM-BASED ALLOCATION IN KOREA'S ETS

Expansion of BM-Based Allocation

The initial and default method of free allocation under the K-ETS is grandfathering, with BM-based allocation gradually expanding as shown in Table 1. In Phases 1 (2015–17) and 2 (2018–20), BM-based allocation was applied to sectors where it was easiest to do so (where little or no change to existing MRV data was necessary

TABLE 1: **EXPANSION OF BM-BASED ALLOCATION IN K-ETS**

SECTORS[a]	PHASE 1 2015-17	PHASE 2 2018-20	PHASE 3 2021-25	PHASE 4 2026-30
CEMENT, OIL REFINERIES, & DOMESTIC AVIATION				
+ POWER, DISTRICT HEAT, & WASTE[b]				
+ STEEL, PETROCHEMICALS, PAPER, BUILDINGS, & WOOD				
ALL SECTORS				

[a] The confirmation of sectors for which BM-based allocation applies is given in the National Allocation Plan for each phase, following consent of the relevant industry sectors.

[b] Electricity consumption at sewage treatment plant.

[1] The alternative to free allocation is auctioning, which should be applied to sectors that can pass their carbon costs to customers and the share of auctioning should be increased as much as possible over time to more completely adopt the polluter-pays principle and drive low carbon action.

[2] CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6

[3] The TMS still continues for smaller emitters outside the scope of the K-ETS.

[4] Additional reserves, covering market stabilization, market making, and liquidity management, are outside the cap.

Steel and petrochemicals are Korea's largest industrial GHG emitting sectors.

as it aligned well with the BM boundary – such as cement, aviation, power, district heat, and waste) and where companies requested it (such as oil refineries). Further expansion in Phase 3 to sectors such as steel and petrochemicals was more challenging, as these sectors are far more complex than previous ones to apply BM-based allocation in that some significant modifications to existing MRV data are required.

Examples of facilities in the steel and petrochemical sectors in Korea are shown in Figures 1 and 2, illustrating their size and complexity.

BM Methodology

The K-ETS legislation does not specify the basis for determining the BM value, so various methods can be used. For Phases 1–3, the BM value is based on the weighted-average emissions intensity of all facilities making the BM product, as shown in Box 1.

FIGURE 1: Integrated steelworks in Korea - the steel sector is Korea's largest industrial GHG-emitting sector

FIGURE 2: Petrochemical plant in Korea – the petrochemical sector is Korea's second-largest industrial GHG-emitting sector

The key advantages of this approach to determining the level of BM value are simplicity and the enabling of the development of BM values even in sectors with a small number of facilities. The disadvantage is that the level is not very ambitious. However, as with other ETS with an absolute cap, the cap ultimately determines the amount of emissions reduced by the K-ETS. The initially calculated allocation amounts based on the BM values are multiplied by a "correction factor" if necessary to reduce the actual amounts that are given to companies so that the maximum amount of allocation available under the K-ETS cap is not exceeded. This correction largely addresses the issue of BM ambition levels under a capped ETS although there will still be a greater risk of excessive free allocation than with a more ambitious approach. As such, it is under consideration to determine BM values in Phase 4 based on best available techniques (BAT).

The overall allocation calculations are also shown in Box 1, including the last equation that involves both BM and GF allocation. The K-ETS has adopted a temporary method of determining the larger value between these two methods as the final value for companies in 5 sectors to which BM-based allocation is newly applied in Phase 3. This has been a very effective way of addressing opposition from some companies with high emissions intensity against BM allocation. However, this is valid only for Phase 3 allocation, and from Phase 4, BM-based allocation will be mandatorily applied to all companies in these 5 new BM sectors.

If MRV data is aligned to BM boundaries, benchmarking is relatively straightforward.

BOX 1: BM METHODOLOGY UNDER PHASE 3 OF K-ETS

BM VALUE (tCO_2e/t)	=	Total GHG emissions of facilities subject to product BM (tCO_2e)[a] / Total production of facilities subject to product BM (t)[a]
BM ALLOCATION (tCO_2e)	=	BM value (tCO_2e/t) x historic activity level (t)[a] x correction factor[b] x CL factor[c]
GF ALLOCATION (tCO_2e)	=	Historic emission level (tCO_2e)[a] x correction factor[b] x CL factor[c]
FINAL ALLOCATION (tCO_2e) (temporary approach)	=	Max (BM allocation, GF allocation)

NOTES

[a] Based on 2017–19 data from the companies' GHG emissions inventories, for all relevant facilities, submitted to the government at the end of March each year. The data for 2019 was available by March 2020; following a 3-month determination process the BM values for Phase 3 were announced by June 2020, six months before the start of the phase. For companies in sectors requiring modifications to MRV data in Phase 3 to align with BM product boundaries, such as steel and petrochemicals, the approval of the improvements was made by 2019 to avoid delays in determining the BM values.

[b] Correction factor to adjust, if necessary, the sum of BM- and GF-based allocations so that it does not exceed the ex ante allocation cap.

[c] CL (carbon leakage) factor is 1.0 for sectors exposed to significant risk of CL. For non-CL sectors, it is 0.9.

The actual BM details for the steel, petrochemical, and paper sectors are shown in Annex 1 including the BM products, values, and boundaries.

3. CHALLENGES AND SOLUTIONS OF BM-BASED ALLOCATION FOR INDUSTRIAL SECTORS

BM Products including MRV Data

The procedure for determining BM products includes the following steps:

a. Are the GHG emissions from the product significant?

b. Is the number of facilities producing the product sufficient to make a BM meaningful?

c. Can product definitions enable comparisons of emissions intensity across companies? Are production volumes proportional to GHG emissions?

d. Can a BM boundary be set and MRV be performed for GHG emissions?

Among these steps, (a) to (c) were sufficient to draw a rough conclusion at the beginning of consultation with companies. However, it took quite a long time to discuss (d). Key issues involved the following:

- *Including certain sub-facilities.* BM boundary setting defines specific and detailed processes or sub-facilities for comparing emissions intensity. There is no problem if all companies have the same sub-facility. When they do not, however, this can be a sensitive issue among companies, for example relating to pollution control facilities at power stations, energy recovery facilities, and sub-facilities that are outsourced.
- *Developing MRV data in line with the BM boundary*. If the facility's MRV data is already aligned to BM boundaries, there is no problem. This is also true if existing MRV data is not aligned, but other sources of monitoring data are available such as energy and production data from companies' enterprise resource planning (ERP) systems. When neither of these is available, alternative methods are used, for example, estimations based on rated capacity of equipment (from specifications), operating time, and other relevant factors.[5] Overarching ETS MRV rules should pertain regardless of the methods used.

[5] Even in this case, the company's total emissions will remain the same as those calculated using calibrated instruments

It was possible to develop benchmarks for integrated steelworks despite only a small number of installations.

TABLE 2: **CHALLENGES AND SOLUTIONS IN DETERMINING BM PRODUCTS**

SECTORS	CHALLENGES	SOLUTIONS
STEEL	There are only two integrated steel companies in Korea and only three installations, yet they have significant GHG emissions. One overall BM product from an integrated steelworks was problematic due to differences in where intermediate products were processed (inside or outside facility boundaries). Integrated steel companies sought to avoid a direct comparison of their overall performance. One company had installed coke dry quenching (CDQ) to recover energy and the other had not. The company without CDQ insisted that energy recovered from CDQ should be excluded from the BM boundary. Electric arc furnace (EAF) high-alloy steel has a small number of manufacturers, low emissions, and large differences in product characteristics.	BM products for individual process lines at integrated steelworks[a] plus one BM product for EAF steelmaking (high alloy steel not chosen): • Coke • Sintered iron ore • Hot metal • EAF carbon steel Energy recovery facilities are included in the BM boundary to induce GHG reduction (the company without CDQ subsequently announced plans to invest in it).
PETRO-CHEMICALS	Some products, such as vinyl chloride monomer and ethylene oxide/ethylene glycol, have a small number of manufacturers. Some sub-facilities are associated with one BM boundary at one company and a different one at another. The production ratio between ethylene and propylene at naphtha cracking center (NCC) plants can vary, but agreeing weights for each product based on energy intensity can be challenging.	BM products for basic chemicals or monomers: • Ethylene, propylene, etc. from naphtha cracking center (NCC) – based on input of a single raw material used to produce various products[b] • Benzene, toluene, & xylene (BTX) – based on input as above • Butadiene (BD) – based on input as above • Styrene monomer (SM) Sub-facilities are assigned to BM boundaries in line with the practice of the majority of companies.
PAPER	The original proposal was to determine 5 BM products. However, some companies produce several products but have no measuring instruments to split the energy used for drying each product.	Product BMs will be delayed until after measuring devices are installed. Instead, a BM based on energy input is applied and acts as a trial for wider application of this approach to sectors in Phase 4 as a fallback option when it is challenging to determine BM products.

[a] By allowing split by process line, five coke, five sintered iron ore, and seven hot metal process lines were included in determining the BM value.

[b] Such a method could be agreed upon by the companies because the industry used the same approach to compare NCC plant's energy intensity before the implementation of the ETS.

This case study provides valuable insights for other countries to develop an effective free allocation system more quickly and easily.

Table 2 shows specific challenges and solutions for determining BM products in Phase 3 of K-ETS.

Buy-In and Cooperation with Industry

Under the K-ETS, companies need to be persuaded about the need to introduce BM-based allocation as Korean ETS legislation allows both BM- and GF-based methods.[6] While it is relatively easy for companies with low GHG emissions intensity to agree to BM allocation, it is more difficult for those with high GHG emissions intensity that may face higher burdens compared with GF methods. The temporary policy of basing allocations on the larger value between BM and GF allocations helped achieve industry buy-in. Although this will tend to increase initial allocation amounts, a correction factor will counteract this effect and ensure that the final allocation amounts comply with the total cap. In addition, an energy BM was available for the government to apply if companies were not cooperative, providing a useful backstop.

The K-ETS relies on the consent and voluntary cooperation of companies to provide production volume data and energy/emissions data at the BM boundary level. Companies with high GHG intensity could be less cooperative, as they would be better off with GF-based allocation. If they do not provide data, the BM value would be biased toward low GHG intensity facilities, resulting in a low BM value and putting all parties at a disadvantage. As such, all companies agreed to provide data.

It was recognized that all affected companies should be consulted during the BM development process and a methodology developed that they all could agree was fair; however, some were passive in the discussion process. Thus, the government organized on-site visits and one-on-one interviews to explain the BM methodology development process in detail and collect relevant comments that were considered in the final decision process.

Overall, five years of in-depth studies and consultation with affected sectors on BM-based allocation took place.

4. LEARNING POINTS AND RECOMMENDATIONS

The successful experience of developing BM-based allocation in the K-ETS could encourage other jurisdictions to develop effective free allocation systems. It provides valuable insights for other jurisdictions to not only develop a similar system but also to do so more quickly and easily. The recommendations and learning points are as follows:

- **Recommendation 1: Use BM-based allocation as the free allocation method, and ensure key details are specified in the ETS legislation.** It becomes problematic if the ETS legislation does not specify the type and key details of free allocation, as this can lead to time-consuming debates about different approaches. The EU-ETS legislation, for example, specified the key details that helped significantly in the smooth introduction of BM-based allocation. Grandfathering is not recommended, as it does not reward early investments in GHG mitigation and low carbon technology.

- **Recommendation 2: Develop BM values for products associated with significant emissions.** Product BMs

[6] The legislation requires that opinions of various stakeholders are collected and reflected in the process of establishing the National Allocation Plan.

Under an ETS with an absolute cap, the cap ultimately controls emissions reductions, however BM values should still be as ambitious as possible.

can be successfully developed even for complex industrial sectors. Alternatives include making virtual products based on proxies such as energy input.

- **Recommendation 3: Determine a level of the BM value in a practical way, while seeking to be as ambitious as possible.** The K-ETS approach of using weighted-average emissions intensity is relatively simple and enables values to be developed even in sectors with a small number of facilities. The initially calculated allocation amounts using the BM value can be multiplied by a correction factor if necessary to reduce the actual amounts to be given to companies so that the maximum amount available under the ETS cap is not exceeded. As such, the cap ultimately controls emissions levels. In Phase 4, the K-ETS is considering to adopt a more ambitious level of the BM value, based on best available techniques. Other ambitious approaches can also be considered such as the average of top 10% best performers as applied by the EU-ETS. These approaches will help not only to avoid an excessive level of correction factor that companies dislike, but more importantly provide a stronger incentive for companies to reduce their GHG emissions intensity.

- **Recommendation 4: Design the monitoring, reporting, and verification system to reflect the boundaries of BM products from the beginning of the ETS.** Several technical challenges can arise if emissions data is not developed at the level of the BM product from the beginning. It will be time consuming to make changes to the MRV system and could delay introduction of BM-based allocation.

- **Recommendation 5: Adopt a consistent and coordinated approach in the process of consulting with industry sectors and developing BM-based allocation methodology.** It may not be easy to successfully introduce BMs if different principles are applied to each sector for setting BM boundaries and BM values or if consultations with industry sectors are undertaken in an inconsistent and uncoordinated way.

ANNEX 1: **BM DETAILS FOR STEEL, PETROCHEMICAL, AND PAPER SECTORS UNDER PHASE 3 OF K-ETS**					
SECTOR	PRODUCT	BM VALUE	BM UNIT	BM BOUNDARY	EXCLUSIONS
STEEL	Coke	0.8702921 tCO_2e/t	Tonnes of coke	Total GHG emission activities of all processes utilized from raw material input to coke production, such as coke oven, coke cooling, energy recovery, coke oven gas purification, pollution prevention facility, etc.	
	Sintered iron ore	0.278873861 tCO_2e/t	Tonnes of sintered iron ore[a]	Total GHG emission activities of all processes utilized from raw material input to sinter ore production such as sintering machine, sinter ore cooling and crushing, waste heat recovery, pollution prevention facility, etc.	Exhaust gas denitrification
	Hot metal	0.42872757 tCO_2e/t	Tonnes of hot metal[b]	Total GHG emission activities of all processes utilized from raw material input to pig iron production, such as blast furnace, hot stove, blast furnace slag treatment, energy recovery, blast furnace gas purification, pollution prevention facility, etc.	FINEX© process
	Electric arc furnace (EAF) carbon steel	0.31824712 tCO_2e/t	Tonnes of crude carbon steel such as slabs, blooms, & billets	Total GHG emission activities of raw material input, electric arc furnace, ladle furnace, continuous casting facility, energy recovery, slag treatment, pollution prevention facility, etc.	Post-processing such as hot rolling, oxygen production, & water treatment
PETRO-CHEMICAL	Naphtha cracking center (NCC) plant producing olefins such as ethylene, propylene, etc.	0.32644755 tCO_2e/t	Tonnes of raw material input directly to the cracking furnace such as naphtha and liquefied petroleum gas	Total GHG emission activities of cracking furnace, primary separation, quench, compression, acid gas removal, chilling train, methane removal, C2/3 purification, C4 removal, pyrolysis gasoline separation, gas turbine generator, fuel gas compression, hydrogen purification, & boiler feed water	Olefin conversion, wet oxidation, acetylene recovery, C5 removal, logistics/storage, cooling tower, gas supply, water/waste water treatment, waste gas incineration, & city gas treatment
	Benzene, toluene, xylene (BTX) plant that uses olefins produced in NCC process as main raw materials	0.15989477 tCO_2e/t	Tonnes of raw material input directly to hydrogen purification[c] + auxiliary raw material input after hydrotreating purification + C5 removal.	Total GHG emission activities of hydrotreating purification, aromatic extraction/purification, C5 removal/purification, C9+ purification, & hydrotreating dealkylation	Hexane purification, cooling tower, gas supply device, & waste gas incineration

ANNEX 1: **BM DETAILS FOR STEEL, PETROCHEMICALS, AND PAPER SECTORS UNDER PHASE 3 OF K-ETS**					
SECTOR	PRODUCT	BM VALUE	BM UNIT	BM BOUNDARY	EXCLUSIONS
PETRO-CHEMICAL (continued)	Butadiene (BD) plant	0.18726718 tCO_2e/t	Tonnes of raw material input directly to heating process such as mixed C4.[d]	Total GHG emission activities of mixed C4 heating, butadiene extraction/distillation/ purification, & solvent recovery/ purification	Low purity butadiene pretreatment, MTBE, logistics/storage, cooling tower, gas supply system, & waste gas incineration
	Styrene monomer (SM) plant	0.44755891 tCO_2e/t	Tonnes of styrene monomer	Total GHG emission activities of ethyl benzene reaction/distillation, styrene monomer reaction/ distillation, & temporary storage tank	Catalyst manufacturing, phenyl acetylene reduction, hydrogen purification, logistics/ storage, cooling tower, gas supply device, & waste gas incineration
PAPER	Combustion facility using biomass[e]	34.8856 tCO_2e/TJ	Gross calorific value (TJ) of input energy	Combustion activities using biomass as fuel included	Facilities at place of business with emissions $<3ktCO_2e$; waste treatment facilities
	Combustion facility using non-biomass	56.3399 tCO_2e/TJ	Gross calorific value (TJ) of input energy	Combustion activities using non-biomass as fuel included	As above

[a] Excluding sintered ore that reenters the BM boundary.
[b] Including foundry pig, excluding pig iron produced in FINEX© process
[c] Limited to raw materials input from outside the BM boundary, excluding hydrogen and raw materials produced and re-entered inside the BM boundary.
[d] Limited to raw materials input from outside the BM boundary, excluding raw materials produced and re-entered inside the BM boundary.
[e] Waste wood, black liquor, and bio solid refuse fuel.