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ORCID Ha, Suk Yong 0000-0002-3971-9931

A Study on the Environmental Effectiveness and Dynamic Efficiency in the Phase I of KETS (Implications from the Comparison with EU ETS)

Ha, Suk Yong

Ph.D Student, Research Center of Climate Change Institute, Dept. of Ecologic Phytochemistry, Hankyong National University, Kyonggi-Do, Korea

ABSTRACT

This study is an overall review and assessment of the results of Phase I of Korea Emission Trading Scheme (KETS) in comparison with those of early stages (Phases I and II) of EU ETS. This comparative evaluation with EU ETS intends to derive implications for the next stage of KETS. As a methodology, comparison with EU ETS is based on the two criteria of environmental effectiveness and dynamic efficiency. On the basis of the criteria, this study examines achievement of an accumulative cap in terms of environmental effects and stability of emission allowances price in terms of dynamic efficiency during Phase I of KETS. Based on environmental effectiveness and dynamic efficiency, Phase I of KETS has been relatively successful compared with EU ETS. Emission allowance allocation reflects the Linear Reduction Factor (LRF) under the Roadmap for 2030 National GHGs Reduction Goals. The government has stabilized the market by actively intervening through a flexibility mechanism to maintain balance between supply and demand of emission allowance, resulting in a relatively stable price of Korean Allowance Units (KAUs). Based on the issues of EU ETS, stringent cap management should continue in the next phase as an incentive to invest in emission reductions. Such action will ultimately motivate companies to more actively shift to low-carbon technology to reduce GHGs emissions. When KETS can provide a clear price signal for the transition to low-carbon technology, it will play a significant role in emission reduction along with other climate policies.

Key words: *Korea Emissions Trading Scheme (KETS), EU Emission Trading Scheme (EU ETS), Environmental Effectiveness, Dynamic Efficiency, Price Signal, Market Stabilzation, Market Reseve, Banking*

1. Introduction

The first planning period from 2015 to 2017 has passed since the launch of the Korea Emissions Trading System (KETS) on Jan. 2015. The submission of the allocated emission allowances during the Phase I of the KETS was completed at mid of 2018. According to the data of Ministry of Environment (2018), 68% (402 companies) among the 592 companies subject to submission of emission allownaces were able to fulfill the compliance, while the others (32%, 190 companies) were lacking the allocated emission allowances to submit. Most of them were submitted through purchase of emission allowances and offset credits. The total emission during the same period was 1.669 billion tons CO_{2eq}. The data (Table 1) showed that there was no shortage of emission allowances with a margin of about 1% (Ministry of Environment, 2018).

In 2014, when the first plan period was set up, the Federation of Korean Industries (FKI) estimated that the government's cap amounts 280 Mt CO_{2eq} lower during the Phase I than industry-calculated figures, making the market itself unable to operate (Kim, 2015). FKI assumed that there would be no emission-trading sellers. In the result, an additional burden of up to 28 trillion KRW would incur to the companies, applying the 100,000 KRW penalty per tCO_{2eq}. Contrary to the predictions at the time of the original plan, there were no cases that an excessive cap setting and insufficient allocation occurred. There were also no sharp

† **Corresponding author:** sunward.ha@gmail.com (17579, Climate Change Research Center, 327, Jungang-ro, Anseong-si, Gyeonggi-do. 17579, Republic of Korea, TEL: 82-31-670-5085)
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rises in prices, unintentional increases in defaults and heavy penalties.

According to the Basic Plan of Emission Trading System (Ministry of Strategy and Finance, 2014), the first goal of the Phase I of KETS is to settle the trading system by accumulating the experience of government and corporate through flexible operation and stabilizing the infrastructure for MRV execution. On this point of view, a general assessment on the first stage's results of the KETS seems to be satisfactory.

The Phase II of KETS is currently in the middle of progress. By December 2019, the basic plan for Phase III has to be established. Afterward the allowances allocation plan will be prepared till June 2020. At this point in the process of stabilizing the KETS, it seems to be relevant to review and evaluate the results of Phase I of the KRTS in order to provide guidance for the next stage.

2. Literature Review

The assessment on the KETS has been conducted in the briefings and reports on the operational results by the government organizations. Especially, many studies on the Phase I of KETS (Table 2) were mainly driven by policy tasks. And most of them focus on a partial topic and issue.

Looking at the main research direction, various topics were covered. Regarding to the policy suggestions, main issues was related to the lack of supply compared with the demand for emissions allowances and the problems of current method of free allocation (Kim and Shim, 2017, Ahn et al. 2018). With regard to policy execution, the researches about the borrowing limit policy (Yu and Lee, 2018) and the economic impacts of the KETS in the First Plan Period were conducted. In addition, the agenda setting (Kang and Kim, 2019) and the recommendation on the policy direction for the next phase of the KETS (Oh and Yoon, 2018) were proposed. Most of the studies and researches focus on partial issues, submitting alternatives for supplementation or improvement of current institutions.

In contrast with the previous studies, this study is to perform a overall review and assessment of the results of the Phase I of KETS by comparison with those of early stages (Phase I and II) of the European Emissions Trading System (EU ETS). Given that there was a lot of trial and error in the early stages of the EU ETS, a comparative assessment with the EU ETS will help draw implications for the next stage of the KETS.

3. Methodology

The EU ETS has been going through many trials and errors since early on. Since the pilot phase of the scheme from 2005 to 2007, the EU ETS has experienced radical reforms introduced in the second phase (2008 to 2012). Reform policy measures have became into effect during the third trading period from 2013 to 2020.

In this study, the comparison with the EU ETS is based on the two criteria: the environmet effectiveness and the dynamic efficiency. Those are the basic concepts for the objectives and operational evaluations that were ultimately

Table 1. Eimission Allowances Allocation Status during the Phase I in KETS

(Unit: M t CO_{2eq})

Year		2015	2016	2017	Total
Pre Allocation ①		543,107	535,858	529,648	1,608,613
Changes ②	Additional	9,091	16,105	26,326	51,492
	Cancelation	△13,351	△20,615	△10,620	△44,586
	Early Action Reduction	-	29,412	21,980	51,392
	Plan Adjustment	-	-	18,643	18,643
Final Allocation (①+②)		538,847	560,760	585,977	1,685,584

(Ministry of Environment, 2018)

Table 2. Studies and Researches Related to the Evaluation and Accessment on the KETS Phase I

Title	Authors	Study Background and Objectives
The Effects of a Borrowing Limit Policy during the First Compliance Period of the Korean ETS (2019)	Yu and Lee	To analyze the effects of the relaxation of the limit of permit borrowing from upcoming compliance years to mitigate market participant concerns regarding volatile permit.
Operation of the KETS and its Establishment: To Identify Some Agendas for Institutional Settlement (2019)	Kang and Kim	To focus on the agenda setting and the presentation of the necessary topics for the future research through the analysis on the Phase I of KETS.
A Study on Feasibility of Utilizing Consignment Auction to Activate the KETS (2018)	Ahn et al.	To examine the possible use of consignment auctions to promote emissions allowances trading in Korea through the study on the emissions allowances trading system of California launched and operated in the US.
A Study of Policy Change on K-ETS and its Objective Conformity (2018)	Oh and Yoon	To evaluate the policy change in the K ETS regarding conformance to its objectives and to suggest K ETS policy direction during the 3rd phase (2021 – 2025).
Analysis on the Economic Impacts of the KETS in the First Plan Period (Year 15~17) (2018)	Oh et al.	To evaluate whether the KETS contributed to the 'cost effective reduction' during the Phase I: appropriateness of carbon prices, market activity, transaction costs etc.
Diagnosis on KETS and its Improvement Plan (2017)	Kim and Shim	To review the operation status of the KETS during the first two years, to identify various problems in the operation process, and to propose policy alternatives.

*Excluding the briefings and reports by the government organizations

pursued when the EU ETS was introduced. EU ETS Directives of EC (2003) states that the EU ETS "promote GHGs reductions in a cost-effective and economically efficient manner." Egenhofer et al. (2010) explains it as follows. In a short-term perspective, the EU ETS aims to reach effectively the emission reduction targets till year 2020 at lowest possible costs. On the other hand, as a long-term vision till 2050 and beyond, it has to accelerate efficiently the development of low carbon breakthrough technologies as an climate change policy in EU. In subsequent study, he sumarizes that the EU ETS aims to achieve its cumulative cap through its dynamic efficiency (Edenhofer et al., 2014).

The environmental effectiveness is mainly the concept related to whether the emission target or the permitted emissions given by the cap has been overachieved or not (Laing et al., 2013). The dynamic efficiency is the ability of the emission trading scheme to ensure attainment of its cumulative cap at least cost, by optimally incentivizing mitigation efforts, investments, and research and development (R&D) over time (Edenhofer et al., 2014).

In general, the dynamic efficiency represents itself as the price signal. Edenhofer (Edenhofer et al., 2014) points out that the carbon price in the emission trading market indicates the level at which internal GHG reductions are more cost-effective than purchasing and surrendering emission allowances. Through the dynamic efficiency, the companies under the ETS get an incentive to implement internal abatement options cheaper than the allowance trading.

On the basis of the mentioned citeria, this study examines how well a acumulative cap has been achieved in terms of environmental effects and how stable the price of emission aloowances has been in terms of dynamic dynamics during the Phase I of the KETS, in comparson with those of the EU ETS. Considering the short experience of the KETS implementation, there are little data and researches enough to carry out satisfactory study, applying directly the above criteria. But the comparative evaluation with the EU ETS which has a long history of the emission trading scheme is helpful to derive implications for the next stage of KETS.

In the next chapter, first, the causes and events of the

problems faced by the early stages of the EU ETS (Phase 1 and 2) will be traced in details. Second, a discussion of reform options for the activation of the EU ETS will follow. Third, these discussions and lessons learned at the EU ETS will be used for the first stage review of KETS.

4. The performance evaluation of the EU ETS

4.1 Evaluation of environment effectiveness

Regarding the evaluation of the environmental effectiveness in the EU ETS, main issues were to review and compare the driving factors of emission abatement during the Phases. According to Edenhofer et al. (2014), those reviews focus on analyzing whether the emission reductions attributed to the EU ETS or whether other external factors such as the economic recession, renewable and energy efficiency policies are more relevant factors for emission reductions.

According to Brown et al. (2012), the EU ETS reduced carbon emissions by 120 million to 300 Mt CO_{2eq}, or roughly 2~5% below the BAU scenario during the phase I (2005–2007). The additional reductions of approximately 340 Mt CO_{2eq} in the first 2 years of Phase II (2008–2009) were achieved. It amounted for roughly 8% below projected BAU emissions. Therefore during those periods in total, emissions within the EU ETS reduced by around 3% of estimated BAU emissions (Fig. 1).

Although many studies including Martin et al. (2014) show the different figures of reduction amount by different methodology, they conclude that there has been quantitatively effective abatement across in both the phase I and during the first 2 years of phase II since the introduction of the EU ETS, helping the EU reach its Kyoto reduction target.

In line with the general macro level studies, many scholars looked into the abatement at business sector levels. The energy sector played a special role for abatement under the EU ETS. First, Ellerman et al. (2010) points out that emissions by energy sector exceeded the allocated allowances in 2005 and 2006, in spite of receiving more than 40% of the annual emissions allocation. The main abatement efforts were driven by fuel switching; the conversion of oil or coal fired powers stations to gas fired power stations. Ellerman et al. (2010) concludes that the EU ETS influenced the fuel switching from coal to gas power stations, mostly through to EUAs price signals, either in terms of actual prices or future price expectations.

Against this argument, using a complex model of energy use and price interactions between fuels (e.g. coal and gas), Delarue et al.(2008) argue that fuel conversion occurred due to external factors not related to fuel prices reflected in EUA prices.

Fig. 1. Allocation of Emission Allowances (EUAs) & Verified Emission by EU all countries (2005 to 2012). (EEA, 2019)

However, despite the effects of external reasons, they find out that the magnitude of the fuel switching was likely to be attributed to a potential influence from EU ETS rules and future expectations as its regulatory effect. Many studies including Ellerman et al. (2010) presented evidence that EU ETS would have provided the companies with the incentives for the fuel switch.

Regarding the abatement of industry sector, Ellerman et al. (2010) adds that its abatement occurred largely through the trade of allowances with the energy sector. He concludes that the EUAs price, in particular the expected future EUAs price, was driving companies to invest in energy efficiency. The high rise of output prices in the electricity sector caused by the EU ETS affected the industrial sector as a whole. Indeed, on the one hand, the power sector was the most motivated to reduce emissions due to the strict allocation of the EUA, while on the other hand the industrial sector attempted to effectively abate GHGs emission mitigate through the EU ETS market.

At any way, as long as the annual cap is observed as a legally binding target and the non-compliance faces severe penalties, it is certain that environmental effectiveness of the EU ETS is delivered during Phase I and the first 2 years of Phase II.

However, other situations have developed since the rest of Phase II. The actual emissions between 2009 and 2013 stayed below the annual cap. Macroeconomic fluctuations such as the recession in year 2008 affected drastically emissions. A recession might result in the increased EUAs supply. Edenhofer et al. (2014) mentions that this would be responsible for a surplus of EUAs as a deference between the pre-allocated EAUs and the verified emission. On the other hand, the development of renewables togather with the economic downturn, market participants didn't need to undertake additional abatement.

Gloaguen and Alberola (2013) evaluates the drivers (Table 3) behind the cumulative emission reductions, comparing to BAU scenario. They find out that the cumulative emission reductions were within range between 1,324 Mt CO_{2eq} and 1,413 Mt CO_{2eq}. The following is the main findings from the studies.

While the annual cap of the EU ETS has been achieved for each year of its operation, the main reasons for these emissions reductions came from factors other than the EU ETS.

According to the analysis of Gloaguen and Alberola (2013), there were overlapping policies with EU ETS. EEA highlighted the importance of co-benefits between air pollution measurements (EU ETS) and climate policies such as 'EU Climate and Energy Package' and 'EU Large Combustion Plant Directive'. Emissions was expected to decline as a result of improvements in energy efficiency and fuel switch motivated by the restricted supply of EUAs with relatively high price. They give an evidence that the implementation of the EU Climate and Energy Package leaded to a emission reduction from sectors outside the EU ETS, such as transport and residential and commercial buildings. The EU Large Combustion Plant Directive also resulted in reducing a emissions abatement through a fuel switching of coal to gas.

Table 3. The summary of Emission Reduction Drivers in sectors between 2005 and 2011

Emissions reduction drivers	Mt CO_{2eq}	%	Remarks
Policies from EU climate and energy package for 2020	766 ~ 805	60%-80%	GHG reduction, renewables, energy efficiency
Energy efficiency		20%-30%	
Impact of the EUAs price signal		0-10%	Relatively small
Economic crisis	296 ~ 346		
Fuel price variations	262		
Total	1,324 ~ 1,413		

(Gloaguen and Alberola, 2013)

Nevertheless these arguments does not directly lead to the conclusion that the EU ETS did not contribute to emission reductions. Importantly, as long as the EUAs' price was positive, the EU ETS contributed to abating emissions in other ways than renewables or energy efficiency policy. Brunner et al. (2009) also points out that complementary measures such as insulation and fuel efficiency standards should be employed in order to exploit the abatement potential of non-covered sectors form EU ETS. They argue that both an absolute cap on emissions and complementary instruments were required to reduce emissions in a cost efficient manner. In fact, Both are complementary rather than conflicting factors for abatement.

In conclusion, on the environmental effectiveness point of view, the evaluation on the early stage of the EU ETS seems to be positive. At macro levels, there was an contribution of the EU ETS to a emission reduction. However, it should also be noted that the emission reductions of individual companies and sectors were influenced by factors other than the EU ETS. As discussed, these include fuel prices (i.e. the difference between coal and gas prices), complimentary overlapping policies and macroeconomic fluctuations such as the recent recession.

In addition, it is important to point out that the initial success of EU ETS mainly came from the tight cap with the strict regulation on potential violation of the scheme. The tight cap contributed to the incentives for investment and the trading of EUAs among business in the expectation of the higher future EUAs price.

4.2 Evaluation of dynamic efficiency

Currently the key question regarding EU ETS performance is the low EUAs price. The reason for this concerns is how the low price of EAU can lead to the deterioration of the dynamic efficiency of EU ETS, decreasing the incentives of low carbon technology investment of the companies.

According to the current study of Edenhofer et al. (2014) on EUAs, the future contracts for prompt EUAs delivery trade at around. 5€ / tCO_{2eq} The future contracts for delivery in the year 2020 are only slightly higher at around 7-8€ / tCO_{2eq}. In fact, it shows that the 2020 price is not at least zero due to the anticipation of future scarcity, in sharp contrast to the period of Phase I, when zero prices did indeed occur. It is a little bit positive, but in general, many studies remark that the actual EUAs price, specifically the future 2020 price, will be too low to drive the dynamic efficiency of ETS.

It is very difficult to judge what a adequate level of EUAs price looks like over time, because there are several driving factors for pricing. Therefore it will be useful to review the price variation in EUAs trade market over the past phases in order to trace the dynamic efficiency (Fig. 2).

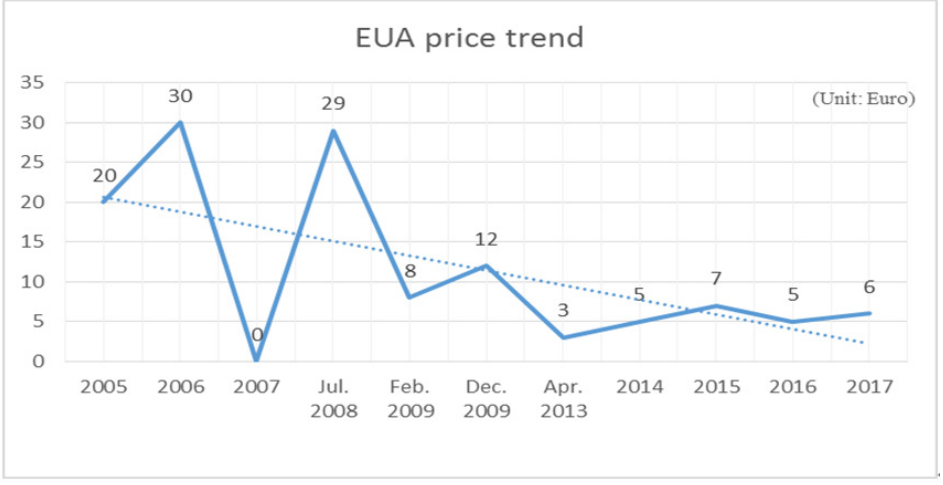


Fig. 2. Spot market price variation of EUAs in EURO/ tCO_{2eq}. This simplification is plotted to show the key event of price crash. (European Energy Exchange EUA market data, 2019)

At the beginning, the EUAs prices were in the range of €20–25/ tCO_{2eq}, reaching a high of approximately €30/ tCO_{2eq} in early 2006, and hovering around €15/ tCO_{2eq} for during the most of 2006. After a steady decline, it reached almost zero at the end of Phase I.

There was lack of liquidity of EUAs as the same phenomenon as in new trading schemes. As already explained by Egenhofer et al. (2010), only the power plants in energy sector participated actively in trading. Due to the high rising gas prices and falling coal prices, power plants had high demand for EUAs with more emissions. Therefore the power sector run short of the supply of EUAs. Furthermore even through the false impression of an supply shortage in the market, the EUAs prices rose up to almost €30 / tCO_{2eq}.

But the market were actually in oversupply state. At early 2006, the verified emissions data of year 2005 was published. According to the report of Hawkins and Jegou (2014), there was a big discrepancy between the actual emission and the allocated amount of the EUAs. The verified data showed that the actual emissions in 2005 was 4~5% percent below the allocated EUAs. The studies of Hawkins & Jegou (2014) show that this over-allocation was responsible for a initial allocation plan largely based on business entities' own estimation of their emissions rather than on actual historical emissions data of regulated entities. In other study of Egenhofer et al. (2010), it is pointed that only three member states could rely on verified data. Due to the lack of the verified data, allowances were allocated through an direct intensive government-industry negotiation without the relevent data.

Once the extent of the over-supply came out to be known, the EUAs price on the market continued to decline after the price crash. What makes the matter worse, it was even more aggravated, because the carrying over banking into the next phase of the allocated allowances was not allowed at the Phase I. At last the carbon price reached to a negligible level.

In line with this price crash, there was a windfall profits during Phase I. Hwakins and Jegou (2014) show that some companies covered by the EU ETS during this phase, especially in electricity field of energy sectors, earned windfall profits by passing the EUAs price through to consumers although they had received allowances free of charge. They passed this price increase of the opportunity cost of producing power through to consumers, although they received in fact the EUAs for free. Therefore they increased its revenue without increased costs. A comprehensive analysis of Ellerman et al. (2010) estimates that windfall profits for the coal, gas, and oil power sectors in Europe totaled Euro 11.4 billion for the Phase I. Insights Global (2009) insists that in case of comparison with the total 730 billion market size of the European utilities by 2009, this amount of windfall profits could be estimated as huge.

At the launch of the Phase II, the European Commission (The Commission) rejected most National Allocation Plans (NAPs) on the basis of the lessons from learned from the Phase I. This is because the unverified plan again resulted in an over-allocation of EUAs. Being compared with the submitted draft NAPs, EUAs were cut by 10% percent on the whole. Thanks to the supply cut, the Phase II prices rose initially to over €20/ tCO_{2eq}, reaching €29 in July 2008.

But during the course of the Phase II (2008–2012), the EUAs price had greatly fluctuated once again. Its prices dropped with the arrival of the financial crisis in autumn 2008. It went down to as little as €8/ tCO_{2eq} in February 2009. Fortunately because in this time carrying over of EUAs into the Phase III was allowed, the low demand for EUAs during the recession did not made EUAs price went down to zero completely. By the end of 2009, the price had almost recovered to around 12 to 14 / tCO_{2eq}.

However, since 2011 summer, EUAs prices have once again declined steadily. In April 2013 it finally fell to less than €3/ tCO_{2eq}. Since allocations from 2008 to 2012 were planned assuming higher expected economic growth rates, the decline in economic activity automatically led to oversupply of the EUA. When the Commission presented its plans for emissions trading reform for the Phase II in early 2008, they predicted average grow 2.2% of GDP per year. But Graichen et al. (2015) mention that in reality, GDP in 2012 was lower than in 2008 because the economy decreased by an average of 0.1% annually during that period. Less economic activity led to lower emissions, especially on the part of energy-intensive industries. This over-allocation was largely driven by this wrong projection about demand for EUAs.

The other aspect related to over-supply of EUAs was an

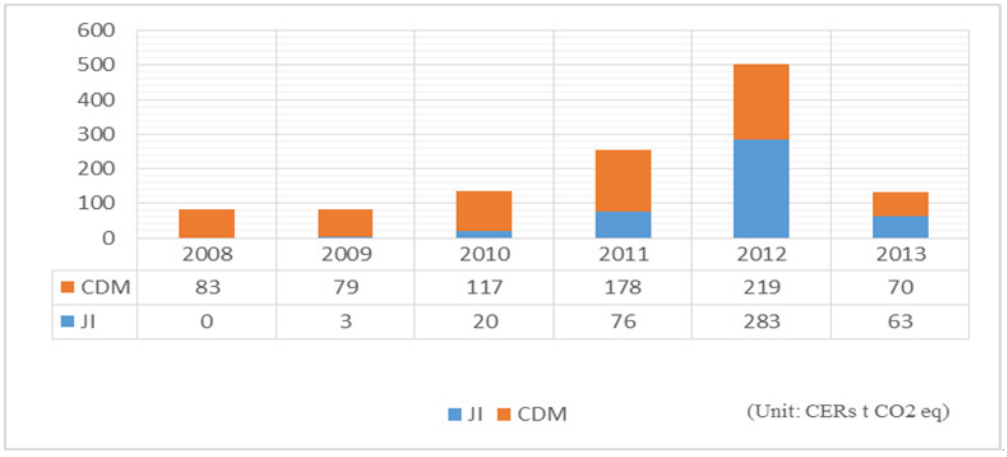


Fig. 3. Historical offset use in the ETS. (Morris et. al. Oct. 2014)

Table. 4. EAUs Surplus, EUAs with emissions and offsets surrendered (2008-2013)

(Unit : M EAUs)

	2,008	2,009	2,010	2,011	2,012	2,013	Total
Supply of Allowances (1)	1,958	1,927	1,998	2,017	2,055	2,084	12,039
Verified Allowances (2)	2,120	1,880	1,939	1,905	1,867	1,908	11,619
Spare EAUs	- 162	47	59	112	188	176	420
Offest Surrenderd (3)	83	82	137	254	502	133	1,191
Surplus (1-2+3)	- 79	129	196	366	690	309	1,611

*2012 EUAs includes 120 M early the Phase III auctions, 2013 includes 30 M late of the Phase II auctions. (Morris, et al. 2014)

problems of CERs in the EU ETS trade market. When drawing up NAPs of the Phase II in 2006, a number of EU member states worried that EAUs prices could be very high in that period. Based on this projection, very generous national regulations were applied on the acceptance of JI/CDM credits. In the result, a large volumes of offset credits was added to national quotas. According to Graichen et al. (2015), the western member states assumed that emissions reduction in emerging countries and the successor states of the Soviet Union would be slightly, but not significantly, cheaper than in EU member states.

As well known, Eastern European countries and the successor states of the Soviet Union had been granted a lot of so-called 'hot air' in the Kyoto Protocol for the period 2008-2012. Russia and Ukraine in 2011 and 2012 turned parts of this 'hot air' into JI credits and sold these in the EU ETS trading market. Graichen et al. (2015) point out nearly

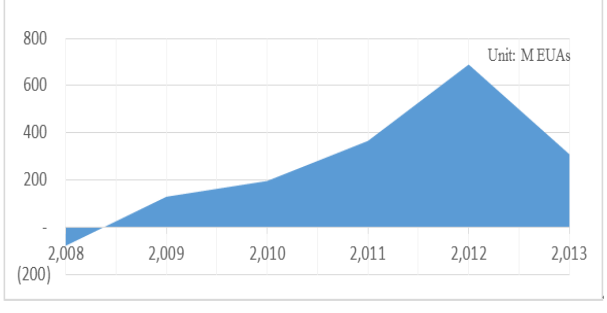


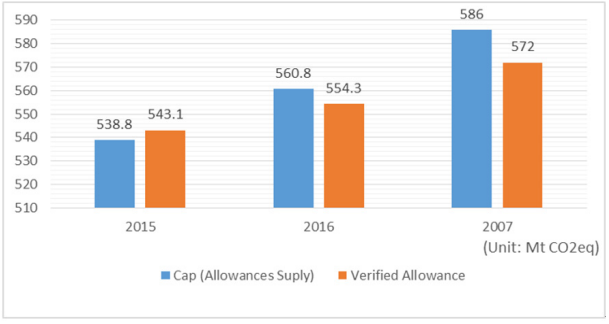
Fig. 4. EAUs Surplus Trends and Projections in the EU ETS in 2018. (EEA, 2018)

450 million JI credits had flowed into the EU ETS by 2013 (Fig. 3).

In consequence, the volume of redeemed JI/CDM credits must be added to the EU's over-allocation when the surplus of EUAs was calculated (Table 4, Fig. 4). The EC (2014) states that at the start of the Phase III (2013-2020), the EU

Table 5. The summary of main causes for price crash in EU ETS

Price Crash (Effects)		Events	Causes	Drivers
Dec. 2007	almost zero	Publication of 2005 verified emission data (Mid of 2016)	Significant discrepancy between allocated allowance and actual emission	System failure
Feb. 2009	8 Euro	Global financial crisis	Economic depression	External shock
Apr. 2013	Less than 3 Euro	Failure of the European Parliament's vote on the Back-loading of allowances	Delayed reform for over -supply of allowances	Political delay and uncertainty



(Unit: M ton CO_{2eq})

	2015	2016	2007	Total
Cap (Allowances Supply)	538.8	560.8	586	1,685.60
Verified Allowance	543.1	554.3	572	1,669.40
Difference	- 4.3	6.5	14	16.2
	△0.81%	1.16%	2.40%	0.90%

Fig. 5. Emission Allowances Vs. Verified Emission during the Phase I in KETS. (MoE, 2018)

ETS was characterised by a surplus of over 2 billion EUAs.

Furthermore, there were some political uncertainty. The study of Neslen (2013) presents that there was the coincidence of the sharp price drop with the failure of the European Parliament's vote on the Back-loading of EUAs. (Regarding 'Back-loading', it will be discussing at Chapter 4.) Grosjean et al. (2014) add that the policy uncertainty on post 2020 targets as well as the lack of credibility of long-term commitment could decreased the demand of EUAs.

To summarize, the evidences clearly presents that the significant over-supply of EUAs caused the low level of the current price (Table 5). It resulted from the wrong projection in demand due to the lack of verified data and the difficulty to adjust to the macroeconomic downturn. The influx of additional offset credits was also added to the surplus of EUAs. In addition, the situation was exacerbated by delays in policy measures like the initial restriction on inter-phase banking and auctions.

The mentioned issues have been partially addressed through an increasing tightening of the cap, the banking of EUAs to future trading periods, the increased auctioning, and the use of verified emissions data as a basis for free allocation under the grandfathering method more recently followed by its replacement.

But despite those amendments, the EU ETS trade market is still struggling with low EAU prices. It works obviously as risks against the proper function of the EU ETS to meet dynamic efficiency targets. Although the EU ETS, on the seems to be positive on contributing to reduce the GHG emission on environmental effectiveness point of view, the low price of EAU can lead to the deterioration of the dynamic efficiency of EU ETS, decreasing the incentives of low carbon technology investment of the companies.

5. The performance evaluation of the KETS

5.1 Evaluation of environment effectiveness

During the Phase I of the KETS, government allocated 1.68 billion tons of pre- and additional emission rights to companies. 1.66 billion tons of the verified emission rights was submitted. In the result, was reserved 16.2 million tons or 0.9 percent of the taget cap was reseved (Fig. 5). According to the data of MoE (2018), among the 592 companies subject to submission for emissions rights in 2017, 402 companies had room for emissions rights, while 190 lacked allocated emissions rights. Most of them lacking emission rights secured emission rights through purchase of emission rights and offset credits in the market.

According to the results of the Phase I of KETS, the cap of allocation of emission rights seems to be managed with the very stabilitiness. There was no shortage or even surplus of emission allowances not enough for the compnanies to manage. In order to assess the environment effectiveness of the Phase I of the KETS in details, it is necessary to look at the national GHGs reduction plan.

At the time of Intended Nationally Determined Contribution (INDC) submission (2015), the governent announced only a relative reduction target of 37% compared to BAU. But at the GHGs Roadmap Plan in 2016 (Fig. 6), a absolute target values of reductuon (536 Mt CO_{2eq}) was presented, reflecting the BAU forecast in 2030 (851 Mt CO_{2eq}).

At the presentation of the 2030 Greenhouse Gas Reduction Roadmap in 2016, the slowdown in economic growth was consided. The growth rate of existing 3.0% per year was revised to that of 2.5% per year, which was applied to the 8th Power Supply and Demand Plan. The Roadpaln is based on the population forecast changes, recent emission trends, and BAU reflecting the changes among the forecasted figures. In the amendation of 2018 Roadplan, the reductuion target is the same to maintain emissions of less than 536 Mt CO_{2eq} after reduction of 37% less than BAU.

In order to maintain the GHGs emissions within 536 Mt CO_{2eq} at 2030, the revised roadmap suggests a reduction plan every three years, while the previous roadmap presents only a single goal in 2030 (Fig. 7). It also includes the policy will to pursue de-coupling, which will reduce the GHGs from 2020 onwards, despite the economic growth, as in developed countries.

As we have seen from the lessons from the EU ETS discussed in the last section, the EU ETS has experience the huge surplus of allowances due to the sever disturbance of the supply-demand balance of EUAs. In late 2014, the Commission proposed a structural reform of the EU ETS for the period beyond 2020, with its new proposal for a climate and energy framework for 2030. Actually this proposal consists of two folds. One is a decrease in the number of allowances from 2021 by 2.2 percent annually. The other is the introduction of a market stability reserve (MSR).

To strictly control EUAs in EU ETS, the Commission proposed Linear Reduction Factor (LRF) which defines a tighter reduction target. The Comission planed a LRF of 2.2% from 2020 onwards, leading to the GHGs reduction of overall 40% by 2030 or 80% by 2050 (baseline year 2005). But curretly the Commission suggestes to kepp the 1.7% annual reduction rate of LRF up to 2020 and beyond. The LRF is neither part of the legal proposal nor a structural reform instrument. It mainly addresses the question of environmental ambition.

On the perspective of environment effective, the emission right allocation in the KETS has been well established, reflecting the Linear Reduction Factor (LRF) which is consistant with Roadmap for 2030 National GHGs Reduction

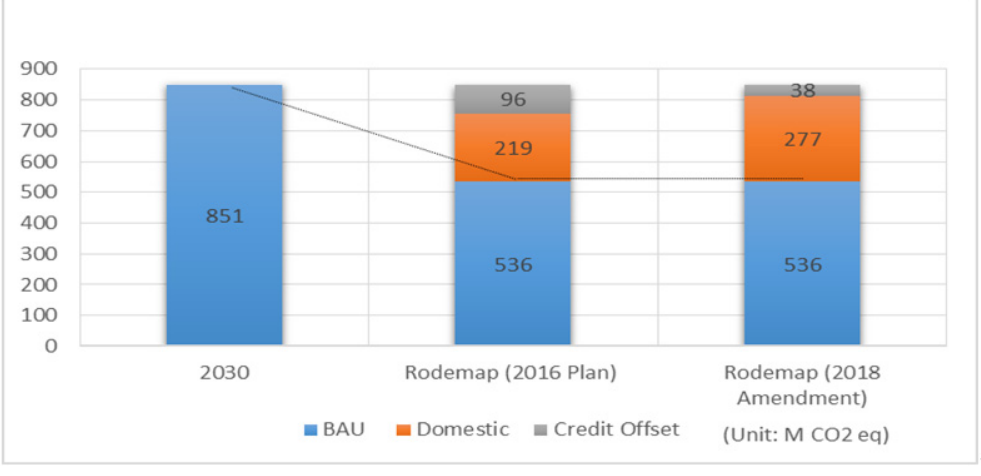


Fig. 6. The GHGs Reduction Roadmap of the National Reduction Targets. (Ministry of Environment, 2018)

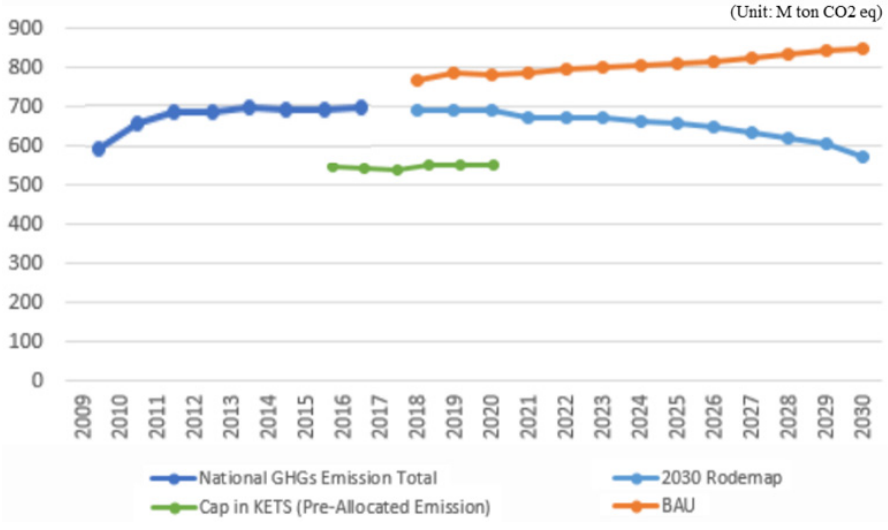
Goals. This means that KETS balances the supply and demand of emission allowances, which, together with other policy measures, contributes to reducing national GHGs.

On the other hand, it is necessary to comment on market flexibility measures related to environment effective. The reserves plan of emission right, initially set at 88.82 Mt CO_{2eq}, was revised to 89.44 Mt CO_{2eq} at Jan. 2017, increasing by 0.62 Mt CO_{2eq} (Table 6). It was used mainly for market stabilization, early reduction action support and resevation of emission rights for new entrance into KETS. 75.58 Mt CO_{2eq} (84.5%) of the reserve was additionally allocated, and the remaining reserve amount was 13.86 Mt CO_{2eq}. Remaining reserves (9.38 CO_{2eq} of market stabilization and 4.48 CO_{2eq} of other uses) was disposed of before the start of the Phase II.

It is helpful to look at the reserve usage in the EU ETS. As mentioned, the MSR in EU ETS was introduced as a legislative proposal. The Commission proposed the creation of a MSR as an automatic stabilizer. The goals of the MSR are to reduce large structural surpluses in the short term. It is to adjust the supply of EUA to be auctioned by 2021 in the EU ETS. But the MSR only adjusts the timing of the auction volume.

Through the MSR mechanism, the surplus volume in circulation will be regulated. If the surplus at any point exceeds an upper threshold (Commission proposal: 833 Mt CO_{2eq}), then the volume of emissions allowance will shrink by 12% of the volume in circulation in the previous year (at least 100 Mt CO_{2eq}). The left EUA will be placed in the MSR. In reverse, if the surplus falls below a certain lower threshold (the Commission proposal: 400 Mt CO_{2eq}), the volume auctioned in the next year will be increased by 100 M EAUs. MSR in the EU ETS will be 'cap-neutral' and leads to change nothing in the overall cap level.

In KETS, allowance auctions are introduced in part (only 3% of the total quota) from the start of the Phase II.



(Unit: Mt CO_{2eq})	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cap in KETS*	-	-	-	-	-	-	543.3	535.9	529.6	547.6	547.6	547.6
GHGs Emission Total	597.6	657.4	682.9	687.1	696.7	690.9	692.9	694.1	-	-	-	-

(Unit: Mt CO_{2eq})	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Roadmap 2030	691			673 to 671			661 to 648			648 to 622			536*
BAU	768	786	783	783	783	783	783	809	809	809	809	809	851

Fig. 7. 2030 Emission Reduction Roadmap with contrast of BAU, Cap in KETS. (Ministry of Environment , 2018)

Allocation of allowances, such as auctions, is carried out periodically by utilizing market functions. In sipte of the difference of the MSR measures between EU ETS and KETS, the implementaion of the allowance reserve will support to increase the market flexibility and stablilization in the emission trading market, controlling the supply and demand of the allowances.

The relevent use of the reserve will help improve market flexibility in the KETS. Without such difficulties as the EU ETS, KETS is expected to effectively achieve its national GHGs reduction targets.

5.2 Evaluation of dynamic efficiency

In order to assess properly the performance of the KETS, it is necessary to review not only the environmet effectiveness but the dynamic efficiency. When the KETS provides the companies with the incentive for emission reduction, the companies can make a continuous effort for emission reduction leading to invest in low-carbon technology. Therefore emission allowance trade market must be maintained under the high predictability and credibility driving its dynamic efficiency. The dynamic efficiency in the emission trading market comes from the liquidity and flexibility of market that can relevently regulate the volume and price of the allocated emission allowances. The market liquidity is controlled largely by the transaction volume of allowances in circulation. On the other hand, the market flexibility is managed by the various policy measures to manage the price fluctuation.

Since market efficiency is presented in terms of the trade volume and the price signals in the market, it is important to examine these two aspects in the KETS.

Since the beginning of the Phase I in KETS in Jan. 2015, trading market has stalled to almost zero trading. Market participants and stakeholders waited and only watched the market because they were not sure about the amount of GHGs to be emitted in the future. But trading has quickly increased year-on-year. Normally, the volume of transaction tend to rise before the time of the submission of the allocated allowance in previous year in order to meet the compliance. Especially, at the end of the Phase I, the trading volume for the emission allowance settlement increased sharply in the first half of 2018 (Fig. 8).

At the same time of the quick increase of transaction volum, there were a price surge temporarily just before the time of the emission allowance settlement (around March) at the second quarter of year 2017 and year 2018 repectively (Fig. 9).

In the meanwhile, the government managed to stabilize the trading market through market intervention. The allocation plan was revised to use some of the reserve. The main use of the reserve is the market stabilization, the allocation for the new entrants to the KETS and the supply for the early reduction action. Key policy measures were also taken to strengthen market liquidity, such as banking restrictions and additional approval of offset credits.

Through the constraint on carrying over amount of banking at Apr, 2017, the government limited the amount of emission allowance for companies to carry over into the Phase II. If companies carry over 10% of the average annual allocation of the Phase I or 20,000 t CO_{2eq} of allocated allowance, the goverment announced to deduct the allocation amount of allowance from the next quota of the Phase II. According to the government's actions, the price that had soared to 24,670

Table 6. The Additional Allocation Status of Reserve during the Pahse I.

(Unit: M ton CO_{2eq})

	Market Stabilization	Others (New Entrance etc.)	Early Reduction Action	Total
Revised	14,316	23,730*	51,392	89,438
(Deducted From Plan)	-14,316	-33,114	-41,392	-88,822
Allocated	4,938	19,251	51,392	75,581
(%)	34.5%	81.1%	100.0%	84.5%
Remains	9,378	4,479	0.2	13,857

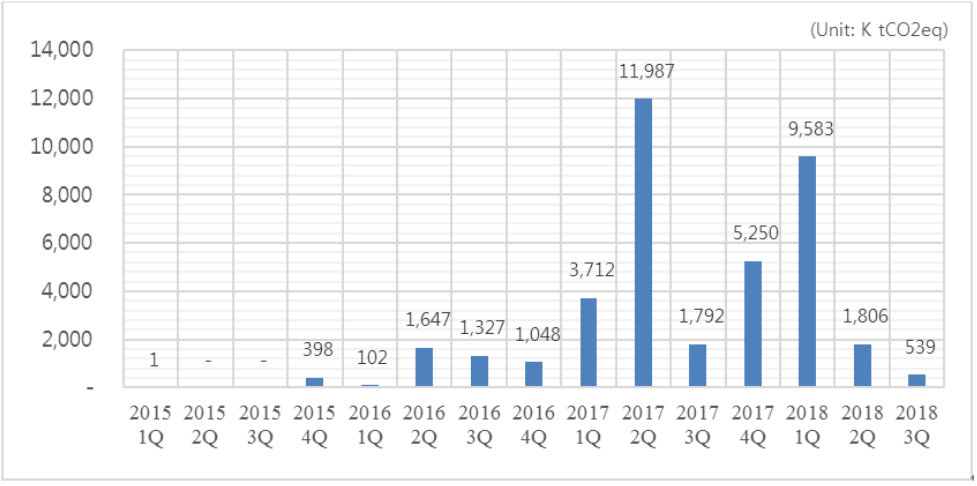


Fig. 8. The Emission Allowances Transaction Volum in Phase I of the KETS of Operation Report of KETS. (Ministry of Environment, 2019)

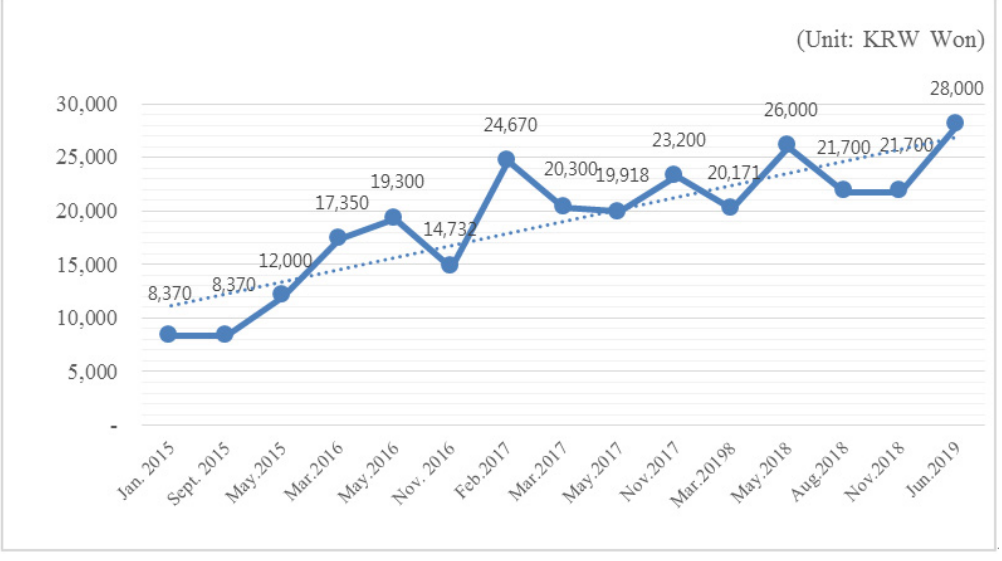


Fig. 9. Price Change Trend in the KETS, presented for price fluctuation (Ministry of Environment GIR, 2019).

KRW was stabilized at the price range of 20,000 KRW.

On the other side, after analyzing the supply and demand situation of emission allowances, the goverment supply additionally some of the revsered amount of emission allowances through auction method. At 2Q in year 2018, the government supplied 5.5 Mt CO_{2eq} for the usage of emission allowance settlement of year 2017. The price, which rose up to 28,000 KRW, has remained at 22,000 KRW again.

In the case of the EU ETS, 'Back-loading' method was introduced in EU ETS to manage the supply and demand of the emission allowance in the market. In order to answer the problem on surplus of emission allowances in the Phase III, the Commission proposed so-called 'Back-loading' as a short-term supplementary measures. Morris et al. (2014) explain that because the new cap level of the Phase II increased substantially the surpluses during its the implementation years, the 'Back-loading' was only to postpone temporarily the auction plan of 900 million EAU of

year 2014-2016 up to the last two years of Phase III (year 2019-2020). The plan was to reduce the auction volume of emission allowance to 400 million EUA during 2014, to 300 million EAU in 2015, and to 200 million EUA in 2016. Edenhofer et al. (2014) add that this was designed to create a temporary scarcity of emission allowances.

In fact, many studies points out that the back-loading decision is still inadequate for addressing the structural and continuing over-supply of the EUA. Whatever the scenarios of surplus EUA is, the problem of over-supply of the EUA seems to solved only through the fundamental reformation of the EU ETS.

Regarding the approval of the use of offset credits, the emission reduction has been allowed from projects outside of the organization boundary of the KETS in domestic area. The emission credit (Korean Offset Credits, KOC) with a specified vintage was generated from the external emission redction projects. The KOC was converted to KCUs in order to be submitted for the settlement of compliance.

During the Phase I in KETS, a total of 252 methodologies were registered for emissions reduction through the low-carbon technology. It consisted of 211 (83.7%) of the CDM methodologies and 41 (16.3%) of domestic development methodologies. Among them, a total of 139 projects (90 CDMs, 49 domestic developments) was approved. A total of 22.47 Mt CO_{2eq} in 81 projects was certificated as reduction achievement amount. The government converted 15.39 Mt CO_{2eq} (68.5%) into Korean Offset Credits (KOC).

The types of methodologies for the GHGs emission reduction includes mainly new renewable energy develpoment, N_2O gas reduction, fuel conversion, landfil gas generation, bioenergy generation and SF6 gas reduction.

In the Phase I, only domestic credits was available for settlement. During each implementation year of phase 1, the KOC that could be used to settle the emission allowance was limited to 10% of the total (Fig. 10). However, in phase 2, it was possible to convert CDM credits (CER) issued from international CDM projects developed by domestic companies since June 2016 to KOC.

Those kinds of the above short term measures for market stabilization eliminated supply-demand imbalance and immediately stabilize the price of emission allowances. But as can be seen from the price trend, the price of the KAU shows the same continuous upward trend.

The focus of the question is not only how to stabilize trading volume or price volatility, but also how to allow companies to switch to low-carbon technology to reduce emissions through dynamic efficiency of the KETS. Very significant lessons learned from the experience of EU ETS is that the current difficulties of the EU ETS were from the oversupply through imbalance between demand and supply. It leads to the persistent low EUAs price. EU ETS is not enough to provide companies with the incentive for emission reduction. In the result, the EU ETS has not played a proper role of the switch to low-carbon technology for emissions reduction.

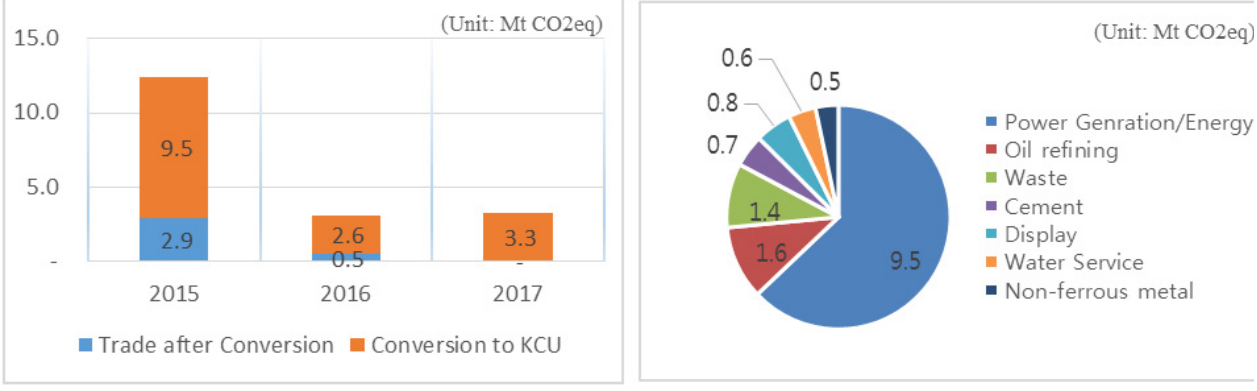


Fig. 10. Trade of KOC in KETS during Phase I (a) and Volume by Business Sector (b) (Ministry of Environment, 2018).

Being compared with EU ETS, KETS is still operating properly in terms of both supply of emissions allowances and price signals driving incentive for emission reduction. In the consideration of the ongoing upward trend in the current price of emission allowance, the pressure for its supply and demand will likely be tight in the future. Given the current price trend in the context of the current economic downturn, we can expect a supply shortage, being accompanied by rising prices in the future at the time of the economic expansion.

6. Conclusion

On the perspective of the environment effective and the dynamic efficiency, the KETS during the Phase I has well operated, being compared with the EU ETS. The emission allowance allocation has been well established, reflecting the Linear Reduction Factor (LRF) under the Roadmap for 2030 National GHGs Reduction Goals. On the other hand, the government has stabilized the market by actively intervening in the market through the flexibility mechanism in order to keep the balance between the supply and demand of emission allowance, resulting in the relatively stable price of the KAUs.

Given the learned lesson from the EU ETS, the stringent cap management in the next phase should be continuosely kept for driving an incentive to invest in emission reductions. It will ultimately lead the companies more actively to shift to the low-carbon technology to reduce the GHGs emission. If the KETS can provide the company with a clear price signal for the transition to the low carbon technology, it will play a significant role in the emission reduction along with other climate policies.

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