EXPERIENCE WITH GREENHOUSE GAS EMISSION ALLOWANCE ALLOCATION AND ANALYSIS OF LESSONS FOR VIET NAM

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Abstract: *This study analyzes and synthesizes international experiences in allocating greenhouse gas emission quotas, drawing lessons for Viet Nam's developing carbon market. The research examines emission trading systems (ETS) and quota allocation methods from various countries and regions, including the European Union, Germany, Austria, the United Kingdom, Switzerland, the United States, Canada, Nigeria, Kenya, South Africa, China, Japan, and New Zealand. Key findings highlight the importance of diversifying allocation methods, combining free allocation, auctioning, and benchmarking approaches. The study emphasizes the need for flexibility in system design, adapting to specific economic and social conditions of each country. Lessons learned include prioritizing high-emission reduction potential sectors, setting reasonable emission caps based on actual data, ensuring transparency in information disclosure, and establishing effective monitoring and evaluation mechanisms. The research also stresses the importance of providing technical support to businesses, especially small and medium enterprises, in complying with ETS regulations. Additionally, the study addresses concerns such as preventing carbon leakage, assessing social impacts, and ensuring international compatibility of the system. These insights provide a valuable foundation for Viet Nam to develop an effective greenhouse gas ETS that aligns with national conditions and sustainable development goals.*

Keywords: *Emission trading system, grandfathering, benchmarking, auction.*

1. Introduction

1.1. General introduction to the greenhouse gas emission trading system

1.1.1. Preliminary information on the implementation of ETS in the world

Carbon markets are mechanisms for trading greenhouse gas (GHG) emission credits to achieve climate goals cost-effectively. These markets exist in two forms: compliance and voluntary. Compliance markets are regulated schemes where participants must meet emission targets set by authorities, while voluntary markets are unregulated platforms where entities choose to offset emissions to meet self-imposed climate goals, such as achieving carbon neutrality. Both governments and private entities can participate in these markets to contribute to emission reduction efforts through carbon credit trading [1].

The carbon market includes two main types of products: Carbon Credits, which represent quantifiable reductions in GHG emissions from specific projects, and GHG Emission Rights, which are allowances that organizations can trade if they reduce their emissions below the limits allocated to them under an Emissions Trading System (ETS). The carbon market is one of the economic mechanisms to enhance GHG mitigation. It continues to play a practical and applicable role at the international level for both developed and developing countries after the Kyoto Protocol came into effect on February

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16, 2005.

As of early 2023, 28 ETS systems were in operation, three more than in 2022, with a further 20 under development or consideration globally, particularly in Latin America and Asia-Pacific. Africa is also taking its first solid steps towards emissions trading. The share of global emissions in ETS regions remained unchanged at 17%, with increased coverage from new systems being offset by overall reductions in ETS-based emissions - as expected given the designs of these systems to reduce emissions [2].

Systems currently in operation have weathered a globally volatile 2022 without major disruption. After a significant increase in 2021, prices across most systems started and ended 2022 at similar levels, despite some volatility during the year. The lack of an increase in the price of allowances in 2022 is notable given the ongoing energy crisis and its impact on consumers, who have experienced a significant increase in the consumer price index and its energy component. Emissions trading has established itself as a valuable revenue source, with 2022 marking another record year, with over $63 billion being raised in a single year. Due to higher quota prices and increased use of auctions, more than half of all ETS revenues raised since 2008 have been collected in 2021 and 2022, allowing many governments to redirect these resources back into further climate action, subsidizing emerging technologies, or supporting lower-income households [2].

1.1.2. Methods of allocating greenhouse gas emission quotas

a) Free allocation of allowances based on historical GHG emission data (grandfathering)

Under the grandfathering approach, companies receive GHG emission allowances based on their historical emissions. Over time, this baseline is typically reduced by a certain percentage to reflect the ambition to achieve emission reductions and/or increased to reflect expected growth. The amount of GHG emission allowances received under this approach is - at least for a trading period - in principle independent of actual changes in production output (except for closures and partial closures of production facilities) [2].

The major advantage of this approach is that it reduces the likelihood of initial opposition from ETS companies, since all facilities receive a free allocation that is expected to be close to their actual emissions, limiting initial costs and the need for large trade-offs in the first years of an ETS. In addition, compared to the allowance-based free allocation approach, the administrative costs of this approach are lower. The grandfathering approach maintains the incentive to mitigate GHG emissions, since companies that reduce emissions can sell their excess allowances, while companies that increase emissions above their historical baseline must pay for these emissions. Furthermore, since companies receive a free allocation that is equivalent to a lump sum that is not contingent on actual production, companies' responses to the ETS will be the same as if they had not received free allowances. This means that companies that do not operate in sectors that require a lot of commercial activity will pass on their carbon costs, thus also incentivizing reduction through product substitution as emissions-intensive products will become more expensive [2].

The downside of the grandfathering approach is that it potentially creates incentives for firms to increase emissions in order to receive higher allowances in the future. It is therefore important that the baseline period is sufficiently early, and that consideration is given to the limitation that historical data may not be available or may be incomplete. Another drawback is that the repeated application of this approach over several ETS periods will limit early action because firms that improve their emissions intensity will receive fewer allowances in the future [2].

The grandfathering approach is less likely to prevent carbon leakage than an allocation approach based on GHG emissions per unit of output. This is because the allocation of quotas per unit of output will decrease as output expands and can therefore be seen as hindering

growth and reducing the competitiveness of growing firms. Furthermore, this allocation approach can result in windfall profits, as some firms with a history of high emissions may have low-cost mitigation options. When these mitigation options are implemented, these firms will have lower compliance obligations but their free allocation of quotas will remain unchanged, thus resulting in windfall profits. Windfall profits will also occur if industries are able to pass on the cost of quotas because they are less competitive. Finally, early mitigation actions may be penalized if they occur before the base period used to determine the free allocation of quotas [2].

b) Free allowance allocation based on benchmarking

Benchmarks provide metrics that make it easy to compare the emissions performance of similar industrial activities. Benchmarks used in the ETS can be grouped into two categories. Product-based benchmarks (PBBs) are a function of the GHG emissions emitted per unit of industrial product. Energy-based benchmarks (EBBs) reflect the GHG emissions resulting from the combustion energy used at a facility. Unlike PBBs, which are expressed as outputs, EBBs are expressed as inputs to the production process and are primarily used as a contingency measure to target a (significant) segment of a facility's emissions profile.

Benchmarks as a tool to support the allocation of emission allowances differ from those developed and applied to compare the energy and emission intensity of production facilities, e.g. for production optimization. When benchmarks are developed for the latter purpose, they focus on the assessment of existing similar facilities with the aim of identifying improvements in the key technologies of the production facilities [3].

Regarding the scope of the allowance, allowances can relate to direct emissions only or to direct and indirect emissions (total emissions). Indirect GHG emissions take into account emissions arising during the production of electricity [3].

c) Auction

Auctions are the process of allocating allowances in which auctions are used to determine the price of allowances. It is a relatively simple and transparent mechanism. Auctions allow for good price discovery in the ETS and provide a strong incentive to reduce, as participating firms must pay for their allowances. There is also no possibility of windfall profits from auctions, as all the allowances a firm uses to comply must be purchased and therefore represent the real cost of carbon. Furthermore, quota auctions raise revenue for governments, which can be used to cut distortionary taxes in other parts of the economy, provide compensation to disadvantaged households adversely affected by the ETS, or fund other projects such as emissions reduction activities [2].

Furthermore, because this approach is relatively simple, it is less susceptible to industry lobbying aimed at supporting affiliated companies. Since companies that implement GHG emission reduction activities early will have to buy fewer allowances at the auction, these companies will be rewarded for any early action to reduce emissions. The main disadvantage is that auctions do not provide protection against carbon leakage and, if introduced early, may not support a smooth transition to the ETS, leading to significant opposition. Industries subject to international competition may have an incentive to move their activities to areas without emission limits (carbon leakage). In addition, there may be concerns about the accessibility of auctions to smaller companies [2].

1.2. Methods

This study uses a synthesis approach to collect other countries' experiences in GHG allowance allocation through relevant studies. In addition, this study analyzes international experiences to draw lessons for Viet Nam.

2. International experience in implementing greenhouse gas emission allowance allocation

2.1. Experience of European countries

2.1.1. European Union Emissions Trading System

The EU ETS is the world's oldest and largest

carbon market, covering 31 countries and accounting for 45% of Europe's GHG emissions. This system has been implemented in four phases since 2005, operating on the "Cap and Trade" principle with total emissions capped and gradually reduced each year.

The method of allocating emission allowances has changed over time [4]:

- Phase 1-2 (2005-2012): Most quotas are allocated for free.

- Phase 3 (2013-2020): Switch to a default method of auction, with 43% of total quotas allocated for free.

- Phase 4 (2021-2030): Continue to allocate for free but focus on sectors with the highest risk of carbon leakage. Sectors with less impact will gradually reduce their free allocation from 30% to 0% by 2030.

The EU ETS also applies measures such as updating benchmarks and adjusting allocations flexibly according to actual production to increase the efficiency of the system.

2.1.2. Lessons learned from Germany

Germany has implemented a national ETS for heating and transport fuels since 2021, complementing the EU ETS. The system is being implemented gradually with the following main features [4]:

- Fixed price phase (2021-2025): Fixed price increases gradually from 25 EUR/tCO_2 in 2021 to 55 EUR/t CO_2 in 2025.

- Auction phase (from 2026): Price corridors will be applied with a minimum of 55 EUR and a maximum of 65 EUR/tCO_2.

- Scope of application: Industry, transport, waste and buildings.

- No free quota allocation but a compensation mechanism to avoid carbon leakage for emissions-intensive trade-exposed industries.

- Eligible sectors for compensation are those listed in the EU ETS Phase 4 carbon leakage list.

- Use of compensation based on sectoral fuel standards and fixed compensation levels instead of free quota allocation.

Germany's experience shows that quota allocation needs to be flexible, adjusted to suit each stage, and combine many methods such as free and auction to achieve the goal of reducing emissions and encouraging technological innovation.

2.1.3. Lessons learned from the Republic of Austria

The Republic of Austria has implemented a national emission certificates trading system (NEHG) from October 2022 for fossil fuels not yet regulated in the EU ETS. Key features include [4]:

- Applicable to the following sectors: Industry, transport, energy, and buildings.

- Introduction and transition phase (2022-2025): Fixed price increases gradually each year from 30 EUR/tCO_2 in 2022 to 55 EUR/tCO_2 in 2025.

- Market phase (from 2026): Expected to apply allowance auction.

- Price stabilization mechanism: Adjustment of price increases based on energy price fluctuations. If energy prices increase/decrease by more than 12.5% in a year, the fixed price increase for the following year will decrease/increase by 50%.

- Allowance allocation: In the 2022-2025 period, the allocation amount is unlimited with a fixed price increasing each year.

The system is designed to be aligned with the reduction targets for non-EU ETS sectors and may transition to EU ETS 2 in the future.

2.1.4. Lessons from the United Kingdom

The UK Emissions Trading Scheme (UK ETS) was implemented from 1 January 2021, replacing participation in the EU ETS. Key features include [4]:

- Scope of application: Energy-intensive industries, power generation and aviation.

- Quota allocation: Combination of auction and free allocation.

- Free allocation: Applicable to eligible aircraft installation and certain industrial installations to reduce the risk of carbon leakage.

- Free allocation approach similar to EU ETS Phase IV, ensuring business continuity.

- Free allocation calculation criteria similar to EU ETS Phase IV.

- Auction: Starting from 19/5/2021, organized

by ICE Futures Europe (ICE).

- Administration: The UK ETS Authority (consisting of the governments of England, Scotland, Wales and the Department of Agriculture, Environment and Rural Affairs of Northern Ireland) is responsible for administration and enforcement.

The system aims to increase the climate ambition of the UK's carbon pricing policy, while protecting the competitiveness of domestic businesses.

2.1.5. Lessons learned from Switzerland

ETS Switzerland started in 2008 with the following main features [4]:

- Initial phase (2008-2012): Voluntary participation.

- Later phase: Mandatory for large organizations, voluntary for medium organizations.

- Scope: Approximately 12% of total national GHG emissions (2021).

- Applicable sectors: Power generation, industry (cement, chemicals, pharmaceuticals, paper, oil refining, steel), domestic aviation and flights to the European Economic Area and the UK.

- Allocation method: Combination of benchmarking and auction.

- Free allocation for the aviation sector will be phased out by 2026.

- Auction volume may be reduced if the total number of circulating quotas exceeds a certain threshold.

- Linked to the EU ETS from January 2020, applying similar standards.

- Legal framework: Federal Act on the Reduction of CO_2 Emissions and administered through the CO_2 Ordinance.

In November 2023, the EU and Switzerland signed an agreement to transfer 2024 emission allowances between linked ETSs, applying daily transfers from January 2024.

2.2. Experience of countries in the Americas

2.2.1. Lessons learned in the United States

Currently, the United States is maintaining and operating 03 ETS systems quite effectively including: i) California Emissions Trading Program; ii) The Massachusetts Limits on Emissions from Electricity Generators and iii) Regional Greenhouse Gas Initiative. In addition, a number of ETSs are in the process of development or being considered for implementation such as: TCI Transportation and Climate Initiative, Pennsylvania, Virginia, New Mexico, New York, North Carolina, Oregon and Washington [5].

- Regional Greenhouse Gas Initiative (RGGI): is the first ETS system in the United States in the energy sector with the participation of the following States: Connecticut; Maine; Maryland; Massachusetts; New Hampshire; New Jersey; New York; Rhode Island; Vermont. Deployed since 2009 with 10 states according to the RGGI Joint Memorandum of Understanding in 2005. Up to now, RGGI is continuing to perfect the Model Regulations and adding stricter regulations to shape the system, moving towards the goal of reducing 30% of GHGs by 2020. Because RGGI is a program, each participating state will implement it according to its management unit. In addition, the RGGI agency - a non-profit unit will stand up to build and operate the program throughout the term.

- California ETS: First implemented in 2012, the California Emissions Trading Program was initiated by the Western Regional Climate Initiative in 2007. To date, this California program has covered nearly 80% of the total GHG emissions of the United States. The agency responsible for implementing this program is the California Air Resources Board (CARB). The legal basis for the formation and operation of the California ETS is the State's Global Warming Response Act of 2006 (AB 32); the amended Act AB 398.

- The Massachusetts Limits on Emissions from Electricity Generators: Implemented in 2018 for the electric power sector, this system, together with RGGI, helps Massachusetts achieve its emissions reduction goals. In 2016, a Massachusetts Supreme Court ruling mandated the state government to actively pursue GHG emission reductions of 25% by 2020 and 80% by 2050, compared to 1990 levels, transforming these targets from

voluntary goals into legal obligations. The Office of Energy and Environmental Enforcement and the Massachusetts Environmental Protection Agency are the focal points for implementing this program. The legal basis for this program is the Regulation on Emission Limits for Electric Power Generation Facilities.

2.2.2. Lessons learned from Canada

The Canadian carbon market is based on the "Canadian Approach to Pricing Carbon Pollution" adopted in 2016. This approach allows Canadian jurisdictions the flexibility to design and implement their own carbon pricing systems to suit their local needs, as long as they meet federal standards.

Canada also has a number of policies in place to support the development of the carbon market. Notably, the free issuance of emission credits is intended to keep companies competitive and avoid "carbon leakage". Since 2019, Canada has implemented a national carbon pricing system called the On-Boarding Offset Program (OBPS), which sets a minimum carbon price and limits emissions for large businesses. In addition, Canada supports clean technology, promotes the use of renewable energy, and provides financial support for projects that reduce emissions [2].

Canada focuses on building partnerships through the Emissions and Atmospheric Quality Program, which provides opportunities for businesses to participate in the carbon market and contribute to emissions reductions. Canada also works with other countries in North America and around the world to develop a global carbon market.

2.3. Experience of African countries

2.3.1. Lessons learned from Nigeria

Nigeria is in the process of building a carbon market, with the passing of the Climate Change Act in November 2021 [6]. This law provides the legal framework for action on climate change, including the establishment of the National Council on Climate Change and the Climate Change Fund.

The National Council on Climate Change is tasked with coordinating the development and implementation of a carbon trading scheme. The Council's Secretariat is responsible for monitoring and reporting on the national carbon fund.

Nigeria is considering both voluntary and mandatory markets, with a target of achieving net zero emissions by 2060. The country intends to use carbon credits and trading to drive the implementation of its NDC targets.

The ETS or cap-and-trade system is expected to be fully implemented as part of Nigeria's long-term low-carbon development strategy, with the recommendation to initially apply to the oil, gas and industrial sectors [7].

Overall, Nigeria is in the early stages of developing a legal framework and operational mechanism for a carbon market, with a clear direction on objectives and priority areas.

2.3.2. Lessons learned from Kenya

The Kenya Climate Change Amendment Act 2023 amends and updates certain provisions of the Climate Change Act 2016 and introduces Section IVA to regulate carbon markets. The carbon market policy guidelines that have been set out will apply to all carbon markets and provide for the definition, scope and validity of carbon credits. The Cabinet Secretary will prescribe additional requirements for carbon market regulation. Carbon market transactions must ensure that: Carbon transactions under this Act are aimed at reducing GHG emissions in accordance with prescribed carbon standards. The mitigation outcomes reported under this Act may be expressed in tonnes of CO_2e. The emissions from carbon offset projects that are kept out of the air for a reasonable period of time under carbon standards and emissions reductions should be carefully recorded for each offset program, using appropriate auditing provisions, corresponding adjustments and offset locations as required by the UNFCCC and other standards bodies. The national carbon register established under the law shall include the following items: Projects, credit programmes implemented to reduce GHG emissions in Kenya, reductions in emissions from deforestation and forest carbon decomposition, permits received

to participate in any initiatives, projects or programmes under this law, carbon funds and GHG emission reduction units, the amount of carbon credits issued or transferred by Kenya, the amount of carbon credits issued for projects and emission reduction programmes recorded by Kenya from the national GHG register, transfers of carbon credits and any carbon credits issued or recorded by Kenya from the greenhouse gas register, records of any corresponding adjustments to carbon credits, cancellations of carbon credits or other credits issued or recorded by Kenya from the national GHG register and any other carbon credits issued or recorded by Kenya from the national GHG register [8].

2.3.3. Lessons learned from South Africa

South Africa introduced the Carbon Tax Act in 2019, which has been updated and amended over the years. The main objective of the Act is to manage the impacts of climate change and contribute to global efforts to stabilize GHG concentrations, based on the “polluter pays” principle. South Africa uses a combination of carbon pricing, economic incentives, and emissions offsets. The main mechanism is the carbon fund quota, with taxpayers receiving an additional 5% of their total GHG emissions when they participate in the carbon fund. The Act has been amended several times to adjust the tax rate, the applicable threshold and related regulations [9], [10], [11], [12], [13], [14], [15], [16], [17], [18]. The scope of application is gradually expanded, including many sectors such as brick and ceramic production, poultry, forestry. The application period lasts until 31/12/2024 with an additional quota of 5% of total GHG emissions in the tax period. This approach shows that South Africa has built a flexible carbon tax system, capable of adjusting over time and expanding the scope of application, demonstrating a cautious and gradual approach to developing the country's carbon market.

2.4. Experience of Asian countries

2.4.1. Lessons learned from China

From 2011 to 2015, China piloted an emissions trading system in seven localities, accounting for 26.7% of the national GDP, including Beijing, Tianjin, Shanghai, Hubei, Chongqing, Guangdong and Shenzhen. The pilot resulted in 57 million tons of carbon being traded. After the pilot phase, China implemented a national ETS in 2017, with emission reduction targets defined in terms of "carbon intensity" in the economy, different from the EU's absolute value.

China initially applied a free allocation mechanism to limit "carbon leakage", with the orientation of gradually selling allowances after 2020. The national ETS initially covered coal and gas-fired power plants, with emission quotas allocated based on power generation output and specific fuel and technology benchmark.

In Beijing, free allocation of quotas is based on historical data and benchmarks, with regular auctions. Chongqing uses free allocation based on historical emission data from 2008-2012 and will start auctions from February 2022. Shanghai uses allocation based on industry-specific standards and regular auctions. Shenzhen uses free allocation based on emission intensity and norms, combined with auctions [2].

These cities all have mechanisms to adjust allocations according to time and actual conditions, demonstrating their flexibility in managing the ETS system. This shows that China is adopting a step-by-step, flexible and tailored approach to the specific conditions of each locality in the process of developing the national carbon market.

2.4.2. Lessons learned from Japan

The Emissions Trading System (ETS) in Japan is notably implemented in two prefectures, Saitama Prefecture and Tokyo City, providing experience in allocating GHG emission quotas in a local context. In Saitama, each emitter has its own emission limit, determined based on its base-year emissions and compliance coefficient. The system is divided into three compliance periods from 2011 to 2024, with emission reduction targets increasing from 8% in the first period (2011-2014) to 15% in the second period (2015-2019) and 22% in the third period (2020-

2024) compared to the base year [2].

The Tokyo ETS is structured similarly to the Saitama one, but has a higher emission reduction target. The first phase (2010-2014) applied an 8% reduction target. The second phase (2015-2019) raised the target to 17%, and the third phase (2020-2024) set a 27% reduction target compared to the base year. Both systems apply different compliance factors to different types of facilities, reflecting the specifics of each industry and the scale of operations [2].

Notably, both systems have adjustment mechanisms for special cases. For example, for medical facilities, the compliance factor is adjusted to reflect the specific energy needs of the industry. Tokyo goes further with special incentives for facilities that demonstrate outstanding performance in emission reduction and energy management, through the granting of "Top-Level Business Facility" or "Near-Top-Level Business Facility" certification.

Both systems demonstrate flexibility in adjusting targets and allocation methods over time. This reflects Japan's gradual and adaptive approach to managing GHG emissions. In this way, the ETS systems can adjust to technological advances, changes in economic structures, and increasingly ambitious environmental goals. The experiences of Saitama and Tokyo provide valuable lessons for the design and operation of ETS systems at the local level and contribute to Japan's overall efforts to reduce GHG emissions.

2.5. Experience from New Zealand

The New Zealand Emissions Trading System (NZ ETS) was implemented in 2012 for the waste sector, with a regulatory framework based on the Climate Change Response Act 2002 and the Emissions Trading Regulations 2008. The system applies to landfills that meet certain criteria, such as handling household waste and operating as a waste treatment business, while excluding small and remote landfills, as well as those that are closed or no longer operating. Participants are required to report their emissions annually and submit corresponding emissions units. New Zealand uses a "self-assessment" model for emissions monitoring, reporting and verification, with the Environmental Protection Agency (EPA) conducting regular audits. Notably, the waste sector does not receive a free allocation of emissions units, as landfill operators are not subject to international competition and can pass on the costs of the NZ ETS obligation to customers.

The system has contributed to a reduction in emissions from the waste sector since 2005, largely through improved solid waste management in municipal landfills and methane recovery. This was driven by the introduction of the National Air Quality Standard in 2004 and the implementation of the NZ ETS since 2013 [19].

New Zealand's experience demonstrates the importance of developing a comprehensive regulatory framework, establishing effective monitoring and reporting systems, and adopting flexible measures to adapt to the specificities of each sector. The lack of a free quota for the waste sector is also noteworthy, reflecting a different approach to managing emissions from this sector compared to many other countries.

3. Lessons for Viet Nam

From the synthesis of international experiences, some conclusions can be drawn in the quota allocation methods of countries and regions as follows:

- Diversify methods: Combining multiple allocation methods such as free allocation based on grandfathering, benchmarking and auction will create greater flexibility and efficiency.

- Customization: Viet Nam needs to develop an ETS system that is suitable for the country's economic and social characteristics and development goals.

- Balance among objectives: Quota allocation needs to balance the goals of reducing emissions, promoting social equity and supporting economic development.

- Flexibility and adaptation: The system needs to be able to adapt to changes in the market and technology.

- Support for businesses: There needs to be policies to support businesses, especially small and medium-sized enterprises, in the transition

to a low-carbon economy.

- Capacity building: Investment in capacity building for regulatory agencies and businesses is needed to ensure effective system operations.

While Viet Nam's carbon trading system may be smaller in scale and less developed compared to established markets like China, the European Union, the United States, or New Zealand, it has the opportunity to learn from their experiences. As Viet Nam develops its own system, particularly when allocating GHG emission quotas, it should consider the following recommendations:

- Combining multiple methods: Viet Nam can combine different allocation methods to achieve the highest efficiency. For example: Initial free allocation: To support small and medium-sized enterprises, especially in the early stages of system implementation. Auction: To create a vibrant carbon market and attract investment in clean technologies. Free allocation based on benchmarking: To ensure fairness and transparency in allocation.

- Prioritizing industries with high emission reduction potential: Should focus on energy industries, cement production, steel, and industries with high emission intensity.

- Allocating quotas reasonably based on actual data, avoiding over-allocation. In the early days of the EU-ETS, the large emissions quotas discouraged many businesses from participating in GHG emissions reductions. The EU set a product quota based on the average GHG emissions of the top ten percent of facilities producing the product. Several allocation models were used in the Chinese pilot market, such as scale allocation or quotas, which are based on the historical emissions of participants.

The choice of Viet Nam's quota allocation method should be appropriate to the characteristics of the waste sector, for example, it is possible to use a performance-based method or a historical emission-based method. In addition, it is necessary to determine a reasonable emission ceiling, balancing the emission reduction target and the implementation capacity of enterprises. Establish a mechanism to adjust the emission ceiling over time to ensure the effectiveness of the system.

GHG quota allocation in Viet Nam should be based on the actual circumstances of the participating entities, which can be lower than the entity's emissions (through inventory). In the initial stage, the allocation according to the quota can be allocated free of charge. After that, the allocation according to the quota is implemented through auction.

- Information disclosure and transparency: Mandatory regulations on information disclosure for listed companies operating in sectors with high carbon emissions. The US experience shows that requiring the disclosure of climate-related financial information such as core emissions, facilities accounting for a high proportion of total assets, and lists of leading raw material suppliers will help businesses and partners understand each other's green financial situation, support state agencies in monitoring businesses, and create a basis for investors to make choices.

- Monitoring and evaluation mechanism: Establish an effective monitoring and evaluation system to ensure compliance with regulations and adjust policies when necessary.

- Technical assistance: Provide technical assistance to businesses, especially small and medium-sized enterprises, to help them understand and comply with the regulations of the system.

In addition, the allocation of quotas should take into account:

- Carbon leakage: Measures are needed to prevent carbon leakage, that is, businesses moving production to countries with less stringent environmental regulations.

- Social impact: It is necessary to assess the impact of the ETS on people's jobs and lives.

- International compatibility: Viet Nam's ETS needs to be compatible with international ETSs to facilitate the trading of carbon credits.

4. Conclusions

This study analyzed and synthesized lessons learned on GHG emission quota allocation from many countries and regions around the world. Thereby, the study provided important lessons

that can be applied to Viet Nam in developing and implementing an emission quota allocation system.

The main lessons include: (1) Diversifying allocation methods, combining free allocation, auction and quota-based allocation; (2) Building a system suitable to Viet Nam's economic and social characteristics; (3) Balancing the goal of reducing emissions and supporting economic development; (4) Designing a flexible system that can adapt to changes; (5) Supporting businesses, especially small and medium-sized enterprises, in the transition process; (6) Investing in capacity building for management agencies and businesses.

The study also emphasizes the importance of transparent information disclosure, establishing effective monitoring and evaluation mechanisms, and providing technical support to enterprises. In addition, the allocation of quotas should pay attention to issues such as preventing carbon leakage, assessing social impacts, and ensuring the international compatibility of the system. These lessons and recommendations will be an important basis for Viet Nam to build an effective GHG emission quota allocation system that is suitable for domestic conditions and towards sustainable development goals.

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Declaration: *The authors declare that this article is their own research work, has not been published before, is not copied or plagiarized; there is no conflict of interest among the authors.*

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