



# A Blueprint for an Emissions Trading System in Bangladesh: Lessons from Global Precedents

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**Abstract:** This study designs a blueprint for an Emissions Trading System (ETS) in Bangladesh through comparative analysis of six global systems: the EU ETS, US SO<sub>2</sub> Program, China Regional Pilots, Mexico ETS, Korea ETS, and California Cap-and-Trade. The research evaluates mechanisms for cap setting, allocation, sectoral coverage, and MRV frameworks to identify optimal design elements. My findings indicate that a phased implementation targeting high-emission industries with output-based allocation alongside inter-temporal and inter-spatial trading would be best for balancing emission reduction with economic growth in Bangladesh. The proposed framework offers policymakers a viable pathway to decarbonization while maintaining industrial competitiveness, while also suggesting pathways of future research to predict environmental and economic impacts.

**Keywords:** Emissions Trading System (ETS), Carbon Pricing, Bangladesh, Climate Policy, Developing Countries, Comparative Policy Analysis, Industrial Decarbonization

## Introduction

As climate change's effects grow more severe, rigid top-down strategies for cutting emissions often fail to reflect the complex realities of global decarbonization. This tension is most evident in developing nations, which often bear the harshest impacts of climate change while struggling to balance economic growth with emissions reduction. These economies are heavily reliant on their industries, as many of them are manufacturing hubs. This manufacturing naturally leads to increased emissions.

Manufacturing is an integral part of these countries' economies, and Bangladesh fits perfectly within this paradigm. One sector alone, the Textiles Industry, contributed to 84.58% of Bangladesh's overall export revenue in the fiscal year 2023-2024 (FICCI Report, 2024). It is also the 4th highest emission-intensive industry.

A top-down regulatory approach to controlling emissions in these industries is economically impractical, as it risks hindering the growth that is vital for local employment and trade. In fact, this idea dates back to the earliest Carbon Emissions Trading Systems, such as the results of Lee et al. (2008), where a fuzzy goal programming model was used to reach the conclusion that ETS was friendlier to Sector GDP than a blanket Carbon Tax Policy. In this paper, I explore the mechanisms of different Emissions Trading Systems, and employ

that learning in proposing a system that can be implemented in Bangladesh.

### **A brief background on Emissions Trading Systems**

The original idea of Emissions Trading can be traced back to a 1960 article by Ronald Coase (Coase, 1960/2013) although it was first fully developed in a 1968 book by John Dales (Dales, 1968/2002).

Although there was a Lead-in-Gasoline Trading Program under the US Environmental Protection Agency between 1982-1987 targeted towards reducing the amount of leaded gasoline produced by refineries, the first Emissions-focused system wouldn't be implemented until 1990. In 1990, the US Environmental Protection Agency launched the Acid Rain Program under Title IV of the Clean Air Act Amendments of 1990 targeting Sulfur dioxide to reduce Acid Rain (Ellerman et al., 2003). The program went into effect in 1995, and a national cap of ~9 Million tons of Sulfur dioxide per year was set (50% below the 1980s level). Emissions dropped from ~16 million tons in 1990 to ~10 million by 2000, and even further as the project continued in phases (Ellerman et al., 2003).

The first Carbon Based ETS was implemented in EU, which became the EU ETS (European Union [EU] Directive, 2003), began operations on 1st January, 2005. It was a direct result of the Kyoto Protocol, when the EU committed to reducing GHG Emissions by 8% below 1990 levels by 2008-2012 (Delbeke et al., 2015). The Pilot Phase (2005-2007) covered some 12,000 Emitting facilities across 25 member States (Joskow, 2008). The system would subsequently go through major changes regarding mechanism, coverage and regulations in latter phases.

### **A Review of Outcomes from Carbon Trading and Carbon Taxation Implementations**

Pan et al. (2024) studied 113 empirical and theoretical studies spanning diverse regions on Carbon taxes and ETSs, and their findings suggested that while Carbon Taxes are generally more cost-effective for implementation, ETSs provide significantly stronger incentive for emission reduction, innovation and output growth, which translates to economic growth.

Li and Jia (2017) studied the differences in economic implications between ETS and Carbon Tax in China by using a Recursive Dynamic General Equilibrium Model. Their findings suggested that in the long run, the negative impact of ETS would be smaller than Carbon Tax on the Chinese economy.

Bai and Ru (2022) studied ETS impacts on Emissions Reductions of usage of Renewable Energy, finding ETSs reduced coal usage by 23.7% while boosting renewables usage by 61.59%, which Carbon Tax had negligible positive correlation with increasing renewables usage.

Al-Abdulqader et al. (2025) studied 30 jurisdictions between 1990 and 2020, where either a carbon tax, an ETS or both had been implemented. Their findings associated a 12.06% reduction in Carbon Emissions with ETS, while a 8.91% reduction under Carbon Tax.

**Table 1.** A review of outcomes between Carbon Trading and Carbon Taxation Implementations

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Li &Jia	2017	ETS better than Tax in Emissions Reduction Hybrid better than both individually
Al-Abdulqader et al.	2025	For 30 Jurisdictions from 1990-2020 ETS Reduction - 12.06% Carbon tax - 8.91%
Bai & Ru	2022	ETS boasted the usage of renewables by 62%, significantly higher than Carbon Tax
Shen & Zhao	2022	For macro impacts, ETS is gentler
Cao et al.	2019	ETS and Carbon Tax Similar Reduction Results ETS lower GDP Loss
Bi et al.	2019	Hybrid Smallest GDP Loss, ETS GDP Loss less than Carbon Tax

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### Research Questions and Framework

Why understanding differing ETS is important: Emissions Trading System vary significantly in terms of mechanisms. These differences exist in Cap Setting Mechanism, Allocation Mechanism, Reserve and Auctioning, Timeline, Targeted Emission, Targeted Industry, Coverage Area, Trading Mechanism, Banking, Trading Competitiveness, Monitoring Mechanism, Enforcement and more. The efficiency and responsiveness of a system depends on the relationship between these mechanisms and that region's particular context.

Why an ETS is needed in Bangladesh: As we will see throughout this paper, ETS when implemented and regulated fairly, has significant positive implications for emissions reduction. This matters for Bangladesh, which stands at the crossroads of several existential issues. Every year, coastal districts face significant land loss (Ali et al., 2025), and extreme weather events become increasingly frequent, impacting agriculture, industry and beyond.

My work is based on the "next best step" framework by Eckersley, (2021). Balancing Economic Growth with Emission Reduction is essential for Bangladesh, and rigid approaches cannot work in an environment like this. In the second part of the paper, I strive for realistic approaches to the potential implementation of an ETS, employing critical problem-solving to see which mechanisms can reduce emissions most without hurting economic growth.

### Research Method

This research adopts a comparative policy analysis framework, combining an examination into existing Emissions Trading Systems (ETS) with a feasibility assessment for Bangladesh.

### **Research Design**

The study proceeds in two phases. The first undertakes a structured comparison of six representative ETS case studies, namely: EU ETS, US EPA Sulfur Dioxide Program, California Cap-and-Trade, China Regional Pilot ETS, Mexico ETS Pilot and Korea ETS. These cases were selected to provide diversity in geographical context, economic development stage, regulatory design, and market maturity. The second phase applies the lessons derived from this comparison to the Bangladeshi context.

### **Case Selection Criteria**

Case studies were chosen according to the following criteria:

- Market Maturity: From well-established markets (EU ETS) to pilot schemes (Mexico).
- Economic Context: Both developing countries and developed Countries.
- Industrial Coverage: Highly emissive sectors (Power, Manufacturing, Industry) to non-productive sectors.
- Mechanism Differences: Distinct approaches to Cap-setting, Allocation, Enforcement.
- Jurisdictional Level: Regional (California), National (Korea) and Continental (Europe) to better understand Regulatory Framework, especially decentralized cap setting and enforcement.

### **Data Sources**

The comparative analysis draws on a combination of:

1. Peer-reviewed academic literature on ETS performance and design.
2. Official government and ETS authority reports.
3. International climate policy databases (e.g., ICAP, C2ES).
4. Secondary datasets providing quantitative indicators of emissions, GDP changes, and market activity.

### **Analytical Framework**

The comparative evaluation employs a multi-criteria analysis, structured around the following policy dimensions:

1. Cap Setting – including absolute vs. intensity-based caps
2. Allocation Mechanism – historical vs. output-based; mass vs. rate-based allocation.
3. Reserve and Auctioning – market stability mechanisms and price floors/ceilings.
4. Sectoral and Geographic Coverage – breadth of participating industries and jurisdictions.
5. Trading Mechanism and Competitiveness – liquidity, market access, and barriers to entry.
6. Monitoring, Reporting, and Verification (MRV) – use of continuous monitoring,

emission factors, and third-party verification.

7. Enforcement – penalties for non-compliance and robustness of regulatory oversight.

## Result and Discussion

### Background, Mechanism and Results of Different ETS

#### European Union ETS

The EU ETS is the world's first Cap-and-Trade Program targeted towards CO<sub>2</sub>. As a direct result of the Kyoto Protocol, the EU ETS is considered the pioneering model for ETS around the world. Phase 1 (2005 to 2007) was the Pilot Phase, and it failed to reduce emissions. In fact, the total emissions in the participating firms increased in the first phase (Abrell et al., 2011). But the learnings from this phase paved the way for future success. Phase 2 lasted from 2008 to 2012. In the first two phases, the cap was not set from top down. Rather, it was calculated bottom-up, and was the sum total of national allocation plans of each Member State. The cap of Phase 1 was 2,096 MtCO<sub>2</sub>, and Phase 2 was almost exactly the same. Phase 3 (2013-2020) was when a decline factor was introduced. The Phase started with 2084 MtCO<sub>2</sub> in 2013, and declined by 1.74% each year reaching 1,816 MtCO<sub>2</sub> in 2020. Phase 4 (2021 to 2030) has seen stricter decline factor so far, with 2.2% for 2021-2023, 4.3% for 2024-2027 and 4.4% for 2028-2030 (International Carbon Action Partnership EU ETS).

Before investigating the structural aspects of the EU ETS, it is worthwhile to understand how the allocation and banking developed over the phases.

- Phase One: The EU ETS, while being regulated centrally, has many aspects that are decentralized. Likewise, in the first phase, allocation was not a matter of central planning. Allowances, allocated via Grandparenting and Auctioning, were based on Member States' National Allocation Plans.
- Phase Two: Around 3% of the allowance allocation was Auctioned in this Phase for the first time by 8 member states. Majority of the allowances were distributed for free.
- Phase Three: This is when auctioning became the primary distribution mechanism, accounting for ~57% of the cap. 88% of the allowances were distributed amongst the Member States based on verified 2005 emissions. 10% were distributed amongst 16 lower-income Member States to facilitate transition and clean development (European Union [EU] Commission Decision, 2020). While some 3/5th of the cap was auctioned off, there were significant free allocations as well. This was done to address potential carbon leakage risk, measured via sector specific benchmarks and trade elasticity. This was most relevant in terms of Industry, where some sectors, deemed at risk of Carbon Leakage, received 100% free allocation. 5% of the cap was reserved for new installations.
- Phase Four: 90% of the Allowances were distributed amongst Member States based on verified Emissions from 2005, and much like Phase Three, 10% was distributed amongst lower income members. One key difference from Phase Three is the earmarking for a reserve of Allowances. Taking potential Carbon Leakage into account, 450 Million Allowances initially meant to be auctioned off were frozen. The intent was having a reserve that could be used for free allocation to specific sectors in case the initial free allocation volume was insufficient.

**Allocation:** There was no banking or borrowing of permits in the first phase of the EU ETS. This collapsed the price of carbon to almost zero by late 2007. Due to the unexpectedly low abatement cost, the emissions actually grew by 2% in the first phase (Abrell et al., 2011). The cap itself was 3% higher than the emissions in 2005. Whether there was over-allocation is a matter of contention and has been the subject of studies via several methods.

According to Egenhofer (2007), most member states set individual cap way too high, almost 4 percent of BAU Emissions. This happened due to lack of reliable industry data and country emissions prior to 2005. By 2006, it was clear that over-allocation had happened.

In their 2006 study, Ellerman and Buchner wanted to evaluate if the pilot was effective in reducing emissions. To do so, they assumed a Business-As-Usual (BAU) baseline that would have been without the scheme in place, and compared it with the actual emissions data. The BAU was based on pre-ETS Emissions Data adjusted with GDP Growth Data and Carbon Intensity trends. Their analysis showed that the BAU emissions level in 2005 was significantly higher than the actual emissions observed, which meant that ETS actually worked. Ellerman and Buchner thus concluded that over-allocation of permits had not occurred. This approach has been rebutted many times, most effectively by Stefano Clo (2009) when he showed that BAU Approach relied on counterfactual scenario with space for bias. Stefano Clo's proportional responsibility showed an over-allocation in the pilot phase.

Abrell et al, (2011) employed a sectoral analysis using firm level data, and found that emission trends and allowances differed between sectors. They noted that the power sector dominated the EU ETS, and was the only sector that used more allowances than it obtained for free during the first two phases. This indicates that the power sector was generally under-allocated, and the rest were over-allocated, as they were net sellers of allowances. The study also showed that over-allocated firms benefitted from their participating in the ETS by increasing their profit margins, and it was the opposite for under-allocated firms.

**Banking:** Parson et al. (2009) noted that the price collapse of the pilot was not due to overallocation, but a significant mechanical flaw. As Inter-temporal trading was not yet allowed, firms quickly realized that by the end of 2007, there were two pathways. The first case entailed a situation where they over-extended beyond their allowances and had to pay a fine. On the other hand, if the allowances were not used before 2008, they would be worthless as they could not be carried into the next phase. Thus market participants realized that the surplus allowances would have no value, and price declined towards zero rapidly, creating a "price seam".

### **US EPA Sulfur Dioxide Program**

The US SO<sub>2</sub> Program was the first nation-scale ETS Program targeting a GHG. It has also been one of the most successful examples of how ETS can be effectively used for controlling emissions. It was so successful that during the Clinton Administration, its effectiveness and acclaim was used by the US to push for Market-based mechanisms within Global Agreements targeted towards Emissions Reduction (Parsons et al., 2009). Significant part of the integration of Market Mechanisms in the Kyoto Protocol was due to this

diplomatic push, which would in a way make the ETS we know today a direct result of the 1990 SO<sub>2</sub> Reduction Act.

The allowances were based on historical fuel usage and heat input data (1985–1987). Power plants received allowances calculated from past activity. Most permits were grandfathered (free), with a small % auctioned (2.8%).

In the very first year of implementation, the system saw one of the steepest drops in SO<sub>2</sub> levels. The 1995 plunge in SO<sub>2</sub> emissions was driven by the market design of ETS, particularly the ability to bank early reductions. Temporal trading further cut costs, and the whole system quickly developed into a robust marketplace. Entities realized that with time the cap will get stricter, and the marginal abatement costs will rise high after 2000. Inter-temporal Trading or Banking (storing allowances for future use) was the most pivotal aspect of this design, as industries realized that they could over abate now for smoother functioning in the future as cap gets stricter. However, borrowing was not allowed.

Inter-spatial trading was also introduced. This proved to be the backbone of the functioning carbon market. Compliance Data for in Phase I showed that one-third of the treatment units obtained allowances either via i) intra-firm transfers or ii) purchases through the allowance market. This allowed the firms to cover excess emissions. This also created a vibrant market, flourishing inter-firm trading.

High Volume of Inter-temporal trading concerned experts the effectiveness of the ETS in future phases, however further research showed that these concerns were not substantiated. Notably, Ellerman & Montero (2007) showed that firms were not reckless in their behavior of storing allowances. Rather, they would choose the most efficient and stabilizing path. Consequently, despite some fluctuations, prices followed a clear upward trend from \$70/ton (1996) to \$200/ton (early 2000s), showing the market was working as intended.

Inter-Temporal Trading cushioned any significant shock that would come in the later phase due to harder cap. Those who adjusted early were rewarded. Those who did not abate as much initially had to buy allowances from the early adopters, further increasing trading competitiveness and keeping prices at a gradual increase.

Another key reason for the system's success had to do with removing regulatory friction. Trading was allowed without ex-ante (based on forecasts) regulatory sign-off. This reduced trading friction significantly, and increased trading volume. Continuous Emission Monitoring Systems (CEMS) gave regulators solid data to enforce the cap without costly disputes, and the program's focus on total emissions (instead of regional) made it possible to design a very flexible trading system. Even though CEMS added a significant portion to the Compliance Costs, it made frictionless, high volume trading possible.

The Initial Phase also had an "opt in" mechanism. This basically represented two voluntary pathways.

1. Phase II power plants joining early in Phase I - Electricity-generating units not required to comply until the stricter Phase II could voluntarily join the earlier Phase I program.
2. Industrial facilities (non-utility SO<sub>2</sub> emitters) could in either Phase I or Phase II.

This mechanism was more due to political and trial-related reasons, and in fact was

slightly detrimental in meeting emission targets. Montero (1999) found that this resulted in a 2% lower decrease in emissions than it was supposed to be. This mechanism had little consequential bearing on the real goal.

Despite the successes of the Program, it had some structural drawbacks too. These flaws would most visibly come forth during the Price Hike of Allowances in late 2005. From early 2004 to December 2005, the price of SO<sub>2</sub> allowances rose significantly from less than \$220/ton to \$1,625/ton. While the exact reason is unclear, some relevant events are closely connected

The Environmental Protection Agency (EPA)'s 2005 CAIR (Clear Air Interstate Rule) imposed stricter SO<sub>2</sub> Caps, increasing the anticipated cost of allowances. The more direct cause, however, is often attributed to the Powder River Basin Coal Disruption, disrupting the supply of low-sulfur coal nationwide. Power Plants were forced to use higher-sulfur coal, increasing emissions and consequently demand for allowances (Parson et al., 2009).

These temporary shocks would have been manageable, especially given the high Inter-temporal trading in the market, which led to firms storing allowances for future use cases. However, this is where the system failed to realize the solution fully. As selling the allowances would increase taxable gain, firms found selling economically inefficient as more taxes had to be paid.

Another key issue was that, the supply of the allowances generally came from regulated utility firms, as they always had more allocation. This introduced complexity to their market speculations. If, for example, a regulated electricity company made a profit from a speculation, the regulatory body overseeing the company might view the profits as something that should be passed along to customers in the form of lower rates. The same logic however did not apply if the speculation went wrong. In case of a loss, the management of said company might be penalized.

These factors made trading very limited, creating a negative feedback loop and amplifying price hikes.

### **California Cap-and-Trade Program**

The California Cap-and-Trade Program began operation in 2012. The system began on a solid foundation, with tracking system for allocation, auction distribution mechanism and trading options. It has gone through 5 Compliance Periods till date, and covers about 76% of the state's GHG Emissions. The critical component that makes California's Cap-and-Trade Program worth studying is its Major Auctioning Reserves, which also leads to significant government proceeds utilized for community good. Till November 2023, \$11.0 Billion from auctioning proceeds have been channeled towards 578,600 individual projects, 12606 affordable housing units, 420,210+ rebates for eco-friendly transportation, nearly 1 million acres of land conservation and more (California Climate Investments Report, 2024). The Adaptation and Mitigation Efforts propelled by the ETS Revenue have led to GHG Reductions of ~110 MtCO<sub>2</sub>.

#### **Compliance Periods**

1. First Compliance Period (2013-2014) - A Cap of 162.8 MtCO<sub>2</sub> was introduced in 2013,

and declined to 159.7 in 2024, a 2% decrease.

2. Second Compliance Period (2015-2017) - New Coverage Industry increased the cap to 394.5 MtCO<sub>2</sub>, and the Cap had a decline factor of 3.1%, reaching 370.4 by 2017.
3. Third Compliance Period (2018-2020) - No new Coverage Area. Cap started at 358.3 in 2018, and the decline factor increased to 3.3%. By 2020, the cap was 334.2 MtCO<sub>2</sub>.
4. Fourth Compliance Period (2021-2023) & Fifth Compliance Period (2024-2026): An approximate decline amount of 13.4 MtCO<sub>2</sub> per year, or about 4% was set. The cap is set to reach 200.5 MtCO<sub>2</sub> by 2030, after which a new formula is set to be introduced (ICAP California Cap-and-Trade Program).

Initially, 90% of the Allocation was Free (based on output benchmarks) and 10% was auctioned (Bang et al., 2017). The criteria for finding the baseline per firm however was a bit more complex than simple “Grandfathering”. The baseline was determined by product-specific benchmarks, latest production data, a cap adjustment factor, an adjustment factor based on leakage risk (ICAP California Cap-and-Trade Program).

The latest metric, that is the Adjustment Factor based on Leakage Risk, is a Allocation Feature that is uniquely approached in the California Cap-and-Trade System. Unlike in some systems, California has politically maintained assistance factors at 100% through 2030 for all sectors, citing ongoing vulnerability. Even so, Auctioning remains a major component because that 100% blanket does not apply to all sectors. In 2024, about 65% of total vintage allowances offered were sold at auction, but this is driven by the program’s overall design, not by leakage-risk adjustments.

Leakage risk means the danger that a firm will respond to carbon costs by moving production (and emissions) out of California, rather than reducing emissions. This risk was scored on Emissions Intensity and Trade Elasticity. This metric has, as mentioned earlier, been frozen till 2030.

### **China Regional Pilot ETS**

China’s ETS Market developed through three phases. (Wu et al., 2023) China ratified the Kyoto Protocol in August, 2002, representing the start of Phase 1, marked by the foundational stage of exploring, preparing and setting up the basics of regional ETSs. Phase 2, between 2009 and 2015 was when the regional pilots were first implemented. At the end of 2011, seven provinces and cities were designated as Pilot Carbon Trading Areas. These were - Beijing, Shanghai, Chongqing, Tianjin, Shenzhen, Hubei and Guangdong. Li & Jia (2016) evaluated the effectiveness of China’s ETS pilots by using the DID model, based on provincial panel data from 2005 to 2016. The findings indicate that the ETS pilots in Beijing, Shanghai, and Hubei significantly curbed local carbon emissions, while the Guangdong pilot was associated with a rise in emissions, and the Tianjin pilot showed no statistically meaningful impact.

The Final Phase is the creation of a National ETS. In 2016, planning for the National ETS began and a national ETS covering the power sector was launched in 2017, covering ~2,200 enterprises in the power sector, representing the largest ETS in the world by volume (Jiang et al., 2016).

In March 2025, plans to include Steel, Cement and Aluminum Sectors within the National ETS were confirmed, bringing in an additional 1,500 entities under the ETS coverage. When in effect, the cumulative coverage of the national ETS is estimated to represent half of China's total GHG Emissions (International Carbon Action Partnership, 2025).

Most studies done in the context of Chinese Pilots, using both scenario analysis and regression analysis, agree that the ETS Pilots have played an important role in reducing CO<sub>2</sub> Emissions. Zhang et al. (2013) and Cui et al. (2014) show that carbon trading has increased emission cost savings, while Cheng et al. (2015) and Zhu et al. (2017) note carbon trading can be tied to GDP growth and industrial output expansion. On the other hand, another study employing CGE model found that despite positive effects on emission reduction, carbon trading had negative effect on GDP (Mu et al., 2018).

To explain the heterogeneity of results in different pilots, Wen et al. (2021) employed a Synthetic Control Method to create synthetic control regions, a weighted combination of non-pilot provinces that closely mimicked the economic and environmental characteristics of the pilot regions before the ETS had been implemented. The study potentially attributed the differences to industries covered, carbon prices, allocation amounts and methods. The same possible attribution has been noted by Cui et al. (2014) and Mu et al., (2018).

Amongst the six pilots studied, Shanghai and Guangdong covered a wide range of industries concentrated on heavy energy consumption. In contrast, for the Beijing ETS, despite having more participants, the proportion of heavy-energy-consumption was relatively low with a larger proportion of non-productive entities. As such, the impact of ETS implementation on industrial output was relatively limited in Beijing, whereas Guangdong and Shanghai lost more than 4% of the region's total output over 4 years (Wen et al., 2021).

Each Pilot has its own allocation mechanism. The Guangdong ETS had the largest initial quota, and was the only one with a bidding auction mechanism. Furthermore, the trading competitiveness in each pilot varied from one another. Chongqing and Tianjin had much lower trading volume, resulting in the lowest carbon prices. Whereas, Shanghai had higher trading volume and much higher carbon prices, despite initial quotas being almost same in all 3 pilots.

Wen et al. (2021) note that firms should be subsidized in the early stages of ETS Implementation, and in a national ETS, local governments must be given a certain degree of flexibility.

### **Mexico ETS Pilot**

The Mexican ETS Pilot (International Carbon Action Partnership, Mexico ETS) is at its nascent stage, and is facing several legislative and mechanical challenges. This is precisely why it should be studied because of the implications these challenges have for replicating the process of setting up an ETS in a country like Bangladesh.

Covering 289 entities emitting more than 100,000 tCO<sub>2</sub> each across the Power, Mining

and Manufacturing Sector, the ETS is the first in Latin America and has been operational since January 2020, reaching its fifth allocation year in 2025. The Pilot featured free allocation based on these specifications:

1. Based on the “Grandfathering” Policy, entities receive free allowances, equal to 100% of their most recent verified emissions.
2. For unverified entities (due to lack of MRV), allocation is based on Historical Emissions.
3. Adjustment allocation can be done in case certain entities request further allowances when an expansion in their production results in additional emissions. 5% of the cap is allocated for this.
4. 5% of the total Allowance Cap is allocated for auctioning. However, no auctioning has happened yet. Furthermore, there is no trading exchange. Allowance trading currently can only be done via direct negotiation between two parties. These factors indicate a low level of interest in the system.

S&P Global reports that according to insider sources, this could be attributed to a lack of clear political will, regulatory uncertainty and lack of implementation capacity. Mexican State Governments are also implementing their own Carbon Pricing Mechanism when the Pilot moves to nation-wide operational phase, However, this has been marked by stark differences. As S&P Global reports, the Current Carbon Tax in the State of Mexico is \$2.56/tCO<sub>2e</sub>, significantly lower than Queretaro’s \$34.90/tCO<sub>2e</sub>.

Inter-temporal trading has not been implemented yet, which can be attributed to the low levels of interest in trading. The same phenomenon was observed in the initial EU ETS, when over-allocation, lax cap setting and lack of banking led to an increase in emissions by 3% over 3 years instead of a decrease.

### **Korea ETS**

The Korean ETS, implemented in 2015, was modeled after the EU ETS. However, it evolved to have its own rules. As Park & Hong (2014) notes, the initial Korean ETS design was a by-product of a political compromise amid a conflict of interests. To date, the KETS has consisted of three phases: Phase 1 for 2015–2017, Phase 2 for 2018–2020, and Phase 3 for 2021–2025.

While the carbon price has been fairly stable due to active government involvement, phase 1 of the ETS, between 2015 and 2018 experienced illiquidity owing to low levels of transactions and volatility according to Etienne & Yu (2017). To manage carbon prices, several steps were taken. These included auctioning of some reserves earmarked for market stabilization. Inter-temporal Trading was expanded as well, as borrowing from later compliance years was allowed for up to 20%. Domestic Offset Credits were also allowed to account for emissions to increase liquidity (Asian Development Bank, 2016).

The Korean ETS covers both direct and indirect emissions, and sets reduction targets by sectors. Preferential attention is directed toward energy-intensive, trade-exposed (EITE) industries. The ETS Act gives the government interventional capacity when the carbon price is too high or low. This may involve adjusting the allowance reserve, restricting allowance holdings, curbing borrowing, regulating offset credits, or imposing a temporary price

ceiling or floor. These stability measures establish the government ownership of the K-ETS (Joo et al., 2023).

In theory, an ETS performs best within a liberalized energy market where carbon costs are passed down to consumers. In Korea, key industries such as steel, petrochemical and cement are highly energy-intensive, emitting 78.4% of industrial greenhouse gases (Joo et al., 2023). To address this within a regulated electricity market, the K-ETS was designed to cover both direct emissions from energy production and indirect emissions from electricity use (Kim & Lim, 2014). Yet this structure generated inefficiencies in the scheme's early phases: because carbon prices were not reflected in electricity tariffs, incentives for fuel switching and low-carbon investment were weak.

The liquidity and volatility challenges persisted until 2020, when in response certain rule changes were introduced in phase 3 (2021-2025). Auctions were expanded, and third-party participation to stimulate market activity was allowed. Even so, the significance of these steps are yet to be seen, as auction remains restricted to specific sectors, and trading competitiveness is largely dominated by the power industry (Eisemann, 2021).

As we understand the global ETS architectures, we now pivot to the specific context of Bangladesh. The success of any system depends on its alignment with local realities. The following section assesses this context by mapping the country's existing policy landscape, key emitting sectors, and institutional capacity, which will directly inform the design of the proposed ETS.

### **Bangladesh's Current Policy Landscape**

Since 2005, several National Level Policy Responses have been initiated by the Government of Bangladesh (Government of Bangladesh, 2021). Notably-

1. National Adaptation Program of Action, 2005, updated in 2009
2. Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009
3. Bangladesh Climate Change Trust Act, 2010
4. National Determined Contributions (NDC), 2015 (Updated in 2021)
5. NDC Implementation Road Map, 2018
6. Bangladesh Delta Plan, 2100
7. Bangladesh Energy Efficiency and Conservation Master Plan up to 2030

One of the first unified Climate Action Initiative was the National Adaptation Program of Action (NAPA), submitted to UNFCCC in 2005 and was concerned with adaptation strategies aimed at increasing disaster preparedness in coastal areas (UNFCCC, 2005). The Bangladesh Climate Change Strategy and Action Plan (BCCSAP) expanded on this by creating frameworks aimed at tackling adaptation, mitigation and capacity building. Finally, under the Paris Agreement, Nationally Determined Contributions were introduced first in 2015 and then updated in 2021. Under the updated NDC (2021), Bangladesh has pledged to reduce GHG Emissions by 27.56 MtCO<sub>2</sub>e or 6.73% below BAU by 2030 by its own resources, and a further 89.47 MtCO<sub>2</sub>e or 21.85% below BAU by 2030 via International Support (Government of Bangladesh, 2021).

However, in terms of Clean Development Mechanisms, Bangladesh has made very

little progress. Till date, Bangladesh has registered 21 projects under the CDM Executive Board. However, only 2 of them have been issued Certified Emissions Reductions till now (Chowdhury et al., 2021).

### Emissions Trading System Design

Given our understanding of different ETSs, we will explore recommendations in 5 different areas. These are-

1. Scope and Coverage
2. Setting the Cap
3. Allocation Mechanism
4. Trading Competitiveness
5. MRV, Offsets and Revenue Usage

### Coverage

ETS's vary widely in scope of industries and gases. However, nearly all of them include the power and manufacturing, as well as Carbon Dioxide before moving onto other industries and greenhouse gases.

**Table 2.** Coverage

Coverage	CO2	N2O	PFCs	CH4	HFCs	SF6	NF3
California	Yes	Yes	Yes	Yes	Yes	Yes	Yes
S.Korea	Yes	Yes	Yes	Yes	Yes	Yes	
EU	Yes	Yes	Yes				
China	Yes						
Mexico	Yes						

Note: Adapted from International Carbon Action Partnership (ICAP) data. This table illustrates the varying scope of gases covered across different emissions trading systems, highlighting California and South Korea's comprehensive coverage compared to systems focused primarily on CO<sub>2</sub>.

Drawing from our discussion on Chinese Pilots, we saw how non-productive industries tend to lead to lower emission reduction. From Korea, we have seen the complications in bringing public power companies under ETS. For the initial phases, I suggest only a select, high emitting industries be brought under the ETS.

**Table 3.** Industry, Employment Figures, GDP Contribution, and Industrial Emissions Contribution

Industry	Employment Figures	GDP Contribution	Industrial Emissions Contribution
Food Processing	~250,000	~2.2%	39%
Cement and Clay	~5.5 Million	~4%	17%
Pulp and Paper	~2.5 Million	~1%	14%
Textile	~4.4 Million	~20%	11%

Note: Proposed Sectoral Coverage for the Bangladesh ETS

### Cap Setting

The cap essentially dictates how an ETS will perform. As such, it must be data informed and balance National Priorities with Ground Realities. In this regard, three kinds of policy interactions that need to be studied closely:

- Complementary - These policies complement the functioning of an ETS, usually designed keeping the ETSs Framework in mind
- Overlapping - These policies are often supplementary and have duplicate incentives, that may distort the real image. Feed in Tariffs, Green Certification Programs are such examples
- Countervailing - These policies may completely negate the function of an ETS and end goal. Such as Fossil Fuel Subsidies, which in turn increase emissions

There are two essential ways of setting a cap-

- Top-down approach; the government sets the cap based on its overall emission reduction objectives and high-level assessment of mitigation potential.
- Bottom-up Approach: the government bases the cap on an assessment of emissions, mitigation potential and costs for each sector and determines an appropriate emissions ceiling for each. The overall cap is then determined. This is less common, and thus has only been implemented in China.

We have seen that an initial over-allocation in the EU ETS led to an increase in emissions, and the cap was not changed in the second phase either. However, I believe a loose cap is necessary to inspire confidence initially and let the market grow out organically. Furthermore, for Bangladesh, a bottoms up approach will allow space for economic growth while emphasizing on the need for emissions reduction.

A clear decline factor needs to be set. We have seen the decline factor slowly increase in EU and California, and in this system it needs to incrementally increase as well, bringing the total cap down gradually and iteratively.

A portion of the cap needs to be earmarked for auctioning and managing temporal shocks. In the US SO<sub>2</sub> Program, a supply-chain disaster forced industries to use high-sulfur coal, causing prices of allowances to skyrocket. However, due to problematic financial hurdles, as we will discuss shortly, no one was willing to sell their allowances. An earmarked reserve in such a circumstance, much like quantitative easing, can lift significant pressure and lead to price stability.

## Allocation

How allowances are allocated has significant implications not only for the performance of the ETS, but also for the risks associated with initial ETS implementation. These risks might involve high costs pass through to consumers from companies, smaller companies not being able to trade, and low participation. How the allocation mechanism is designed is directly correlated with these risks, as well as the potential of carbon leakage.

Allowance allocation methods:

- **Auctioning:** The level of auctioning varies significantly in existing ETSs. In some newer jurisdictions like Chinese Pilots, auctioning is almost non-existent. Again, the share of auctioning in the EU ETS has developed over time, and represented 54% of allowances sold in Phase 3. We have seen how auctioning can raise significant revenue, and how this revenue has been funneled to high-impact adaptation and mitigation activities across our cases, specially California. The revenue can be used to support complementary climate policies, and in turn increase public and private sector support for ETS. Auctioning also removes the possibility of corruption. However, I do not believe a large part of the cap can be earmarked for auctioning in the early phase of a Bangladeshi system. It will not only put smaller firms at a disadvantage, but also reduce adoption from the very beginning. A gradual implementation of auctioning (like in the EU ETS) is much more reasonable.
- **Free Allocation:** Free Allocation mechanisms are informed by some idea of a baseline. This baseline can be calculated in different ways. One key factor however is assistance rates, which entails the level of emissions that receive free allocation. This is especially key for Sensitive Industries and Industries with high risk of Carbon Leakage. Free allocation methods include-
  1. Grandparenting
  2. Historical Benchmarked Allocation
  3. Output-Based Benchmarked Allocation
- **Grandparenting:** Based on Historical Emissions and Assistance rate, Grandparenting does not depend on Future Output decisions of a firm. Grandparenting has primarily been implemented in the first two Phase of EU ETS, as well as the Korean ETS for select Sectors. While this approach can help compensate for stranded assets, it has significant drawbacks. Grandparenting provides weak incentive for abatement, creates a barrier for new market entrants and does not dynamically adjust if a firm ceases production, leaving unused allowances in the market.
- **Historical Benchmarked:** The Assistance Rate in Historical Benchmarked is different from Grandparenting, as it determined by applying a sector wide product benchmark emissions intensity to historical output levels. This means that, similar firms have the same assistance rate.

This method incentivizes early movers and creates a level playing field for similar firms. However, establishing accurate product benchmarks is difficult and complex.

**Output Based Benchmarked Allocation:** The key difference between OBA and

Historical Benchmarking is that OBA adjusts allocations to reflect the actual level of production in each compliance period. Consequently, the abatement incentive also iteratively shifts.

This design particularly mitigates carbon leakage risks, and is easier for market entry of new firms. The low cost pass-through is excellent for firm competitiveness, but ultimately may reduce the demand for abatement.

OBA is best in the context of a Bangladeshi ETS for a few clear reasons. Firstly, consideration of carbon leakage is deeply important, considering Bangladesh's export-oriented manufacturing and growing reputation as a manufacturing hub for foreign companies. Secondly, by mitigating cost pass-through, OBA enables key industries to continue to grow and employ thousands. Lastly, given the dynamic growth of Bangladesh's industrial sector, OBA will allow new and more entrants to have a level playing field.

The first phases can have grandfathering (for verified) and historical emissions (for unverified), as it is the simplest and fastest to implement (much like Mexico). However, as the system becomes operational and data collection (MRV) becomes robust, the system should switch to OBA with some reserves earmarked for auctioning.

### **Trading Competitiveness**

Liquidity is one of the key features of a well-functioning carbon trading market. A market like this adjusts to internal and external shocks in a stable manner, keeping depth and liquidity predictable. While some volatility in carbon prices is beneficial, as it conveys signals about abatement costs to participants, significant swings can have extreme repercussions. Consequently, certain steps must be taken to ensure stability, activity and resistance to external shocks.

The most prominent lesson for a new ETS would be Inter-temporal and Inter-spatial trading. We have seen in the EU ETS pilot, as there was no inter-temporal trading, firms quickly realized that their allowances were meaningless if left unused. This drove price downward, and created a "price seam" between the first and second phase. Inter-temporal trading must be allowed, specifically both banking and borrowing. Banking entails saving allowances for a future phase, while borrowing entails taking allowances from a future phase for current use. In US SO<sub>2</sub> Program, we have seen how drastically emission reduction happened in the first phase because firms knew that the cap would get stricter with time, and consequently they saved up allowances for the future, driving emissions down in the present. Ellerman & Montero (2007) showed that firms did not offload additional allowance at once in future phases either, and so the effectiveness of future phases were maintained as well.

Borrowing can allow firms to cushion against internal and external shocks in the short term, and plan more effective strategies in the long term. Inter-spatial trading, or trading within firms must be made easier through more relaxed regulations in case of bilateral trade, and a transparent platform in case of a marketplace. Understanding a dedicated platform and its nuances is beyond the scope of this study, and future research into platforms of EU ETS, California cap-and-trade and China's national ETS can shed more light on the matter.

The sale of carbon allowances must be exempt from capital gains tax. We notice how the “lock-in” effect further exacerbated the price crunch during the 2005 price shock in US SO<sub>2</sub> Program, driven by companies holding onto allowances instead of selling to not incur capital gains. To increase trading competitiveness, carbon allowances should be defined as a compliance instrument, and not a financial asset for investment.

The regulatory body must be active and involved to ensure trading competitiveness. From our understanding of the Korean ETS, this may involve adjusting allowance reserves, inter-temporal trading, regulating use of offsets, or imposing price ceilings or price floors to counter shocks when necessary

### **MRV, Offsets and Revenue Usage**

The integrity of any ETS hinges on a robust Monitoring, Reporting, and Verification (MRV) system. Furthermore, opening up opportunities for firms to offset their additional emissions by funding local conservation, adaptation and mitigation projects can not only generate funding but also increase indirect emission reduction. Revenue accrued from auctioning should also be invested in properly planned activities adjacent to environmental policy.

For Bangladesh, MRV requires establishing clear protocols for emissions monitoring, third-party verification of reports, and a graduated enforcement mechanism. Enforcement mechanisms can range from public disclosure (“naming and shaming”) for minor infractions, to significant penalties such as “make-good” requirements, where offenders might need to surrender additional allowances as compensation.

To enhance flexibility and cost-effectiveness, the system could establish provisions for future integration with international carbon markets under Article 6 of the Paris Agreement to allow for over-emitting firms to offset by purchasing Internationally Transferred Mitigation Outcomes (ITMOs), especially for projects in Bangladesh.

Auctioning revenue can become a critical source of public and political support, like in the case of California and EU. The proceeds can be channeled into a dedicated climate fund, financing initiatives in adaptation, renewable energy, conservation, just transition programs for affected communities and more. Furthermore, increased auctioning revenue can allow the government to offer tax rebates, significantly increasing general support. In any case, thorough planning and transparency in this matter is a must.

### **The trade-off between emission reduction and economic growth**

In the initial phases, the EU ETS was most successful in the power generating sector, showing significant reductions in the EU15 countries (Muûls et al., 2016). Power companies were able to pass most of the permit costs to consumers, which translated to higher electricity prices. No major effects on employment in treatment firms were noted. The positive correlation with Stock Prices of Power Companies with Carbon Prices indicated profitability due to Free permit Allocations.

Marin et al. (2018) studied Manufacturing Companies in the European Union and

found that treated firms actually gained from EU ETS, showing positive affected turnover, markup, investment intensity and labor productivity. Petrick and Wagner (2014) studied German Manufacturing firms via a combined propensity score matching and DID approach, and found that the ETS had no significant effect on employment. Furthermore, their research showed a positive effect in Phase II of the ETS on Gross Output. Abrell et al. (2011) researched the effect of EU ETS on Profit Margins and Employment of European Companies, and found no negative impact on profit margin, but noticeable negative effect on employment.

Dong et al. (2018) investigated whether the National ETS in China could achieve the Porter Effect. Put forth by Michael Porter in 1991, the “Porter Hypothesis” suggests that reasonable and strict environmental protection policies inspires innovation and productivity benefits, increasing a firm’s competitiveness and allows for both Environmental and Economic Gain. Dong et al. (2018) found that while the Porter Effect could not be realized in the short term in China, in the long term the national ETS favors energy saving and emissions reduction, consequently generating greater economic and environmental benefits. That is, even if the Porter Effect is not realized in the Short Term, it does become apparent in the Long Term.

Xiao et al. (2021) studied the total factor productivity of treatment group firms and found that the TFP advanced by 14% in pilot regions. Cheng et al. (2015) conducted sectoral analysis of employment levels, and their research indicated that in the Service and Clean Energy Sectors, there was net positive employment due to increased demand for professionals in Clean Energy. Their findings also indicated a negative employment impact in iron and steel sector. Song et al. (2016) proposed an argument in favor of ETS-marked firms having greater market value due to enhanced environmental awareness amongst consumers.

### **Future Research Direction**

This paper is intended to be a starting point for literature exploring the feasibility of an ETS for Bangladesh. As such, the future research holds exciting prospects and opportunities. In this section, I will discuss some potential avenues for future research, including ones that I will be pursuing

Several Mathematical Models can serve the foundational role necessary for forecasting. Fuzzy Goal Programming Model (as used by Lee et al. (2008)) to compare ETS versus Carbon Taxation for Taiwanese Petrochemical Industries), Agent-Based Models (ABMs) (as used by Cong and Wei (2010) to study impact of ETS on Chinese Power Sector).

One of the most widely used model category is the DID (Difference in Difference Model), where regions with ETS (treatment group) and regions without ETS (control group) can be compared to cleanly isolate erroneous explanatory variables. Zhang et al. (2016) employed a DID framework to model nationwide carbon trading scenarios in China. Their analysis indicated that, when both economic growth and environmental protection constraints are applied, interprovincial carbon trading could reduce annual CO<sub>2</sub> emissions to 7.19 billion tons, roughly 27.27% lower than in the unconstrained baseline. The same

model was applied by Chen et al. (2020) to find that the Regional Chinese Pilots reduced emissions by 13.39%. Similar figures came up in Hu et al. (2019), where using provincial-level panel data from Chinese Pilots, from 2005 to 2015, a 15.5% reduction of CO<sub>2</sub> in treatment groups alongside a 22.8% reduction of energy consumption was found. Beyond Emissions Forecasting, DID has been critical in understanding correlation with other factors.

Notably, Marin et al. (2018) applied a DID model to examine how the EU's ETS influences firm-level economic performance, finding that companies respond by passing the resulting higher costs on to customers while simultaneously enhancing their labor productivity. Furthermore, Dong et al. (2018) studied Pilot areas in China to check if ETS can bring in the "Porter Effect", which indicates concurrent economic and environment dividend. Their results suggested a positive relationship between Emissions Trading Systems and concurrent environment and economic growth.

Naturally, the prospect of accurate forecasting becomes challenging due to the lack of sectoral data, or a potential pilot implementation for treatment group variable. This can potentially be mediated by the use of Synthetic Data. The use of Synthetic data in Environmental Science Research is picking up at a gradual pace, especially pollution prediction. Replicating panel data from countries with similar variables (India/Mexico/China), adjusting them, normalizing them and using them to create new Synthetic Datasets to base DID (and other models on) can potentially be instrumental in feasibility studies regarding the eventual ETS implementation.

### Conclusion

An Emissions Trading System is more than just a theoretical option for Bangladesh, but a strategic and viable instrument that can play a significant role in meeting national emission reduction goals while maintaining economic output. However, this system, as we have seen, needs to be carefully calibrated to the realities on the ground. Without this, the issues that cropped up at some of the cases that have been explored will inevitably be present in this system as well. The success of a Bangladeshi ETS will hinge on specific future research, sustained political will, development of transparent institutions and integration of carbon pricing into climate and industrial policies.

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