Introduction of Carbon Compliance Market in Pakistan: A Case from Cement Industry

By:

Aitzaz Ul Hassan ***01-111221-138***

Nigarish Asghar ***01-111221-190***

Mahin Rashid ***01-111221-229***

Bachelor of Business Administration

Supervisor:

Mr. Abdullah Hafeez

Marketing and Business Department

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Majors: FIN

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Names of Student(s): Enroll #

- Aitzaz ul Hassan 01-111221-138
- Nigarish Asghar 01-111221-190
- Mahin Rashid 01-111221-229

Class: Bachelor of Business Administration

Approved by:

____

Abdullah Hafeez

Supervisor

____

Qurat Ul Ain Waqar

Research Coordinator

____

Dr. Aftab Haider
Head of Department

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Table of Contents

LIST OF ABBREVIATION

Abbreviation	Full Form
2DS	Two Degrees Scenario
CCER	China Certified Emission Reduction
CCPI	Climate Change Performance Index
CDM	Clean Development Mechanism
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent (CO_2 and other greenhouse gases expressed in terms of CO_2 potential)
COP	Conference of the Parties
ESG	Environmental, Social, and Governance
ETS	Emissions Trading System
EU	European Union
EU ETS	European Union Emissions Trading System
FCCL	Fauji Cement Company Limited
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IEA	International Energy Agency
IFRS	International Financial Reporting Standards
ISO	International Organization for Standardization
JI	Joint Implementation
LRF	Linear Reduction Factor (annual rate of emissions cap decline in carbon markets)
LULUCF	Land Use, Land-Use Change, and Forestry
MRV	Monitoring, Reporting, and Verification
NDC	Nationally Determined Contribution
NO_x	Nitrogen Oxides (collective term for NO and NO_2 gases)
PAT	Profit After Tax
PSX	Pakistan Stock Exchange

Abbreviation	Full Form
SAP	Systems, Applications, and Products
SDG	Sustainable Development Goal(s)
SECP	Securities and Exchange Commission of Pakistan
SO_x	Sulfur Oxides
SSP	Shared Socioeconomic Pathway
UNFCCC	United Nations Framework Convention on Climate Change
UNO	United Nations Organization

LIST OF FIGURES

LIST OF TABLES

Table 13: New- Calculated Ratios of FCCL after Income Statement Projection

EXECUTIVE SUMMARY

Pakistan faces an existential crisis because of climate change although its greenhouse gas emissions remain below 1% of worldwide emissions. The nation of Pakistan maintains its position as one of the world most vulnerable countries when it comes to climate change because it experiences extreme heatwaves, floods, water shortages, food shortages and major economic damage. The 2022-2025 flood and heatwave events resulted in damage that surpassed $30 billion while they interrupted economic development paths and revealed fundamental problems with climate resistance systems and funding systems. The country emission levels keep increasing because Pakistan relies on fossil fuels and has not adopted enough renewable energy systems and its industrial sector operates with high carbon emissions. The difference between Pakistan climate promises and its ability to execute these plans keeps expanding. The research fills an essential policy void because it creates a homegrown carbon pricing system which proves emissions reductions through measurable data and generates environmentally friendly climate funding. The Paris Agreement Article 6 enables Pakistan to create carbon market rules, but the current system operates through voluntary measures which do not provide adequate support for industrial sectors to achieve deep carbon reduction targets. The research solves this problem by creating a sector-based Emissions Trading System which tests the cement industry because it produces high emissions, drives economic growth and connects to both energy and construction markets. The research shows that Pakistan cement industry generates more emissions than worldwide standards because it uses excessive clinker in production and depends on coal as its main fuel source while using few alternative fuels. The current business operations will result in extreme sectoral emissions which will rise more than 300% during the next fifty years thus violating Pakistan NDC and SDG-13 targets. The research proposes a two-stage ETS system which draws from Chinese and German models to solve this problem through capacity development, performance assessment, banking system management and price stabilization mechanisms. Research conducted with company data proves that the ETS system achieves maximum emission reduction at minimum cost while protecting industrial operations and producing funds for climate resilience initiatives. The research results confirm that a compliance-based ETS system provides an effective method to establish a low-carbon climate-resilient Pakistani economy at a large scale.

CHAPTER 01: INTRODUCTION

Climate change is emerging as one of the greatest challenges we face presently, mainly fueled by the increase in GHG emissions from our economic and industrial activities. As gases like CO_2 and methane accumulate in the atmosphere, they intensify the greenhouse effect, accelerating global warming and unbalancing natural and socio-economic systems. In this scenario, the concept of carbon footprint has become important to measure total GHG emissions related to human actions, organizations and production procedures (Abuzer Çelekli & Özgür Eren Zariç, 2023).

Pakistan is ranked in top 10 vulnerable countries despite its contribution to global GHG emissions is less than 1%. Due to the vulnerability Pakistan is ranked as 1st country in 2025 that has been affected by climate change (Coordination, 2024). This vulnerability has been defined based on rising temperature, floods, lack of water resources, drought, increasing risk to food and economic insecurity (Rehman, 2025). According to studies Pakistan is projected to experience a significant temperature increase, with T-min rising by 3.0–4.0 °C, T-max by 4.0–5.0 °C, and T-mean by around 3.5–4.5 °C under the low-emission SSP1-2.6 scenario, and up to 6.0–7.0 °C (T-min), 7.0–8.0 °C (T-max), and 6.5–7.5 °C (T-mean) under the high-emission SSP5-8.5 scenario by 2100 (Baig, et al., 2025).

Additionally, Pakistan experienced extreme flood situation in 2022 between June and October in Indus River that killed more than 1700 people and damaged 33 million people causing the loss of $30 billion in the economy. This flood follows the trajectory of 2010 flood that damaged 2 million people. Main reasons behind extreme flood were unpredictable rain and melting of glaciers due to climate change effects (P. Rafferty & Metych, 2025). The National Disaster Management Authority reports 922 fatalities and 1,047 injuries, with more than 93,800 people displaced and sheltering in 1,631 relief camps. Over 5,900 homes have been damaged and 1,946 destroyed (Global Water Partnership, 2025).

The financial loss caused by the recent flood is $1.4 billion, which is around 33% of Pakistan GDP. Pakistan GDP increased 6.2% in FY22, declined to -0.2% in FY23, and recovered to 2.5% in FY24, led by a 6.4% agriculture boom. Growth is forecast at 2.7% in FY25, but the 2025 floods have trimmed FY26 projections from 3.46% to 3.17%, with agriculture growth declining from 2.2% to 1.1%. Punjab faced the highest crop damage, with more than 1.3 million acres inundated (Arif Habib Limited, 2025).

From 1947 to 2024 Pakistan has emitted 17455.816 million tonnes of CO_2e (Ritchie, Roser, & Rosado, OurWorldinData.org., 2020). And it has been projected that current year GHG emissions will be 547 million tons and will reach 1 billion tons after 25 years (Pakistan Emissions Profile, n.d.).

1.1 Background

The total quantity of CO_2 emissions and other greenhouse gases produced through direct and indirect activities of products, organizations and human activities makes up a carbon footprint. The carbon footprint represents all emissions that stem from human activities through direct production, consumption and from accumulated emissions throughout product lifecycles (Wiedmann & Minx, 2007).

Human activities that produce GHG emissions have made climate change an immediate worldwide emergency because these emissions strengthen global warming and create disturbances in natural and human-made systems. The combination of industrial growth, fossil fuel usage, deforestation, transportation and unsustainable farming practices has led to substantial atmospheric greenhouse gas accumulation which produces abnormal weather events, glacier melting and sea level elevation. The changing environment creates significant challenges for ecosystems, food security, human health and social stability throughout different regions particularly in countries that are climate vulnerable. Climate change impacts have become more severe indicating that worldwide action through coordinated mitigation and adaptation efforts must start immediately ((Abbass, et al., 2022).

Climate change depends heavily on the carbon footprint as its main cause. The annual release of 44 billion tonnes of CO_2 occurs because of fossil fuel combustion and forest destruction (Amasuomo & Imtiaz, 2016).The reports demonstrate that climate change leads to faster sea-level increase, coastal destruction, biodiversity decline and glaciers ice melting. Environmental systems experience disruption from carbon-driven climate change which causes damage to agricultural production, reduces productivity and harms tourism-based economic areas. An Emissions Trading System is a smart, market-driven approach designed to cut down greenhouse gas emissions by putting a price on carbon within a regulated setup. A governing body establishes a total emissions limit and either allocates or auctions off allowances to the companies involved. Those firms that manage to emit less can sell their extra allowances, while those that produce more emissions need to purchase additional permits to stay compliant. By allowing emissions to be traded, ETS taps into market forces to achieve cost-effective reductions in emissions (Komla Kukah, Jin, Kyei, & Perera).

From 2001 onward, total worldwide GHG emissions have shown a clear overall rise, increasing from 40 billion tonnes of CO_2e in 2001 to roughly 53 billion tonnes by 2024. The sharpest growth occurred through the 2000s, followed by a slower climb and slight year-to-year fluctuations after 2012, but emissions have remained near record highs throughout the period as you can see in the graph (Ritchie, Rosado, & Roser, Greenhouse gas emissions, 2025).

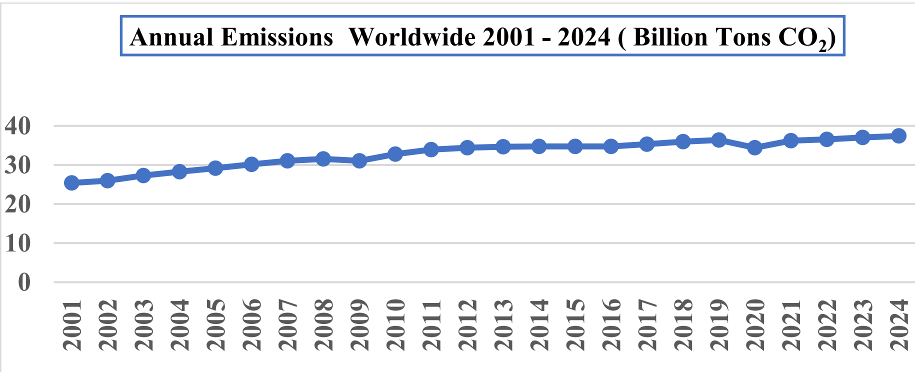

Figure 1: *Total Worldwide CO_2 Emissions (2001-2024)*

This significant rise in GHG emissions is due to increase in human activity level. Burning fossil fuels, livestock and deforestation are key drivers in rise of GHG emissions. These activities majorly raise CO2 emissions that contribute almost 75% to GHG emissions (Balakrishnan, 2025). As you can see, the graph below shows how CO2 emissions have been rising for the past 24 years.

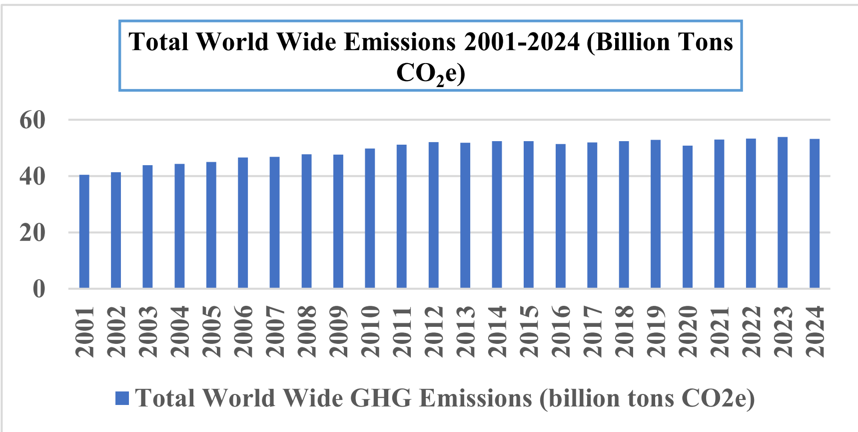

Figure 2: *Total Worldwide CO_2e Emissions (2001-2024)*

1.1. 1. Effects on Health and Population due to Climate Change

Climate change stands as a major worldwide threat to population health because it creates multiple environmental and social stressors that intensify each other. The combination of rising temperatures and more frequent heatwaves creates dangerous conditions for heat exhaustion, heatstroke and heart-related problems which affect older adults and people who work outdoors. The combination of severe storms, flooding and droughts creates problems for water distribution, sanitation and food delivery systems which lead to higher risks of waterborne diseases, food shortages and population displacement.

The expansion of disease-carrying vector habitats because of changing rainfall patterns and warming temperatures leads to faster disease transmission of malaria, dengue and other mosquito-borne illnesses. The formation of ground-level ozone becomes more severe during hot weather which leads to increased cases of asthma and other respiratory diseases. The psychological effects of climate-related uncertainty, loss and repeated disaster exposure lead to increasing rates of anxiety, depression, trauma and psychological distress among affected communities. Climate change transforms essential environmental factors for human health while creating greater health risks for disadvantaged groups who already face elevated health disparities (Eyzaguirre, Sousa, Jesus Martin, Fernandes, & B. Oliveira-Filho, 2025).

1.2 Problem Statement

"*The absence of a government-implemented standardized framework for assessing, analyzing, and mitigating carbon footprints in Pakistan Cement industry, along with the absence of domestic carbon market, limit sector contribution to national and global climate goals and increase it's vulnerable, underscoring the urgent need for a systematic approach to environmental sustainability in Pakistan industrial sector"*

The country of Pakistan endures worsening climate events including heatwaves and floods and glacier melting and water shortages despite producing only 1% of worldwide greenhouse gas emissions. The fulfillment of SDG 13 required continuous financial backing to execute both climate change prevention and mitigation pathways. The updated NDC 3.0 of Pakistan includes a 50% reduction in projected carbon emissions below business-as-usual levels by 2030 which heavily relies on international financial support, technology sharing and capacity development. The hundreds of billions of dollars needed for investment have not led to sufficient climate finance inflows which creates a substantial funding deficit that endangers national climate target achievement. The Paris Agreement Article 6 enables Pakistan to use cooperative approaches for climate finance mobilization through international carbon markets which support both financial support and decarbonization efforts. The establishment of voluntary and compliance carbon markets allows businesses to purchase emission offsets and trade credits which generate new financial opportunities while promoting sustainable low-carbon development.

According to National Climate Change Performance Index experts, some of the important rankings of Pakistan regarding climate change are as follows:

Indicators	Weighting	Ratings	Rank
GHG emissions	40%	High	11
GHG 2030 Target Compare to Well below two degrees benchmark.	10%	High	12
Renewable Energy	20%	Very low	58
Renewable energy 2030 Target (including Hydro)- compared to well below two degrees benchmark.	5%	Very low	50
Climate Policy	20%	Low	45
National Climate Policy	10%	Low	44
International Climate Policy	10%	Low	42

Table 1: *Pakistan Climate Change performance by CCPI*

The cement industry holds strategic importance for decarbonization efforts because it drives economic growth and generates substantial national greenhouse gas emissions. The country holds a position among the world leading cement producers while depending on coal for operations and maintaining clinker ratios above global benchmarks. The cement sector has experienced a dramatic increase in emissions over the last several decades because of calcination processes, fuel combustion and electricity consumption. The cement industry will produce rising emissions at an alarming rate unless immediate action is implemented which will damage Pakistan climate objectives. The integration of cement sector decarbonization into carbon market systems and financial programs enables Pakistan to meet its NDC targets and

SDG 13 while securing necessary climate funding for sustainable development and building climate resilience.

The UNFCCC received Pakistan updated NDC in 2021 which included a commitment to reduce projected carbon emissions by 50 percent below business-as-usual levels by 2030.The international support needed for 35 % of this reduction will require more than USD 101 billion during the period from 2021 to 2030. Most of the funding secured by 2024 originated from concessional loans, multilateral climate funds and bilateral aid programs (Goverment of Pakistan, 2021).

The World Bank predicts Pakistan needs USD 348 billion in total investments from 2023 to 2030 to handle its climate issues effectively which represents 10.7% of the country total GDP during this period. The total investment needs for Pakistan amount to USD 152 billion (44%) for adaptation and resilience programs and USD 196 billion (56%) for decarbonization initiatives (Pakistan Country Climate and Development Report, 2022).

An examination of past funding patterns shows a wide disparity between Pakistan climate finance requirements and the resources obtained. During the last ten years, the country has received only about USD 1.4 to 2.0 billion per year in climate-related funds on average, far below what is needed (Rehmat, et al., 2023).

1.3 Purpose and Objective of the Study

The primary purpose of this study is to conceptualize and design a structured carbon-compliance market for Pakistan, using the cement industry as the analytical case. The study addresses the sector rapidly increasing greenhouse gas emissions and its limited integration of sustainable industrial practices. It aims to propose a fully articulated Emissions Trading System model that defines the allowance-allocation procedure for the first two phases, establishes banking rules, sets the selling-price mechanism, and projects government revenue. Each component of the system will be tested as part of the analysis.

It further aims to calculate firm level compliance costs for selected cement companies, identifying which firms will generate surplus allowances that can be traded as an additional revenue stream and which will face allowance deficits, thereby reducing profitability and influence abatement decisions.

In parallel, the study highlights how much revenue the government can generate through the sale of allowances and how this revenue can serve as a sustainable public-finance channel to support national climate-resilience and adaptation priorities. By establishing this framework, the research intends to strengthen Pakistan capacity to meet its NDC 3.0 commitments, SDG 13 obligations, and Article 6 requirements of the Paris Agreement, while enabling a shift toward climate-responsible industrial development.

The study concludes by suggesting suitability of ETS system for Pakistan. This research also responds to a critical gap in the existing literature, as Pakistan currently lacks empirical, sector-specific, and policy-ready models for operationalizing a domestic ETS aligned with global compliance market standards.

1.4 Study Questions

1) How can an emissions trading system be designed for Pakistan cement industry to effectively lower carbon emissions while still promoting industrial sustainability?

2) Which allowance calculation and allocation procedures, along with banking rules, are best suited to Pakistan industrial structure and policy environment, ensuring that the ETS aligns with global market standards?

3) How can the proposed ETS generate revenue for the government, and in what ways can these carbon-market revenues be reinvested in climate-resilience initiatives to maximize public benefit?

4) How will introducing an ETS in Pakistan cement industry impact individual cement firms financial performance and opportunities to trade allowances?

1.5 Companies Overview

1.5.1 Lucky cement

The company was established in 1993 as the main business of Yunus Brothers Group. The company operates as Pakistan leading cement manufacturer with 15.30 million tons of annual production capacity and holds the distinction of being the first SECP-certified Shariah-compliant company listed on the PSX.

Domestic Operations Lucky operates two cement plants which function as complete integrated facilities at Pezu Plant in District Lakki Marwat, Khyber Pakhtunkhwa and Karachi Plant Gadap Town, Karachi. The two plants operate as a single unit to supply the entire Pakistani market through their wide distribution and warehousing system.

International Footprint LCL Investment Holdings Limited serves as the corporate entity that allows Lucky to operate and co-own the following businesses. The Najmat Al Samawah Company for Cement Industry operates an integrated plant in Iraq while its 1.82 MTPA clinker production line started operations in 2025. The Al-Mabrooka Cement Manufacturing Company Ltd operates a grinding facility in Basra. Nyumba Ya Akiba (Congo)S. A operates as a complete cement production facility in the Democratic Republic of Congo with a production capacity of 1.18 MTPA. The company operates more than 21 MTPA of cement production facilities across the world which serve markets in Africa and South Asia and the Middle East and the Americas. The Pakistani cement manufacturer Lucky Cement achieved its highest-ever sea-based export milestone when it shipped more than 3 million tons of cement and clinker during FY 2025.

Power & Sustainability Assets

The facility operates as a self-sufficient power plant which generates 214 MW of electricity while feeding excess power into the national power grid. The company operates two solar power facilities with a combined capacity of 74.3 MW located at Pezu and Karachi. The Karachi Plant operates a 28.8 MW wind power generation facility. The power plants utilize Waste Heat Recovery Systems (WHRS) as part of their operations. The company operates two waste management facilities which convert Refuse-Derived Fuel and Tyre-Derived Fuel into usable energy sources.

Strategic Direction & Future Sustainability Outlook

The company is working towards maintaining leadership in the Pakistani cement market while steadily entering new markets abroad. Keeping in view the Sustainable Development Goals set by the United Nations for the year 2030, it focuses on the integration of renewable energy, reduction of waste, and community development, initiated by the Aziz Tabba Foundation (Lucky Cement, 2025).

1.5.2 Fauji Cement

Fauji cement Ltd. plays critical role in the Pakistani market as one of the leading cement producing firms in the country, by virtue of being a subsidiary of the Fauji Foundation Group's and by contributing to sustainable development in the industry. The mission of the company is "Innovating Towards a Greener Future." Currently, the company has expanded from having only one cement factory to being a vertical national cement manufacturer with significant operations and financial performance.

FCCL has four integrated cement plants across Pakistan, which give it optimum access to markets & logistics advantages. The Jhang Bahtar Plant in Attock has been functioning as its main plant, with three production lines, using waste heat recovery and solar power solutions. The Wah Plant in Rawalpindi District operates with high efficiency while maintaining energy-saving practices. The Nizampur Plant in Nowshera started operations in 2019 as a 6,500 tons per day brownfield expansion project. The D.G. Khan Plant in southern Punjab became operational in 2023 after a fast-track construction period. The company operates a polypropylene bag manufacturing facility at Hattar Industrial Estate (KPK) which it purchased in 2024 to meet about 90% of its packaging needs. FCCL operates at 51-52% capacity utilization while producing 5.37 million tons of cement in FY 2025 with exports reaching 10% of total sales that mainly go to Afghanistan.

Sustainability and Energy Efficiency Initiatives

FCCL maintains its position as the most sustainable cement company through its major renewable energy and decarbonization programs. The company installed 15 MW of solar power systems during FY 2025 which brought its total renewable energy capacity to 67.5 MW across four facilities. The company uses dual Waste Heat Recovery systems together with renewables to generate 80% of its daytime power consumption which makes it one of Pakistan leading cement producers in renewable energy usage. The company uses 75% of its fuel supply from domestic coal sources and 12% from Refuse-Derived Fuel and biomass alternatives to decrease its reliance on foreign fossil fuel imports. The major facilities of the company implement extensive rainwater collection systems and water conservation plans to reduce their resource consumption.

FCCL holds various international certifications that include ISO 9001 for Quality Management, ISO 14001 for Environmental Management, ISO 45001 for Occupational Health and Safety, ISO 50001 for Energy Management and ISO 14064-1:2018 for greenhouse gas quantification and verifications. The company sustainability initiatives support both Pakistan Nationally Determined Contributions and UN Sustainable Development Goal 13.

Strategic Direction and Sustainability Future Outlook

FCCL plans to advance through modern technology adoption and energy diversity expansion and export market expansion. The company plans to reach 100 MW of renewable energy capacity by FY 2027 while working to achieve complete ESG compliance under IFRS S1 and S2 standards. The company plans to enter new markets in Central Asia while implementing SAP S/4HANA for digital process optimization. The cement sector of Pakistan benefits from Fauji Cement Company Limited through its four modern integrated plants and complete packaging facility and its 80% usage of renewable and recovered energy resources (Fauji Cement, 2025).

1.5.3 Link of ETS with Cement Industry

The cement industry forms a key pillar of Pakistan industrial economy, closely linked to construction, housing, and infrastructure development**.** Pakistan ranks 15^{th} globally in cement production with a 1% contribution to total GDP. The sector that employees 40,000 workers still face the major challenge of high reliance on imported coal and carbon emissions regulations.

Manufacturers in the South benefit from lower transportation costs due to proximity to ports for importing coal from Indonesia and Australia, while those in the North access export markets such as Afghanistan and India at higher transport expenses. Industrialized countries throughout the world have accomplished the goal of decreasing their dependence on fossil fuels for cement manufacturing since the early 2000s. The Netherlands and Switzerland have achieved 83% and 48% alternative fuel substitution rates in their cement production while the United States reached 16% alternative fuel usage in their total fuel consumption during 2016.

In contrast, Pakistan cement plants continue to depend primarily on a mix of imported and domestic coal, missing opportunities to lower energy costs typically 30–40% of production expenses and curb emissions. Although the government has introduced substantial incentives, including record allocations in the 2021–22 Public Sector Development Program, housing subsidies, and major infrastructure projects that have driven capacity growth from 8.89 MMT in 1990 to 73 MMT in 2023, production utilization has fallen to 61% amid slowing demand and export declines. This expansion has fueled a sharp rise in greenhouse gas emissions.CO_2

from calcination increased by 687% since 1990 to 28.6 million tons, while fuel combustion emissions reached 21 million tons, and electricity-related emissions climbed to 4.59 million tons. Additional Scope 3 emissions from truck-based cement logistics characterized by overloading and inefficient mileage further amplify the sector carbon footprint.

If we do not take desirable steps towards decarbonizing the cement industry, emissions from cement sector will grow by 308% till 2025. Following table summarizes the emissions analysis, providing a visual reference that complements (Nust).

Period	**Emissions (Million Tonnes)**	**Emissions Increase (%)**	**Comments**
1990–2020	24.92	687	Increase in emissions within the baseline period (1990–2020)
Average Baseline (1990–2020)	11.74	—	Average baseline emissions
2021–2030	31.86	171.5	Projected increase relative to average baseline emissions
2031–2040	39.89	239.95	Projected increase relative to average baseline emissions
2041–2050	47.92	308.38	Projected increase relative to average baseline emissions

Table 2: *Pakistan Cement Sector Forecasted Emissions*

Given the global shift toward carbon pricing and alternative fuels, these trends underscore the urgency for Pakistan to adopt an Emissions Trading System to drive decarbonization, incentivize cleaner energy use, and align the cement industry with international climate commitments while maintaining competitiveness.

CHAPTER 02: RELEVANT STUDIES AND THEORIES

2.1 The Global Climate Change Landscape

Climate change has appeared to become one of the most analyzed global issues in environmental and economic forums, due to its effects on nature and economies. Many studies confirm human actions to be at least among the main reasons for climate change in current years. Today, analyses demonstrate importance in monitoring trends in emissions, identifying major emitters, and analyzing policies to reduce climate risks in the future through appropriate strategies (IPCC, 2018). While the literature acknowledges that the primary source of climate change is carbon dioxide resulting from human activity, global CO2 emissions for the year 2017 were 35.8 Gt, registering a 2.6 percent rise in 2018. On the other hand, the concentration of CO2 has continuously risen from 280 ppm during the pre-industrial era to close to 380 ppm (UNEP; IPCC). The rising emissions are diverging from the IPCC's reduction goal that requires a reduction of 45-50 percent by 2050 to cap warming at 2°C. This is highly relevant for sectors like energy & heating (25%) and transport (15%), emphasizing the urgency for decarbonization in these sectors (UNEP).

The literature overwhelmingly suggests that the global consequences of climate change do not affect all countries equally, with developing and least-developed countries being far more vulnerable as their ability to adapt is low. According to data from the Climate Risk Index from 2000 to 2020, some of the most acutely affected countries by climate change are non-Asian, including small island countries highly exposed to hurricanes and sea level rise, but also African countries, such as Mozambique, that have suffered a lot of cyclones and flooding. Such results demonstrate that climate vulnerability is indeed not confined to specific areas in the world but a global concern that affects mainly those countries which contribute very little to global GHG emissions.

The present body of work acknowledges the role of human-induced carbon dioxide emission as the principal cause of climate change, which resulted in the emission of 35.8 Gt of CO_2 in the year 2017 and a further increase of 2.6% in the following year (UNEP; IPCC). Simultaneously, the increase in atmospheric concentrations of CO_2 increased from the pre-industrial level of 280 ppm to nearly 380 ppm (UNEP; IPCC). The emission trend is moving further away from the IPCC's goals of reducing carbon dioxide emission by 45-50% by the year 2050 to limit warming to 2°C by targeting sectors that have high emission rates, including the power and heat sector (25%) and the transport sector (15%) about which the need to go green is extremely urgent (Qiu, et al., 2025).

On similar lines, the study about the heatwave of 2025 from India & Pakistan shows that it has an early start, high temperatures, high rates of death, damage to crops, reduction in productivity, and effects on GDP, thus increasing the evidence that heat waves pose both short-term & long-term economic & health hazards (India Pakistan heatwave Climate Change, 2025).

2.2 East Asia: A Carbon-Intensive Region

Empirical evidence suggested that East Asia stands as a highly carbon-intensive area worldwide because it produces thirty percent of global CO_2 emissions while showing significant differences in emission levels between countries. The carbon emissions from East Asia stem mainly from China which produced more than 80% of the region total emissions from 2012 to 2021 through its coal power plants and fast industrial development (Xia, Liu, Fan, & Ren, 2025). Further studies proved that electricity and heat sector in China produces approximately 53.4% of its total emissions because the country depends heavily on fossil fuels although it continues to expand its renewable energy infrastructure (Li, Raza, & Cucculelli, 2024).

Japan and South Korea demonstrate steady emission patterns because their populations and economies grow at a slower rate while their energy systems transform and they pursue aggressive carbon neutrality targets. The CO_2 emissions of Japan decreased from 1.28 billion tons in 2012 to 1.06 billion tons in 2021 while South Korea maintained a constant 5% share of regional emissions from 2012 to till now. Mongolia has experienced a steady increase in CO2 emissions which mainly stems from Ulaanbaatar coal-fired power plants that generate most of the country's energy (Xia L. L., 2025). Broader regional analyses further highlight that economic growth, energy consumption, and fossil fuel reliance remain the dominant drivers of East Asia emissions, while renewable energy adoption and foreign direct investment are associated with long-term mitigation potential. (Hariyani, Prasetyo, Ha, Dam, & Nguyen, 2024).We can see the emissions trend of the region for 02 years in the following graph (Centre, 2025) (Yao, Fan, Qi, Feng, & Zhou, 2025):

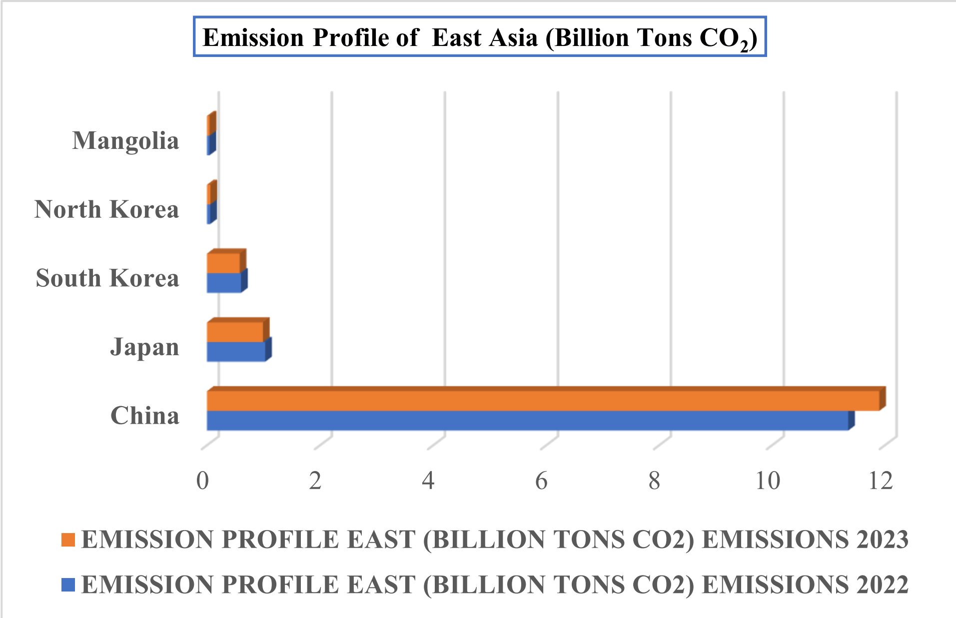

Figure 3: *East Asian Region Emissions Comparison (2022-2023)*

2.3 Mapping Europe Emissions Landscape:

Europe shows multiple national pathways to carbon reduction through its complex emission profile which lacks a unified regional approach. The decreasing emissions rates during economic expansion stem from different national approaches to environmental change. The regional emission pattern depends on Germany, France, Italy and Spain because these nations implemented clean energy systems, efficiency enhancements and economic structure transformations. The Netherlands shows how trade activities and logistics operations and industrial activities maintain high emission levels even though the country achieves excellent efficiency improvements. The Central and Eastern European region faces ongoing coal-related challenges while Sweden and Finland achieve lower emission rates through their renewable energy and clean power infrastructure.

The diverse national approaches to carbon reduction in Europe create a complex emission profile which results from industrial and energy selection and governmental decisions about environmental policy (Bianco, Cascetta, & Nardini, 2024). Europe carbon emissions follow a continuous downward pattern which stems from regulatory actions instead of parallel national transformation efforts. The EU-27 experienced decreasing greenhouse gas emissions since the middle of the 2000s because market-based climate governance started to dominate the scene.

The emissions data demonstrate a continuous decline since the beginning of the period while economic activities and investment activities continued to grow which shows some separation between economic expansion and carbon pollution. The main factor behind this transformation emerged from emissions pricing which forced businesses to decrease their emissions per unit while they developed environmentally friendly solutions. ETS became stricter while companies invested more, and the system maintained its long-term stability which transformed the emissions patterns in energy-intensive and industrial sectors. The regional emissions pattern in Europe results from policy-enforced industrial transformations instead of uniform national energy patterns and manufacturing sectors (Klimko & Hasprova, 2025).

2.4 Escalating Emissions and Vulnerability in South Asia

South Asia faces excessive carbon footprint damage because its large population base combines with its heavy use of fossil fuels. The region produced 44% of greenhouse gas emissions worldwide during 2022. The climate models predict that South Asia will experience a temperature increase of 2–4°C during the next 30 years. The areas of Bangladesh and specific regions in India contain vulnerable coastal communities who experience worsening flooding and rising sea levels. The economic effects of climate change have created significant social consequences. The combination of climate disasters will drive 62 million South Asians into extreme poverty while causing economic losses that will reach 13% of the region's total GDP by 2030. The region of South Asia experiences rising fossil fuel usage because its industrial development and urban expansion and expanding population numbers lead to increased emissions (Abbas, Yang, & Lahr, 2024).

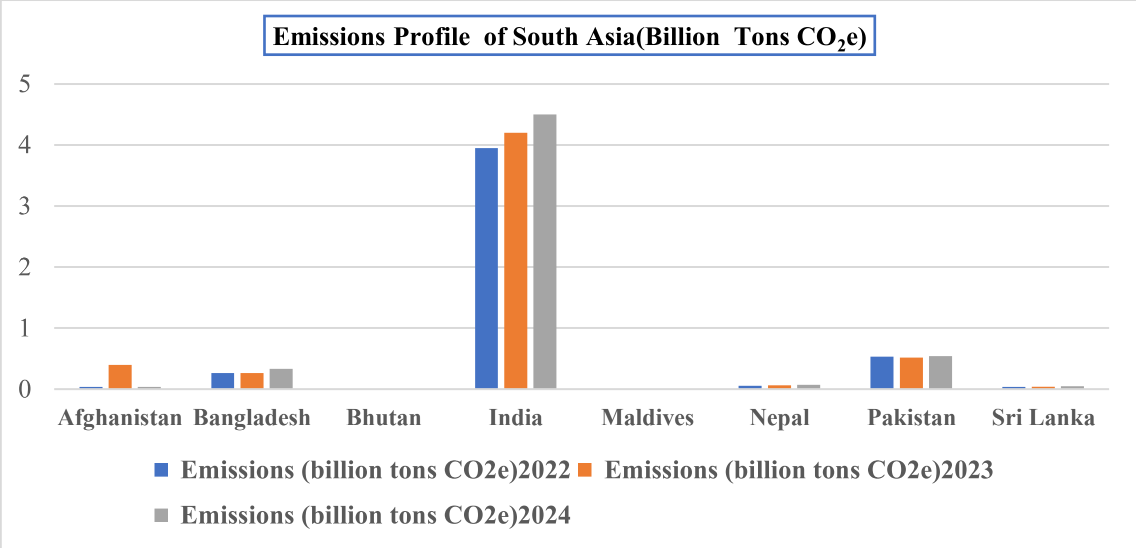

Figure 4: *South Asia Emissions Comparison (2022-2023)*

2.5 Pakistan Industry Emission Analysis

The World Emissions Clock shows that industrial activities in Pakistan generate 120.4 million tons CO_2e of 0.5 tonns of CO_2 emissions per person because of rising carbon emissions that accompany population growth greenhouse gas emissions which positions the sector as a major emission source for the country. The industrial sector produces the most emissions through other industries which release 51.5 million tons CO_2e followed by waste-related industrial emissions that produce 47.9 million tons CO_2e. The cement production process generates 12 million tons CO_2e because it requires significant amounts of energy and complex manufacturing steps.

The chemical industry produces 8.7 million tons emissions from its operations. The metal industry generates 2,055 ktCO_2e of emissions which represents a significant portion of the total industrial emissions. The industrial emissions of Pakistan stem mainly from manufacturing and waste sectors while cement and chemical production require immediate decarbonization efforts.

The energy systems sector in Pakistan generates most of its GHG emissions through fossil fuel usage because the country lacks sufficient clean energy infrastructure. This sector generates 78.8 MtCO_2e of total emissions which amounts to 0.3 tons of emissions per person. The sector depends on fossil fuels because they produce 7.2 MtCO_2e of emissions which indicates Pakistan continues to use oil and gas and coal for power generation and industrial activities. The national power generation process emits 3.3 MtCO_2e of greenhouse gases because thermal power plants remain the leading source of electricity generation. The heating sector generates 338.7 ktCO_2e of emissions because it accounts for a major part of industrial and residential thermal energy usage. The energy system emissions in Pakistan stem mainly from fossil fuel burning and electricity production which requires immediate action to develop renewable energy sources, enhance power generation efficiency and reduce carbon emissions (Pakistan, Pakistan's Biennial Transparency Report (BTR) 2024, 2024).

The buildings sector in Pakistan generates increasing amounts of GHG because the expanding urban areas require more energy for heating, cooling and cooking. The World Emissions Clock predicts that the sector will produce 35.3 million metric tons of CO_2e during 2025 which amounts to 0.2 tons of emissions per person.

The heating sector relies most heavily on coal because many buildings continue to use carbon-intensive fuels for their operations. The increasing usage of air conditioning and refrigeration systems during rising temperatures leads to 5.5 million tonns CO_2e emissions from cooling activities. The use of natural gas for heating and cooking produces 3.1 million tons CO_2e while oil-based heating and cooking generates 727.7 ktCO_2e.

The AFOLU sector which includes agriculture, forestry and other land use activities became Pakistan's leading source of greenhouse gas emissions in 2021 because it produced the most significant number of emissions that year. The AFOLU sector produced 243.76 million tons CO_2e which made up 46.75% of national emissions while surpassing the 40.9% contribution from the energy sector.

The AFOLU framework shows that livestock activities generated the most emissions which reached 130.14 million tonns (53.4%) through enteric fermentation and manure management processes that produced methane. The 66.80 MtCO_2 (27.4%) emissions from managed soils originated mainly from synthetic fertilizer use, organic matter breakdown and nitrogen leaching into water systems. The total emissions from land use changes including forest and cropland dynamics reached 34.82 MtCO_2e (14.3%) and rice cultivation produced 12.00 MtCO_2e (4.9%) through anaerobic decomposition in flooded rice paddies. The emissions were calculated using the IPCC 2006 Guidelines with Tier-1 methodology based on national data from agricultural statistics and forestry assessments and livestock records.

The transport sector generates significant GHG emissions in Pakistan because of its economic value and increasing energy requirements. The transport sector produced 51.01 million tonnes of GHG emissions in 2021 which accounted for 23.92% of all energy sector emissions in

Pakistan. The majority of transport sector emissions stem from fossil fuel combustion in road vehicles and additional emissions occur from aviation, railways and water-borne navigation. The main emissions consist of 49.50 million tonnes carbon dioxide and smaller amounts of methane at 0.66 million tonnes and nitrous oxide at 0.85 million tonnes.

The transport sector of Pakistan generates most of its emissions through road transport while rail, aviation and water-borne navigation produce smaller amounts. The report shows that fast urban development and economic expansion drive up transport energy usage although the adoption of environmentally friendly technologies advances at a slow pace. The government has launched multiple emission reduction plans which include better fuel standards and electric vehicle promotion and electric bus implementation in cities and EV charging station development to minimize future emissions. The sector faces significant barriers to large-scale decarbonization because of expensive initial costs and restricted charging facilities and power grid limitations (Pakistan, Pakistan’s Biennial Transparency Report (BTR) 2024, 2024).

2.6 Pakistan Climate Performance Gap

Due to Pakistan escalating emissions, high energy consumption, and low renewable energy projects we have been ranked as 31st country in climate change performance index 2025. While India has been ranked as 10th and EU has been ranked 16th despite, India is in the list of top polluters. Reason behind this India is strongly investing in renewable energy projects such as large solar power projects and initiative of rooftop solar program is a carbon mitigation plan. On the other hand, EU has finalized its climate policy framework in which they mentioned they will cut off their emissions by 55% till 2030 even though CCPI experts believed that results will be more than commitment. EU will be operating on Net Zero by 2050 because EU ETS has cut off free allowance mechanism and strongly focused on carbon adjustment mechanism (Climate Change Performance Index, n.d.).

2.7 Cement Production and Emissions

The cement manufacturing process produces high carbon emissions and Pakistan production methods make these challenges even more severe. The clinker-to-cement ratio in Pakistan stands at 0.95 which exceeds the worldwide average of 0.72. The high clinker-to-cement ratio of 0.95 in Pakistan industry leads to elevated emissions because limestone calcination produces the most carbon-intensive intermediate product. The emission intensity of Pakistan cement sector is estimated at 0.79 t-CO_2 per ton of clinker, compared to the global benchmark of 0.6 t-CO_2/t-clinker (Qureshi, Zia, & Bashir, Pakistan's Cement Sector: A Road to Decarbonization – Scoping Study, 2023).

The sector produces additional carbon emissions because of its energy consumption and emits 8.9 million tons annually (Zia, Qureshi, Aslam, & Zulfiqar, 2024). The fuel composition of Pakistan consists of 85% coal , 12% natural gas while biomass and waste fuels account for less than 0.1% The cement industry depends on coal for 85% of its fuel supply which results in combustion emissions that combine with process emissions to make it the largest industrial energy consumer in Pakistan at 33% and the second-largest energy user at 12.1% of total national energy consumption (Qureshi, Zia, & Bashir, Qureshi, S.; Zia, U. ur R.; Bashir, N., 2023).

The future projections demonstrate that cement manufacturing directly affects the number of emissions released into the atmosphere. The Business-as-Usual projection shows that CO_2 emissions will increase from 25.6 Mt in 2022 to reach more than 34 Mt by 2030 and exceed 70 Mt by 2050. The NDC pathway of Pakistan sets emission targets at 29.5 Mt for 2030 and 38 Mt for 2050 which represents a maximum 44% decrease from the Business-as-Usual scenario. The achievement of a Net Zero pathway by 2050 demands fundamental changes including lower clinker ratios, renewable energy sources, Carbon Capture and Storage technology deployment.

The evidence shows that Pakistan cement industry operates as a key economic force while producing excessive carbon emissions that exceed national levels. The industry operates as an oligopoly because of its coal-based energy system and high clinker ratio which results in emission levels that exceed worldwide standards.

The sector requires immediate implementation of decarbonization strategies because its growing production will otherwise lead to increased emissions, which makes it essential for policy instruments like an Emission Trading System to address this issue (Qureshi, Zia, & Bashir, Pakistan's Cement Sector: A Road to Decarbonization – Scoping Study, 2023).

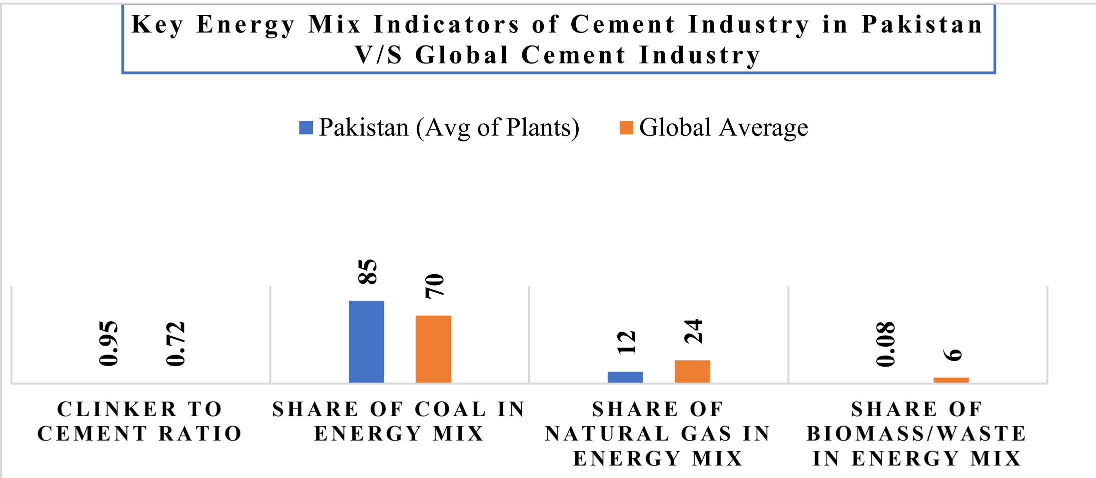

Figure 05: *Pakistan Cement Industry Energy Mix Comparison with Global Industry*

2.8 Pakistan Carbon Market Policy

The government of Pakistan has established the Policy Guidelines for Trading in Carbon Markets to help the nation shift toward a low-carbon economic system. The guidelines follow Article 6 of the Paris Agreement to create both voluntary and compliance-based carbon markets through legal and institutional structures in Pakistan. The policy works to boost private sector involvement while supporting sustainable growth and drawing international climate funding through carbon credit market activities. The policy targets three main goals which involve economic growth, environmental protection and fair distribution of benefits to local communities. The framework establishes clear MRV systems and sets up a National Carbon Registry and Carbon Market Working Group to monitor project authorization and implementation. The policy establishes the corresponding adjustment fee as a financial tool to distribute revenue between federal and provincial governments (Ministry of Climate Change & Environmental Coordination, 2024).

The policy analysts identify three main barriers to successful implementation which include institutional problems and regulatory conflicts and insufficient private sector motivation that could reduce market expansion and investor trust. The policy brief suggests that Pakistan should improve its enforcement systems and simplify approval procedures and adopt EU Emissions Trading System standards to boost its participation in worldwide carbon markets (Salman A. &., 2025).

2.9 Significance of ETS Markets

The global fight against GHG emissions finds its most effective economic solution through carbon markets. The financial systems of carbon markets establish emission value through certified carbon credits which enable countries and organizations to exchange emission rights. The carbon market sector consists of two main categories such as compliance carbon markets operating under national and international laws such as the Kyoto Protocol and EU ETS while voluntary carbon markets operate through corporate sustainability initiatives and net-zero target purchases.

The compliance market operates under government-established mandatory emission limits, but the voluntary market operates based on corporate sustainability goals and net-zero emission targets. These markets create carbon price signals that direct emission reductions toward the most affordable solutions while stimulating investments in renewable energy and low-carbon technology development (Tri, Suphi, & Ufuk, 2024).

Due to the change in global regulations, strict carbon cap policies, and consumer demand carbon markets have shown tremendous growth. As per MRFR analysis, the Compliance Carbon Credit Market Size was estimated at $11.42 Billion in 2023. The Compliance Carbon Credit Market Industry is expected to grow from $12.19 Billion in 2024 to $ 25.0 Billion by 2035. The Compliance Carbon Credit Market growth rate is expected to be around 6.74% during the forecast period (2025 - 2035) (Jaiswal, 2025).

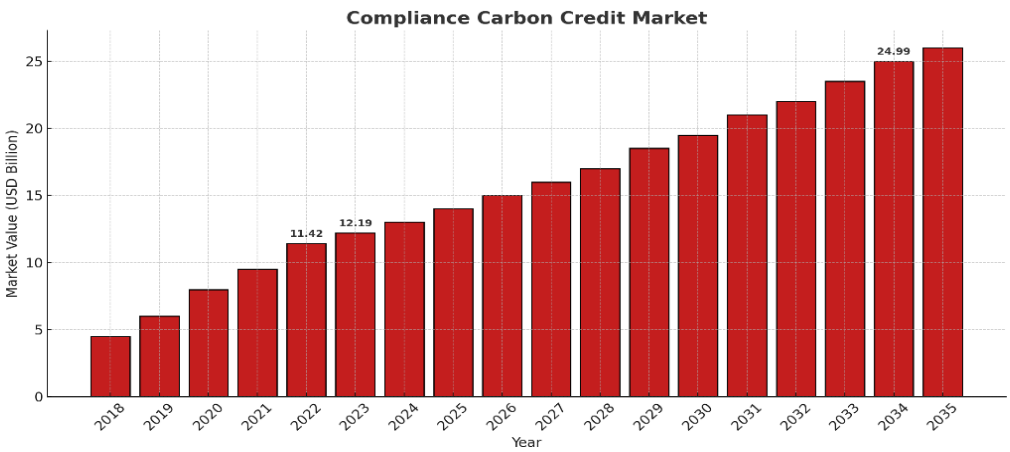

Figure 06: *Trend of Carbon Compliance Markets (2018-2035)*

The voluntary carbon market system contains multiple major disadvantages. The actual reduction of emissions through carbon offset programs exceeds reported figures but tracking carbon reduction or removal in forestry and land-use projects remains difficult. The process of proving additionality remains difficult because emissions might relocate to different areas (leakage). The market system motivates developers and certification bodies and rating agencies to make false claims because buyers lack the skills and interest to check credit quality. The market experiences pricing problems and inconsistent quality because different credit types and project standards and co-benefits create wide variations. The lack of standardized net-zero disclosure rules allows companies to present deceptive information about their carbon reduction efforts while they choose inexpensive offsets instead of implementing actual emission cuts. The low carbon prices in voluntary markets compared to compliance markets create conditions for excessive offsetting which hinders actual decarbonization progress (Smaran & Kumar, 2024).

The Paris Agreement from 2015 through Article 6 provided Pakistan with a fresh chance to participate in worldwide carbon market activities. The researchers predict Pakistan will produce 40–75 million tons of tradable carbon credits annually which would result in between $400 million and $2.25 billion in yearly revenue (Butt, Mahmood, & Ali, 2025).

2.10 Strategic Assessment

2.10.1 Environmental Policy Landscape (External)

Pakistan commits to reduce overall emissions by 50% till 2030. To meet the commitment Pakistan, must shift to 60% renewable energy, 30% electric vehicle and totally ban on imported coal till 2030.Pakistan still need 35% climate finance from international resources to decarbonize its economy (Goverment of Pakistan, 2025). In addition, Pakistan has introduced carbon levy on fuel Rs.2.50 for cleaner fuel consumption across the country (Akhter, 2025). In contrast Pakistan has introduced carbon market trading policy which encourage private sector to engage in voluntary markets (Ministry of Climate Change & Environmental Coordination, 2024).

A simple Carbon Levy serves as a financial instrument for revenue generation, yet its association with achieving rigorous Net-Zero goals is diluted by a limited strategic impact on companies with high financial reserves. While Pakistan existing Credit Trading Policy by the Ministry of Climate Change and Environmental Coordination strategically encourages private sector engagement in offset projects and Corporate Social Responsibility, the introduction of a sovereign Emissions Trading System is proposed as the superior mitigation and revenue model. The ETS guarantees a verifiable reduction in overall environmental impact, drives deep decarbonization across industries, and strengthens the domestic economy in compliance with SDG 13.

2.10.2 Stakeholder Analysis (Internal)

Despite the highest production, in world of blue economy and green supply, competitive advantage between the leaders is monitored through kiln efficiency, Clinker factor, Fuel mix (coal vs. AFR), Waste-heat recovery, on-site solar and Logistics**.** The production of cement requires significant amounts of energy because it takes 1MT of clinker to use 4.6mln BTUs of energy which equals burning 160Kg of bituminous coal (Dusseldorf, 2017)**.**

The data presented in the table demonstrates that fuel costs represent the largest portion of expenses in Pakistan cement industry. The unit cost of cement production consists of 57% fuel expenses followed by 15% power costs and 7% packaging expenses and 6% raw materials expenses and 15% other expenses. Several companies including Lucky Cement demonstrate fuel costs that reach between 60% to 67% of their total expenses while their fuel costs amount to 53% of their total expenses. The production costs and profit margins of cement manufacturers will directly experience the impact of coal price fluctuations and future carbon pricing. The combination of waste-heat recovery systems and onsite solar power and alternative fuel usage with clinker factor reduction creates structural advantages for plants which reduce costs and emissions while enhancing market competitiveness (Tauseef, Wajih, & Mirza, 2024).

Sr.	Company	Raw Material (%)	Packaging (%)	Fuel (%)	Power (%)	Others (%)
1	**Attock Cement Pakistan Ltd.**	6	6	54	12	22
2	**Bestway Cement Ltd.**	7	8	53	19	12
3	**Cherat Cement Company Ltd.**	7	8	53	14	17
4	**DG Khan Cement Company Ltd.**	2	7	54	15	23
5	**Dewan Cement Ltd.**	8	9	55	15	14
6	**Fauji Cement Company Ltd.**	9	6	56	16	13

7	**Flying Cement Company Ltd.**	4	11	40	36	9
8	**FECTO Cement Ltd.**	4	5	62	19	9
9	**Gharibwal Cement Ltd.**	5	5	67	10	13
10	**Kohat Cement Company Ltd.**	6	8	57	21	8
11	**Pioneer Cement Ltd.**	6	8	59	16	11
12	**Maple Leaf Cement Factory Ltd.**	6	7	53	14	19
13	**Power Cement Ltd.**	11	6	59	16	8
14	**Thatta Cement Company Ltd.**	8	6	61	17	7
15	**Lucky Cement Ltd.**	6	7	53	14	19
Sector Average		**6**	**7**	**57**	**15**	**15**

Table 03: *Cement Industry Product Manufacturing Components Comparison*

Further analysis shows that cement industry leaders maintain a relatively low grid dependency level of 36.5%. The reported number underrepresents the actual situation. The system shows strong bias because Maple Leaf Cement operates as the dominant player while its grid dependency reaches only 4%. The country maintains low dependency levels because it uses fossil fuels as its primary energy source instead of renewable power. Maple Leaf operates its business through coal power which generates 54% of its total operations. The sector depends heavily on coal as its main power source. The cement industry consumes 16% of all coal used in the country during 2023-2024 which makes it the third biggest coal user in the nation.

Leaders Comparison of Renewable Energy Projects						
Company	**Solar Capacity (MW)**	**Wind Power Project (MW)**	**WHR Systems (MW)**	**Total of Renewable Energy Portfolio (MW)**	**Dependency on Grid (%)**	**Source**

Lucky Cement	74	28.8	56	158.8	45	(Siddiqi, CN Cement, 2025)
Bestway Cement	112.23	-	67	179.23	45	(Bestway Cement Limited, 2024) (Bestway Cement Limited, 2024)
Fauji Cement	67	-	64	131	52	(Fauji Cement Company Limited, n.d.)
Maple Leaf	20	-	37	57	4	(OneStone Consulting, 2024) (BMA Capital Researchers, 2025)
Leaders Average	**68.31**	**7.20**	**56**	**131.51**	**36.5**	

Table 04: *Cement Industry Leaders Renewable Projects Comparison*

Moreover, the cement industry shows rising dependence on natural fossil fuels because consumption patterns indicate annual growth. The data shows coal usage patterns that change over time but the predicted reduction for 2023-2024 might not lead to a permanent decrease because it follows production patterns (Pakistan Ministery of Finance, 2024). A compliance-based carbon pricing system which includes an Emissions Trading System needs to be established to achieve sustainable production throughout the long term. Although an ETS may initially pressure profit margins, it will incentivize crucial investment in renewable energy projects. In the long run, this transition will strengthen companies balance sheets through the acquisition of proprietary power generation assets, leading to increased profitability and greater energy security. Improved CSR reporting and a reduced carbon footprint are essential for accessing climate-conscious markets, particularly in regions like Europe.

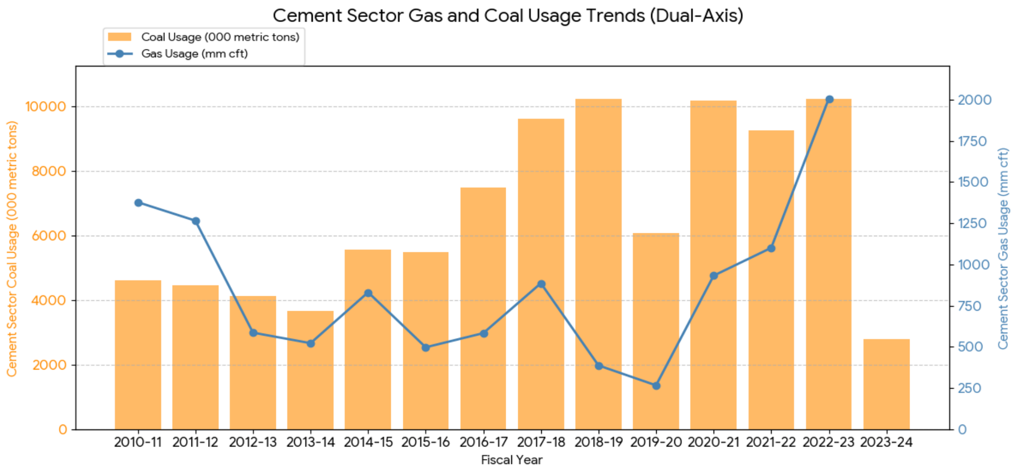

Figure 07: *Pakistan Cement Sector Gas and Coal Usage Trends (2010-2024)*

2.11 PESTEL Analysis

2.11.1 Political Assessment

ETS markets have high political acceptability as compared to carbon tax (Pegels, 2016). Because these systems are directly managed and controlled by respective ministries (United Nations). Pakistan governments have launched national electric vehicle policy, national climate change policy, national forest policy, national clean air policy and policy for trading in carbon markets which highlight that Pakistan government will appreciate this initiative.

2.11.2 Economic Assessment

ETS systems are established with green objectives. When companies work on compliance markets they face financial pressure, especially SME (Andersson, 2025). But still European ETS has successfully cut emissions in starting years without affecting economy (Nachtigall, 2023). Even if it temporarily reduces revenue, profits, or affects employee turnover, we should still implement it so that every future investment decision is aligned with sustainability and environmental responsibility.

2.11.3 Social Assessment

European union has established social climate fund alongside ETS to mitigate the social impact of ETS. These are utilized to most vulnerable sectors who don’t have money so they can equally get a chance to decarbonize themselves (European Commission, n.d.). Additionally, the International Energy Agency and other analysts have predicted that this wave of market-driven innovation will create two to six "green jobs" for each fossil fuel job lost (Alfaro-Pelico, Bloch, Pesta, & Tyson, 2023). So ETS is a way to create green jobs and help the most vulnerable sectors such as power through SCF to achieve their climate goals that highlights social acceptability of system.

2.11.4 Technological Assessment

The adoption of modern technologies like Carbon Capture, Utilization, and Storage presents a compelling case for managing CO2 emissions. The process of stopping these emissions requires two essential actions which include CO2 collection from its origin at cement plants followed by its transfer to facilities where it will either stay permanently or get converted into useful products. The International Energy Agency states that the implementation of new technologies which include carbon capture systems will help achieve major CO2 reduction targets by 2050 according to their 2DS scenario which predicts a 48% decrease from the RTS baseline.

2.11.5 Legal Assessment

As a part of UNO Pakistan has adopted Trading regulations at COP-29 in Baku (Tauqeer Sheikh, 2024). To achieve our net-zero goals and close Pakistan climate-finance gap for mitigation, the legal system will support this ETS and enact the necessary policy and regulatory amendments to enable investment and effective implementation.

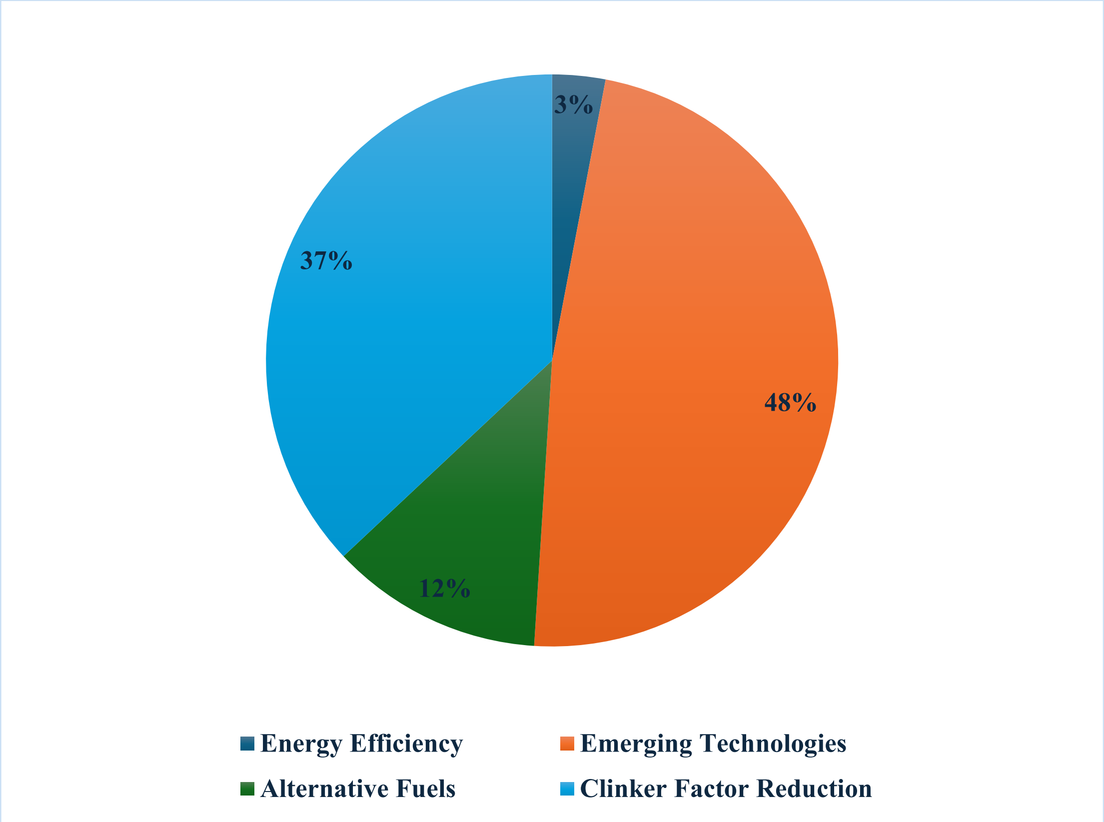

Figure 08: *Cement Sector Decarbonization Potential*

CHAPTER 03: DESIGN AND IMPLEMENTATION

3.1 Project Design

3.1.1 Scope

This research project proposes an effective ETS System for Pakistan industry, specifically to mitigate the impact of climate change using two corporations from cement industry such as Fauji Cement Ltd. and Lucky Cement Ltd. as case studies. The researchers attempted to contact other cement corporations to obtain emissions data and increase the sample size for more robust results; however, reliable data that could be publicly disclosed was not available.

The study investigates how an ETS can be adopted in Pakistan to address the country escalating emissions trajectory, support the achievement of 2030 climate targets, generate revenue to mitigate climate impacts, and encourage organizations to take active steps toward improving their social and environmental governance. The research focuses particularly on the design and testing of compliance carbon markets in Pakistan, contributing to the development of a national carbon market policy aimed at transitioning the country toward a low-carbon economy.

The study period covers the fiscal year 2023–2024, beginning on July 1, 2023, and ending on June 30, 2024, a period during which both Pakistan and the global community experienced severe climate-related events, including extreme weather conditions and rising temperatures, underscoring the urgent need for climate action. The study includes top 16 cement companies listed on PSX that are widely used for analysis. Fauji Cement Ltd. and Lucky Cement Ltd. are the two firms selected for ETS testing to assess the impact of the system on corporate financial performance through comparative analysis.

3.1.2 Methodology

This study adopts a quantitative research approach based on secondary data**.** All analyses are conducted using numerical data and statistical calculations derived from publicly available sources. The research relies on existing emissions, financial, and policy data.

To identify a suitable Emissions Trading System framework for Pakistan, the study reviews and compares established ETS models, including those implemented in the European Union, China, and Germany. These systems are examined to understand their structural design, allocation mechanisms, and economic implications. Based on this comparative secondary analysis, the study proposes an ETS model that is most appropriate for Pakistan industrial and regulatory context.

The study employs a mono-method approach, utilizing only secondary and numerical data. No questionnaires or interviews are required, as the selection of companies is based solely on the availability of emissions data. Data organization and calculations are performed using Microsoft Excel.

The population includes 16 cement companies previously used by researchers to forecast emissions for the cement sector. Two companies are purposefully selected based on the public availability of their emissions data, which will be used to test the proposed ETS model.

3.2 Data Collection and Techniques

The entire study relies on secondary data sources, selected based on their authenticity, reliability, and relevance to the study objectives. The project is credible and replicable to other cement firms and industry since the model has been tested on 02 companies because of data availability. The authenticated data has been used to ensure replicability and credibility of research.

The time frame of 2023–2024 marks a period during which climate vulnerability significantly impacted Pakistan, prompting firms to begin taking actions toward sustainability. Both selected companies also made strategic decisions to reduce emissions; however, the resulting benefits from these efforts remained untested. This provided the researcher with an opportunity to initiate the design of an ETS system aligned with Pakistan Carbon Market Policy 2024.

3.3 Companies Annual and Sustainability Report

The main basis for data sets is the annual reports of all companies and sustainability disclosure of report of Fauji and Lucky cement. The sustainability report of FCCL provide CO2e emissions and annual reports of companies utilized to get following data:

- **Clinker Production**
- **Cement Production**
- **Capacity Utilization**

- **Financial Statement**
- **Financial Ratios**

This data is publicly available on the official websites of the companies and provides standardized, audited information essential for testing the ETS system and evaluating its impact on firm performance.

3.3.1 Other Sources

- Documents from the China Ministry of Ecology and Environment (translated in English to extract information)
- European Commission Website
- International Carbon Action Reports
- Ditch Carbon website was utilized to get access to lucky cement annual sustainability reports

3.3.2 Data Analysis and Approach

The research begins with a comparative analysis of three established ETS models such as the EU ETS System, selected for its maturity; the China ETS, chosen for its strategic significance and effectiveness within the Asian context; and the German ETS. Based on this strategic assessment, the most suitable ETS model for Pakistan will be proposed in alignment with national needs and regulatory requirements.

To test the proposed system allowance allocation procedures and all other analyses will utilize secondary data. Additional calculations including surplus allowances, government revenue projections, and firm-level compliance costs under the ETS will also be conducted based on allocated allowances. To assess the impact of ETS implementation on firm-level financial performance, the analysis begins with the recalculation of the income statement for the selected fiscal year (2023-2024), incorporating the adjusted compliance costs. Subsequently, financial ratios will be recalculated to reflect the financial implications of the ETS costs. A statistical interpretation will be carried out to evaluate how these adjustments affect the company's overall performance.

Ratio analysis will commence with the recalculation of the net profit margin ratio to quantify how the inclusion of new compliance expenses reduces net profit per unit of sales. Furthermore, Earnings Per Share will be calculated to determine the effect on shareholder returns and return on equity will be assessed to evaluate the impact on owner returns. ROI is calculated to evaluate how efficiently the firm generates returns from its total investments after incorporating ETS compliance costs. It helps assess whether profitability remains sustainable under the new carbon cost structure

The ETS system tends to have a positive impact on firms with strong sustainability practices; Tesla serves as a notable example, deriving significant revenue from the sale of unused allocated allowances. Conversely, firms with low sustainability integration often experience negative impacts on performance under ETS implementation.

3.4 Existing ETS Model

3.4.1 European Union ETS System

Allowance Distribution Method and Cap Setting Approaches

The initial program period from 2005 to 2007 gave all power plants and industrial facilities free emission allowances due to the unavailability of reliable emissions date. While the system used a €40 penalty for each ton of CO_2 emitted to build the MRV system and create the world's first carbon pricing system. The second phase of the program (2008–2012) implemented Kyoto Protocol compliance through enforceable emission reduction targets which allocated 10% of available allowances for auctions and gave 90% of allowances away for free while increasing the non-compliance penalty rate by 150%.

The 2008 financial crisis resulted in emission reductions that exceeded what experts had predicted. The polluter-pays principle adopted auctioning as its default allocation method which began in Phase 3 and persisted until free allowance distribution started to stop carbon leakage. The EU ETS began its testing phase to manage GHG emissions which now extends to electricity, heat generation, industrial activities and both aviation since 2012 and maritime transport since 2024. The emissions control system operates through a cap mechanism which establishes a highest allowed emission level by distributing emission allowances that represent one tonne of CO_2-equivalent) pollution.

Cap on Industrial Manufacturing, Maritime Transport, Heat generation and Electricity and Aviation

The EU ETS has maintained a unified EU-wide cap for power and industrial emissions since 2013, which decreases each year through the Linear Reduction Factor. The LRF maintained a 1.74% rate until 2020 before it rose to 2.2% in 2021 and then reached 4.3% for the period from 2024 to 2027 and 4.4% starting from 2028 after the 2023 ETS revision which established a 62% emissions reduction target for 2030 based on 2005 levels. The program included two separate one-time cap reductions which involved 90 million allowances for 2024 and 27 million allowances for 2026. The cap received and 78.4 million allowance expansion during 2024 to add maritime transportation to its scope. The Commission Decision from 27 July 2023 established the 2024 cap at 1,386,051,745 allowances. The auction process determines the allocation of most allowances while specific sectors receive free allowances to protect against carbon leakage, and the program maintains separate funds for innovation and social climate initiatives and new market entry support.

Price Control Mechanism

The Market Stability Reserve functions as the EU ETS main market stabilization system which was created to handle the persistent surplus of allowances that developed following 2009 because of worldwide economic downturn and excessive international offset usage which caused carbon prices to drop and reduced climate change reduction efforts. The MSR system operates by changing the amount of available auction supply according to the Total Number of Allowances in Circulation value. The system removes up to 24% of auction supply when TNAC reaches 833 million, but it adds 100 million allowances to auctions when TNAC drops below 400 million. The invalidation rule which started in 2023 makes all reserve allowances beyond 400 million invalids from 2024 onward to establish enduring market stability through a dependable emissions reduction indicator.

MRV Framework

The EU ETS Monitoring, Reporting and Verification system operates through an annual compliance cycle which enables precise and uniform and open GHG emission tracking for all sectors under its coverage. The Monitoring and Reporting Regulation requires industrial installations, aircraft operators and maritime operators who started monitoring in 2024 to follow an approved monitoring plan for emission tracking. The MRR requires operators to submit their annual emissions reports for verification by March 31st followed by allowance surrender on September 30th. The Accreditation and Verification Regulation enable accredited verifiers to perform verification activities through Commission guidance and standardized templates and the ERT Tool. The MRV principles which aviation and maritime sectors share include sector-specific tools like the Eurocontrol Small Emitter Tool and shipping-specific reporting requirements (EU Commission, n.d.)·

Use of offsets

The EU ETS system initially permitted international offset usage for compliance, but it introduced increasing environmental protection measures which resulted in a total ban of international offsets starting from 1 January 2021. The first phase of the program from 2005 to 2007 allowed CDM and JI credit issuance without any specific numerical restrictions except for big hydropower and LULUCF projects but no offsets were applied because of low allowance prices. The Phase 2 period from 2008 to 2012 excluded JI credits which originated from non-Kyoto countries while maintaining the ban on LULUCF, nuclear projects and implementing more stringent hydropower project evaluation standards and establishing offset usage limits through National Allocation Plans. The third phase of the program which operated from 2013 to 2020 implemented strict evaluation criteria which restricted post-2012 emission reduction credits to developing nations and prohibited industrial gas credit applications and established a 50% ETS reduction limit for Phase 2 and 3 combined at 1.6 Gt CO_2e. The EU ETS eliminated international offset usage for compliance during Phase 4 which spanned from 2021 to 2030 (Tan).

Integration Linkages

Since 2020, the EU ETS has functioned as a unified system alongside the Swiss ETS, enabling the mutual use of allowances for compliance purposes. This integration necessitated the alignment of several key design elements, such as cap setting, monitoring, reporting, and verification standards, registries, and compliance regulations. The linkage has led to improved market liquidity, greater price stability, increased flexibility for regulated entities, and has served as a practical example of how cross-border ETS integration can work effectively (General: The EU-Swiss Linking Agreement, n.d.).

3.4.2 China ETS

Allowance Distribution Method

The ETS system in China underwent three distinct developmental phases. The first phase (2013–2016) implemented seven regional pilot schemes which monitored power and major industrial sectors through free allowance distribution based on their historical emissions and benchmarks to develop MRV systems and registry and compliance infrastructure instead of reducing emissions directly. The national ETS began its operation during Phase 2 (2021–2022) when it became the biggest carbon emissions system worldwide which started with power sector coverage through free allowance distribution based on output-based intensity benchmarks.

The Chinese government chose to base its carbon reduction strategy on intensity targets instead of establishing absolute emission limits. The system became more robust during Phase 3 starting in 2023 because it established stricter performance standards and restricted banking activities yet preserved both free allocation and auction-free mechanisms to enhance operational performance but restrict total emission decreases when production expands. The system enforces compliance through three types of penalties which include financial penalties and future allowance reductions and administrative and reputational sanctions. The system focuses on building capacity while it implements progressive rule development (Ewing).

Cap-Setting Approach in China Emissions Trading Scheme

China defines sector coverage in the Phase-I through a grandfathering approach which gives each entity the same number of verified emissions as they decide for year 2026 and applies this to the cement and steel sectors. The grandfathering system exists to make sure all covered entities must follow MRV requirements and learn about the procedures for obtaining allowances and returning them. Formula is given as fellow:

$$\boldsymbol{Total\ Verified\ Emissions} = Total\ Allowance\ Allocated \leftarrow\ (\boldsymbol{Form. 1.0})$$

The ETS system of China for the cement sector uses a performance-based allocation method which depends on intensity to enhance operational efficiency while avoiding strict absolute emission restrictions during Phase 02. The system includes performance benchmarking as a fundamental element which the Ministry of Ecology and Environment uses to establish sectoral balance values that show the emissions-intensity level which makes total allocated allowances equal to verified emissions. The system compares each entity's emissions intensity to the benchmark value which determines the number of allowances they should receive through percentage-based adjustments that benefit efficient performers but penalize less efficient ones.

Formulas for Allowance Allocation in Phase II:

$$\boldsymbol{Benchmark} = \frac{\sum(Verified\ Emissionsi)}{\sum(Clinker\ Outputi)} \leftarrow (\boldsymbol{Form.1.1})$$

$$\textbf{Emissions Intensity} = \frac{Verified\ CO2e}{\text{Clinker Production}} \leftarrow (\boldsymbol{Form.1.2})$$

$$\boldsymbol{Deviation} = \frac{I_{Installation} - I_{Benchmark}}{I_{Benchmark}} \leftarrow (\boldsymbol{Form.1.3})$$

1.Allowance Allocation for Installations Within ±20% of the Benchmark

$$\boldsymbol{Allowances} = Verified\ Emissions * (1 - (Deviation \times 0.15) \leftarrow (\boldsymbol{Form.1.4})$$

2.Allowance Allocation for Installations Exceeding ±20% Deviation

$$\boldsymbol{Allowances} = \boldsymbol{verified}\ emissions * \pm 3\% \leftarrow (\textbf{Form. 1.5})$$

MRV Framework of China Emissions Trading Scheme

The Chinese emissions trading scheme requires plant-level fuel-based emissions monitoring to calculate carbon dioxide emissions through standardized methods which power generation units must follow. The steel sector requires company-level calculations for its allowance process, but cement and aluminum smelting facilities need to establish their allocations at the facility level before they can combine them. Independent third parties verify reports for accuracy through their verification process while regulatory bodies oversee the system to improve their monitoring of compliance. The framework links MRV accuracy directly to market performance and emission allowance distribution which helps reduce reporting mistakes and stops emission underestimation to create market stability. The development of MRV rules continues as an essential process to improve emission data accuracy which will maintain the long-term success of China ETS throughout its expanding operational scope (Iea, 2024).

Use of Offsets under China Emissions Trading Scheme

The ETS system of China enables covered entities to use offset credits through the China Certified Emission Reduction scheme which lets them fulfill their compliance requirements by using both government-issued emission allowances and CCER credits. ETS generates CCERs through its approved voluntary projects which include renewable energy and forestry initiatives, but these credits have limited quantitative availability to protect the ETS as the main compliance system. The 2024 CCER scheme relaunch established better connections between China voluntary and mandatory carbon markets which enabled businesses to meet their carbon targets at affordable costs while preserving environmental standards.

International Linkages of China Emissions Trading Scheme

The Chinese government created its emissions trading scheme which operates as a national carbon pricing system that plans to link with international markets in the future (Heggelund, Iselin Stensdal , & Duan, 2022).

3.5.3 Germany National Emissions Trading System

The German government established its national Emissions Trading System in 2021 to establish emission pricing for heating and transport fuel emissions which operated outside the EU ETS framework. The system used fixed allowance prices during its first five years (2021–2025) to create market stability during its initial operation while fuel suppliers needed to surrender one allowance for every ton of CO_2 they emitted. The system will switch to auction-based pricing with price limits in 2026 to achieve better market-based pricing stability before it merges with EU ETS 2 in 2027.

The scheme uses a flexible cap system during its fixed-price and corridor phases before it transitions to a mandatory cap which matches Germany Effort Sharing Regulation targets under ETS 2. The Non-compliance penalties consist of twice the fixed price during the early phase and €100 per tCO_2 from 2026 and penalties for incorrect reporting. The system provides coverage to fuel suppliers who serve transport operations and buildings that require heating and small industrial combustion facilities and waste incineration plants starting from 2024 and major fossil fuel operations except for emissions that fall under the EU ETS and the system operates independently from international frameworks before it merges into the EU-wide ETS 2 framework (International Carbon Action Partnership).

<u>Net Profit Margin:</u>

The profit margin ratio indicates the percentage net profit that a business makes from the total sales revenues.

$$\boldsymbol{Net\ Profit\ Margin} = \frac{Net\ Income}{Total\ Revenue} \quad \textbf{↤(Form.1.6)}$$

It is used to gauge how ETS compliance costs would have altered the profitability of FCCL and luck per unit of sales.

<u>Earnings per Share:</u>

E.P.S measures how much profit the bank generates for each outstanding share.

$$\boldsymbol{EPS} = \frac{Net\ Income}{Number\ of\ Shares\ Outstanding} \quad \textbf{↤(Form.1.7)}$$

Higher EPS(Recalculated) will indicate that the company maintained strong profitability and shareholder returns despite the added ETS compliance costs, reflecting efficient carbon management.

<u>Return on Investment:</u>

This ratio defines the performance of investments which have been made in company in relation to what output (in form of income) they give. It can be used to give apple to apple comparisons to potential investors who are seeking to invest among multiple companies.

$$\boldsymbol{ROI} = \frac{Net\ Income}{Total\ Asset} \quad \textbf{↤(Form. 1.8)}$$

ROI will indicate how effectively the company continues to generate returns from its total investments after accounting for ETS compliance costs. This will illustrate in carbon market policy either the investor must invest in Fauji or Lucky cement.

<u>Return to Equity:</u>

ROE demonstrates the performance of a firm in terms of its efficiency in utilizing shareholder capital to make earnings.

$$\boldsymbol{ROE} = \frac{\boldsymbol{Profit\ After\ Tax}}{\boldsymbol{Average\ Total\ Equity}} \quad \textbf{↤(Form.1.9)}$$

ROE is calculated to evaluate the impact of ETS compliance costs on the company’s ability to generate returns for its shareholders.

3.7 Ethical Considerations

The study uses only publicly available data. No personal or customer-level data will be accessed. All reports, articles, and ministry documents used in this chapter are cited properly following APA 6th style. No figure was changed to force any specific result.

CHAPTER 04: TESTING AND DEPLOYMENT

4.1 Purposed ETS Model for Pakistan

After deep-down research, it was determined that only 02 cement companies in Pakistan Fauji and Lucky Cement publicly report their GHG emissions for 2024. Fauji Cement disclosures are limited to Scope 1 and Scope 2 emissions, whereas Lucky Cement reports emissions across all scopes, providing the most complete dataset within the sector. The data shows that only FFCL has verified its non-GHG emissions through measurements of NO_x and SO_x and particulate matter. The sector does not have any verified emissions inventories which means the national cement industry emissions remain based on unverified assumptions instead of actual authenticated data.

The Chinese ETS framework with revised banking rules along with one component of German ETS known as price mechanism provides an appropriate model for Pakistan because it addresses the current data restrictions which Pakistan faces. China experienced similar challenges when it started its emissions reduction program because the country operated a big industrial sector which produced substantial GHG emissions while dealing with unorganized and inconsistent emission records. The system implements its phases through standardized MRV procedures which show how to create reliable emissions reports in areas with inconsistent baseline data quality.

The German ETS pricing mechanism needs to be implemented in Pakistan because its fixed-price allowance system matches the country current fiscal and administrative framework. The government should view free systems as liabilities because their operations need to stay within strict budget limits which require them to ask for additional funding. The government should establish a restricted set of fixed-price allowances which would function as a cost-recovery system to fund ETS administrative costs while producing stable revenue without affecting market stability. The system requires Pakistan to implement a dual system which combines Chinese methods for allowance distribution with banking rules for procedure control and German-based fixed-price reserve systems to achieve both reliable data and financial stability.

The Pakistani industrial sector now represents 18% of GDP instead of its previous 26% share in 1996 because of which fully auction-based allocation and high penalty systems would create additional obstacles for industrial development. The established framework decreases industrial expenses for emissions monitoring while allowing businesses to track their emissions and enhance their operations through improved methods and contemporary manufacturing techniques. The Chinese ETS model implementation matches Pakistan strategic position with China because CPEC 2.0 (Green CPEC) provides opportunities for technical assistance and future market integration of ETS.

Sr.	Company	$MTCO_2e$ (2024)	% Contribution
1	**Fauji Cement Company Ltd.**	4,092,878	13%
2	**Bestway Cement Ltd.**	N/A	N/A
3	**Lucky Cement Ltd.**	667,685.07	2.09%
4	**DG Khan Cement Company Ltd.**	N/A	N/A
5	**Dewan Cement Ltd.**	N/A	N/A
6	**Attock Cement Pakistan Ltd.**	N/A	N/A
7	**Flying Cement Company Ltd.**	N/A	N/A
8	**FECTO Cement Ltd.**	N/A	N/A
9	**Gharibwal Cement Ltd.**	N/A	N/A
10	**Kohat Cement Company Ltd.**	N/A	N/A
11	**Pioneer Cement Ltd.**	N/A	N/A
12	**Maple Leaf Cement Factory Ltd.**	N/A	N/A
13	**Power Cement Ltd.**	N/A	N/A

14	**Thatta Cement Company Ltd.**	N/A	N/A
15	**Cherat Cement Company Ltd.**	N/A	N/A
	Total Cement Sector Emissions	**31860000**[1]	

Table 05: *Cement Sector Company Wise Emissions*

4.2 Implementation framework of Pakistan ETS

4.2.1 Allowance Allocation Procedure

Phase I: Pilot Allocation Approach (1-2 Years)

The proposed ETS will start with a basic allocation system which uses the Chinese national ETS pilot testing design to track all cement sector operations and their complete GHG emissions using (form.1.0) as mentioned above. The main objective of this phase is to enable regulators to build their institutional strength while fixing technical deficiencies which will help businesses to establish dependable systems for tracking their GHG emissions. The pilot period will use verified emissions to determine allowance distribution which provides administrative ease while minimizing industry compliance requirements.

The system maintains a balanced relationship between verified emissions and allocated allowances through this method. The system will allow the release of additional allowances when entity emissions rise because of elevated production levels before the annual surrender deadline. The system prevents accidental penalty activation during ETS data collection and learning operations.

Phase II: Introduction of Performance Benchmarking (3-5 Years)

Beginning in the second phase, the Ministry of Climate Change and Environmental Coordination will introduce an intensity-based, performance-linked allocation mechanism, like

[1] *Actual GHG emissions data for the cement sector were not available; therefore, this study relies on projections from a NUST research project estimating cement sector emissions for the period 2021–2030.* Decarbonizing-the-Cement-Industry-R11.pdf

the methodology applied in the Chinese ETS. This approach shifts the Pakistan ETS system towards efficiency enhancement while maintaining a manageable level of complexity for participating in installations.

I. Calculation of Sectoral Benchmark (Balance Value)

The cement sector requires a sectoral benchmark which we also call the balance value that can be calculated using (form .1.1) as mentioned above. The system will evaluate each installation emissions intensity (tCO_2e per unit of output) against the benchmark to determine percentage deviations which will control allowance modifications.

II. Emission Intensity and Deviation for all Entities

After calculating the benchmark value, calculation of emissions intensity for each selected entity will be determined using (form .1.2).

After determining the emissions intensity for each company, the next step involves calculating the percentage deviation of each installation from the sectoral benchmark using (form.1.3). This deviation measure is essential for proceeding to the subsequent allocation analysis.

4.3 Rules for Allowance Allocation after the Calculation of Benchmark and Emission Intensity

4.3.1 Allowance Allocation for Installations Within ±20% of the Benchmark

The allocation of allowances for entities with emissions intensity between 20% above and 20% below the benchmark will depend on their distance from the benchmark value. The system makes positive adjustments when performance exceeds the benchmark, but it reduces values when performance falls below the benchmark. For allocation process in this category, we can use (form.1.4).

4.3.2 Allowance Allocation for Installations Exceeding ±20% Deviation

The system imposes a maximum adjustment limit for installations which shows more than ±20% variation in their emissions intensity compared to the benchmark value. The system implements this cap to stop large performance-based rewards or penalties.

Under this cap, the best-performing entities will obtain their verified emissions plus an additional 3% maximum. The worst-performing entities must receive at least 97% of their confirmed emissions. The system enables a managed process to shift from traditional reporting methods to performance-based resource distribution systems. For allocation process in this category, we can use (form.1.5).

4.4 Banking Rule

The Chinese ETS banking framework allows entities to bank 100000 surplus allowances because Chinese cement facilities produce 5% of worldwide GHG emissions. The proposed Pakistan ETS contains allowance allocations which have lower values than the previous system. The Chinese banking cap should not be applied directly because it would create an unfair situation which could result in banks holding more assets than their market value allows. The Pakistan ETS framework includes two essential elements which maintain both proportionate emissions reduction and sufficient market liquidity.

Pakistan ETS Should maintains banking limit of 20,000 allowances which remains constant. The company should receive an additional tax credit which equals 100% of all sales made by the organization during the compliance period. The system requires companies to use their excess allowances for market transactions, which prevents them from building up unlimited stockpiles of allowances. The system functions to enhance market activity, maintain stable prices and liquid market conditions.

4.5 Fixed Price Allowance Mechanism for Phase II

4.5.1 Proposed Fixed-Price Mechanism and Rationale for Cost Recovery

Unlike the Chinese National ETS, which mainly uses intensity-based allocation and market-clearing prices, we suggest adding a fixed-price component of Rs. 2,500 per tonne for Phase II. A look at the financial performance of the cement industry shows that Lucky Cement stands out with the highest PAT among all companies for FY2023–24. Interestingly, while Lucky contributes just 2% of the total emissions in the sector, Fauji Cement, which has a PAT that's 88.65% lower than Lucky's, is responsible for about 13% of total emissions. The impressive financial results of Lucky Cement can't be solely explained by inventory tweaks or selling off older stock; data on clinker production also shows that they consistently produce more than Fauji and other competitors. Instead, Lucky's success seems to stem from their early adoption of decarbonization strategies, energy-efficient practices, and smart clinker ratios. This profitability analysis offers valuable insights for regulators, indicating that all companies can handle the costs of fixed-price allowances without jeopardizing their operational stability, which strengthens the argument for including a fixed-price element in the allocation system.

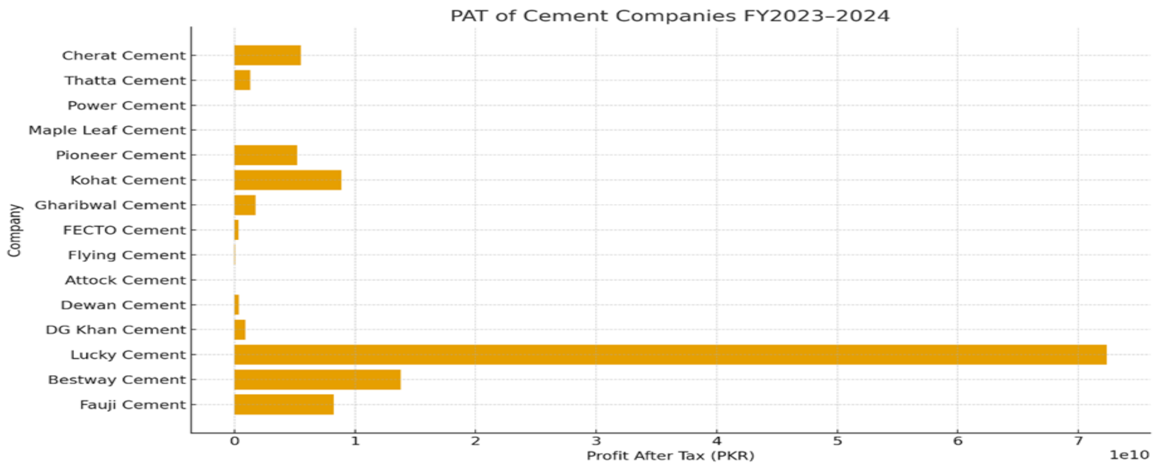

Figure 09: *Cement Companies PAT Comparison*

4.5.2 Technical Rules for Fixed-Price Allowance Allocation

1. Over-Performing Firms

Entities whose verified emissions intensity remains below the benchmark will be classified as over-performing. These firms demonstrate superior carbon-efficiency and will be treated as follows:

- **Surplus Allowances:** All surplus allowances generated through performance below the benchmark will be allocated free of cost.
- **Fixed-Price Allocation:** In addition, firms will be required to purchase 20% of their reported emissions allowances at the fixed price of Rs. 2,500 per tonne.

2. Under-Performing Firms

Entities that go over the emissions benchmark will be labeled as under-performing. Their allocation will still adhere to the usual sectoral allocation methodology, but with a more stringent fixed-price obligation in place.

- **Reported Emissions Allowances:** Companies that aren't performing well will receive their allowances based on a set allocation formula that has already been established.

- **Fixed-Price Requirement:** To comply, they need to buy 30% of their reported emissions allowances at a set price of Rs. 2,500 per tonne.

4.6 Testing and Simulation of Purposed ETS Model

4.6.1 Calculation for Phase I

The total cement sector emissions emit 31,860,000 tCO_2e during the baseline year of 2024[2]. Using formula (1.0) we can calculate allowances for 2024.

Accordingly:

$$\mathbf{31{,}860{,}000\ tCO_2e = 31{,}860{,}000}$$

The one allowance system enables the release of one tonne of CO_2e so the total of 31.86 million allowances matches the entire sector emissions during this time. The system prevents any compliance issues from occurring during the pilot period so facilities can concentrate on creating precise GHG reports, enhancing data acquisition systems and Phase II performance-based allocation readiness.

4.6.2 Calculation for Phase II

The first task of Phase II requires determining annual clinker production for all cement manufacturers to establish the benchmark value. Since most companies report their production data in short tons, the values were standardized by converting them into metric tons using the conversion factor:

$$\mathbf{1\ ton = 0.907185\ metric\ tonnes}$$

For Fauji Cement Company Ltd., the actual clinker production for 2024 was not disclosed in their publicly available reports. Therefore, clinker output was estimated by applying the reported clinker factor (95%) to the total cement production of 5 million tons for that year. This estimation follows the standard relationship:

$$\mathbf{Clinker\ Production} = \text{Clinker Factor} \times \text{Cement Production}$$

[2] *We have assumed that total cement sector forecasted emission are actual verified emissions.*

Similarly, for DG Khan Cement Company Ltd., clinker production was derived using its installed clinker production capacity (6,720,000 tons) multiplied by the reported capacity utilization rate of 65%. Thus, clinker output was calculated according to this formula:

$$\textbf{Clinker Production} = \text{Installed Clinker Capacity} \times \text{Capacity Utilization}$$

After determining clinker production for each firm, the benchmark emissions intensity was computed using the benchmark formula presented earlier (form. 1.1) that is **1.072852532 tCO2e/t clinker**. This benchmark provides the standardized reference value against which the emissions performance of each company is assessed for Phase II analysis.

Sr.	Company	Clinker Production (MT)
1	**Fauji Cement Company Ltd.**	4,308,128.75
2	**Bestway Cement Ltd.**	6098513
3	**Lucky Cement**	8,160,000
4	**DG Khan Cement Company Ltd.**	3,962,632.80
5	**Dewan Cement Ltd.**	1,137,611
6	**Attock Cement Pakistan Ltd.**	2375379
7	**Flying Cement Company Ltd.**	292,700.40
8	**FECTO Cement Ltd.**	590,910.70
9	**Gharibwal Cement Ltd.**	292700
10	**Kohat Cement Company Ltd.**	1,990,000.7
11	**Pioneer Cement Ltd.**	1833.42
12	**Maple Leaf Cement Factory Ltd.**	3,290,000.40
13	**Power Cement Ltd.**	2,073,195
14	**Thatta Cement Company Ltd.**	423,491
15	**Cherat Cement Company Ltd.**	2,135,176.70
16	**Dandot Cement Ltd.**	82701
Total 2024 Clinker Production of Industry		**29696532.42**

Benchmark Rate for 2024	**1.072852532 tCO2e/t clinker[3]**

Table 06: *Benchmark Rate Calculation*

After establishing the sectoral benchmark, emissions intensity for Fauji and Lucky Cement is calculated using (form. 1.2), followed by deviation from the benchmark using (form.1.3). The results show Fauji Cement runs at 11% lower than its defined benchmark but Lucky Cement shows different operational performance. The system generates 92% less emissions than the benchmark because it operates with much better emissions efficiency relative to sectoral benchmark expectations. Based on these deviation outcomes, allowance allocation for Fauji Cement was determined using (form 1.4), as the facility falls within the threshold category defined for moderate over performance. In contrast, Lucky Cement qualifies for allocation under (form. 1.5).

Surplus allowances were then computed as the difference between allocated allowances and verified emissions. The financial reports show Fauji Cement maintains an 8.54% surplus, but Lucky Cement operates with a surplus of 3%. Importantly, these surplus allowances do not mean organization has to increase their emissions in the next compliance period. Instead, the surpluses show that both firms are outperforming when we compare them with sectoral benchmarks, meaning they are carbon efficient.

The companies will keep their present operational efficiency during the upcoming surrender year, which will position them in a more favorable financial and sustainability position, as surplus allowances can be banked for future compliance or sold to other obligated entities within the carbon market. Banking also serves as a strategic buffer for periods in which production may increase, and emissions intensity. So, companies don’t have to buy extra allowances from other organizations

The creation of extra allowances serves as a reward for ongoing emissions reductions, rather than a sign of possible future spikes in emissions. It highlights that both companies are making impressive strides in decarbonization compared to industry standards.

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[3] *Benchmark Rate=31860,000/29696532.42=1.07tCO2e/t clinker*

Sr.	Company	Emissions Intensity (%)	Deviation (%)	Allowance Allocation (MT)	Surplus (MT)
1	**Fauji Cement**	95[4]	-11[5]	4163158.747[6]	70280[7]
2	**Lucky Cement**	08	-92	687715.6221	20030.5521

Table 07: *Calculations for Allowances Allocation Phase-II*

4.7 Banking Rule Test

Suppose verified emissions level of FCCL will remain unchanged during the upcoming compliance year which results in a surplus of 70,280.747 allowances. The company starts by depositing its maximum allowed fixed amount which equals 20,000. The remaining surplus (50,280.747 allowances) cannot be banked directly. The company needs to access the market for selling excess inventory because this action will help them reach the required bankable volume according to the new regulation.

Parameter	Value
Entity	Fauji Cement Company Limited
Total Surplus Allowances	70,280.747
Maximum Fixed Bankable Allowances	20,000
Remaining Surplus After Fixed Banking	50,280.747[8]
Allowances Sold to Expand Banking Capacity	25,140.374[9]
Final Banked Allowances	45,140.374[10]

Table 08: *Banking Rule Testing Calculations*

4.8 Fixed Price Allocation Rule Testing to generate Government Revenue

Based on the above calculations, both selected companies fall under Rule 01, whereby entities performing better than the benchmark receive surplus allowances free of cost. Under this rule, only a fixed percentage of their reported emissions is subject to the fixed-price mechanism.

[4] *FCCL Emissions Intensity = 4,092,878/4,308,128.75. Same way we calculate for Lucky Cement*
[5] *FCCL Deviation= (95%-107%)/107%. Same way we calculate for Lucky Cement*
[6] *FCCL Allowance Allocation= 4092878*{(1- 15%*(-11%)}. Same way we calculate for Lucky Cement*
[7] *FCCL Surplus= 4163158.747-4092878. Same way we calculate for Lucky Cement*
[8] *Remaining Surplus=70,280.747-20,000*
[9] *Allowance Sold to Expand Banking Limit=50280.747*50%*
[10] *Final Banked Allowances= Allowed Allowances+ 25140.37(Generated through sale)*

Accordingly, the resulting government revenue from the sale of these fixed-price allowances is calculated as follows:

Sr.	Company	Allowance Allocation (MT)	Surplus (MT)	Allowance Required for Compliance	Government Revenue from Fixed-Price Sales (PKR)
1	Fauji Cement	4163158.747[11]	70280[12]	4092878.747[13]	2,046,439,373.50[14]
2	Lucky Cement	687715.6221	20030.5521	667685.07	333842535
Total Revenue					PKR 2,380,281,908.50

Table 09: *Calculations for Government Revenue*

Pakistan ETS system has the potential to generate Two billion, three hundred eighty million, two hundred eighty-one thousand, nine hundred eight rupees and fifty paisa from 02 companies.

4.9 Impact on Firm Performance

Seeing impact of compliance cost that was PKR 2,380,281,908.50 as determined in fixed price rule allocation method. We adjust this cost in the other expense section of both companies and recalculate the net profit to see change in companies annual profit and recalculate the ratios following results have been revealed.

4.9.1 FCCL Analysis

Following the adjustment for allowance costs amounting to PKR 2,046,439,373.50, the recalculated profit for Fauji Cement revealed a significant 13% decline in net profit. The company's 55% capacity utilization substantially contributed to the profit reduction, driven by a change in an external policy variable. Additionally, the net profit margin ratio decreased by

[11] As calculated in above table.
[12] As calculated in above table.
[13] FCCL required allowance for compliance=4163158.747-70280. Same as calculated for Lucky Cement (Allocated-Surplus)
*[14] Government Revenue= 4092878.747*20%*2500. Same as Calculated for Lucky (Allowance Required for Compliance*20%* Allowance Price)*

1%, indicating that the company now earns 1% less profit for every PKR 100 in sales, primarily due to the limited adoption of sustainable production practices.

Furthermore, Earnings Per Share declined by 13%, reflecting a reduced return for shareholders because of the newly introduced ETS compliance expense. This suggests that investors may experience diminished value where companies lack commitment to green practices. The implementation of an ETS system may, therefore, incentivize investment in firms that actively integrate sustainability into their business operations.

Moreover, a 1% decrease in ROI signals reduced investment efficiency and slightly lower profitability, which may lower investor confidence. A 1% drop in ROE after incorporating ETS expenses indicates that the company's ability to generate profit from shareholders' equity has weakened slightly due to the added compliance cost. This reduction reflects:

- Lower net income resulting from ETS expense deductions
- Reduced efficiency of equity utilization under the new cost structure
- A mild decline in shareholder profitability, signaling financial sensitivity to carbon-pricing mechanisms
- Early-stage evidence that ETS costs can erode return metrics, even when the percentage decrease appears small

Calculations:

FCCL Income Statement 2024

Rupees '000

Revenue	**Actual**	**Projected**
	80026226	80026226
Cost of Sales	(54345821)	(54345821)
Gross Profit	25680405	25680405
Admin, Selling and other Expenses	(5088471)	(7134910.37)[15]
EBIT	20591934	18545494.63
Interest Expense	(5236980)	(52369800)

[15] PKR. 2,046,439,373.50 expense from ETS Compliance has been adjusted in this section.

EBT	15354954	13308514.63
Tax (46.44%)	(7130840.638)	(6180474.194)
Profit after Tax	8224113.362	7128040.436
Change in Profit	**-13%**	

Table 10: *Projected Income Statement of FCCL*

FCCL Financial Ratios 2024			
	Actual	**Based on Projected Statements**	**% Change**
Net Profit Margin	10%	9%[16]	-1
EPS	Rs. 3.35	Rs. 2.90[17]	-13
ROI	6%	5%[18]	-1
ROE	12%	10%[19]	-2

Table 11: *New- Calculated Ratios of FCCL after Income Statement Projection*

4.9.2 Lucky Cement Analysis

When we investigated the impact of ETS on Lucky cement financial health there was a just insignificant change in profit because Lucky cement has low emissions which proves they incorporate green practices in their whole business following all SDGs such as:

- SDG 07 (Affordable and Clean Energy)
- SDG 09 (Industry Innovation and Infrastructure)
- SDG 12 (Responsible Consumption and Production)
- SDG 13 (Climate Action)
- SDG 17 (Partnership for Sustainable Goals)

On the other hand, lucky cement is subsidiary and they have other sources of income that contribute to its total profit so cost PKR. 333842535 does not affect company performance.

Calculations:

[16] *FCCL Net Profit Margin Ratio= 7128040.436/80026226*

[17] *FCCL E.P. S=7128040000/2454661493*

[18] *FCCL R.O. I=7128040.436/147636299*

[19] *FCCL R.O. E= 7128040.436/ (73398853 +65175737)/2*

Lucky Cement Income Statement 2024		
Rupees '000		
Revenue	**Actual**	**Projected**
Net sales	410995183	410995183
Cost of sales	(287478242)	(287478242)
Gross profit	123516941	123516941
Distribution cost	(15785531)	(15785531)
Administrative expenses	(7652978)	(7652978)
Finance cost	(36698507)	(36698507)
Other expenses	(3674585)	(4008427)[20]
Other income	16185370	16185370
	75890710	75556868
Share of profit - joint ventures and associates	16209618	16209618
Profit before Taxation and Levy	92100328	91766486
Levy	(1798556)	(1798556)
Profit before Taxation	90301772	89967930
Taxation (19.89%)	(17961022.45)	(17894621.3)
Profit after Taxation	72340749.55	72073308.7
Change in Profit	**-0.00369696**	

Table 12: *Projected Income Statement of Lucky Cement*

Lucky Cement Financial Ratios 2024		
	Actual	**Based on Projected Statements**
Net Profit Margin	18%	18%[21]

[20] *PKR.333842535 expense from ETS compliance has been adjusted in this section.*
[21] Lucky Cement Net Profit Margin Ratio= 72073308.7/410995183

EPS	Rs.220.51	Rs.219.71[22]
ROI	11%	11%[23]
ROE	25%	25%[24]

Table 13: *New- Calculated Ratios of FCCL after Income Statement Projection*

4.9.3 Comparative Analysis

Lucky Cement Ltd. has managed to maintain stable financial performance, unlike FCCL, which has been more impacted by ETS compliance costs. This resilience can be attributed to Lucky Cement's robust profit margins, thanks to high sales volumes and the implementation of efficient, sustainable production methods that lead to lower emissions and better gross margins. On the other hand, FCCL has experienced a more significant short-term effect from ETS compliance costs, but these expenses are expected to be balanced out in future periods through the sale of excess allowances, as FCCL works on reducing its emissions. Overall, the results suggest that the proposed ETS model is effective and appropriate for implementation, as it encourages emissions reductions while ensuring the financial health of the companies involved.

[22] Lucky E.P. S=72073308000/328042932
[23] Lucky R.O. I= 72073308.7/ 659661625
[24] Lucky R.O. E= 72073308.7/ (310631448 + 260999059)/2

CHAPTER 5: BENEFITS OF THE PROJECT

5.1 Least-Cost Compliance for the Cement Industry

In the context of the proposed ETS framework, a central allowance price of PKR 2,500 per ton of CO_2 was established and empirically assessed to determine its effect on the profitability of firms within Pakistan cement industry. The findings suggest that this price point does not result in a statistically significant negative effect on the overall performance of firms. Although compliance costs are incurred by firms with emissions exceeding the benchmark, these expenses are largely mitigated through the sale of excess allowances by more efficient producers. Companies such as Lucky Cement and Fauji Cement, which exhibit relatively lower emissions intensity, are positioned to either gain directly from the ETS via allowance sales or offset compliance costs through trading revenues.

The analysis indicates that even for firms facing net compliance costs, the financial repercussions remain manageable and do not significantly detract from profitability. Rather, the ETS establishes a market-driven incentive framework that financially rewards environmental efficiency. This system allows firms to sustain economic performance while concurrently enhancing their environmental and sustainability results. In summary, the evaluated allowance price strikes a balance between environmental efficacy and economic viability, ensuring that emissions reductions are achieved without jeopardizing the financial stability of cement manufacturers, while fostering improved sustainability performance throughout the sector.

5.2 Generation of Climate Finance

The ETS framework illustrates the capacity to produce reliable public revenues via allowance auctioning as the analysis predicts revenues exceeding PKR.2 billion revenues from two companies only. These revenues constitute a self-sustaining climate mechanism that can be reinvested into industrial decarbonization initiatives, improvements in MRV systems, and focused assistance for at-risk firms or communities. This approach diminishes dependence on external climate financing and bolsters fiscal sustainability, rendering climate mitigation economically feasible over the long term.

5. 3 Enhancing Institutional and Regulatory Capacity

The execution and evaluation of the ETS necessitates strong Monitoring, Reporting, and Verification protocols. Consequently, the initiative aids in the establishment of standardized emissions accounting, better data quality, and strengthened regulatory oversight to meet climate targets such as reduction of 17% in emissions over next ten years. These institutional advancements reach beyond the cement industry and lay the foundation for broadening carbon regulation to additional energy-intensive sectors, thereby enhancing Pakistan overall capacity for climate governance.

5.4 Economic Advantages

The proposed Emissions Trading System offers substantial economic benefits beyond emissions reduction by fostering green employment, encouraging domestic investment, and enabling participation in international carbon markets. By establishing a regulated carbon price, the system creates demand for professional roles in emissions monitoring, verification, auditing, carbon trading, and energy management, thereby generating green jobs and strengthening domestic technical capacity. At the same time, the ETS supports domestic offset mechanisms, allowing verified emissions reductions from renewable energy, waste-to-energy, reforestation, and industrial efficiency projects to be monetized. This channels private capital toward cost-effective mitigation, lowers overall compliance costs, and broadens participation beyond regulated entities. Furthermore, alignment with regional systems such as China national ETS could allow Pakistan-generated carbon credits to be recognized as valid offsets, creating an export-oriented revenue stream and attracting foreign investment. Such linkage would reduce compliance costs for Chinese firms while generating foreign exchange for Pakistan, enhancing regional climate cooperation. Overall, these mechanisms position the ETS not merely as a regulatory instrument but as an economic enabler that supports job creation, green investment, improved firm-level sustainability performance, and long-term economic resilience.

5.5 Conceptual Contribution

Academically, the given project bridges a broad research gap because previous studies are only limited to emission calculations and offset procedures. In practice, this study frames a feasible ETS system for Pakistan and comparatively tests it on firm performance. Cement firms can estimate their compliance cost using this model so they should implement sustainable procedures before the implementation of compliance period. In general, the project demonstrates that ETS system is not just a model for sustainable finance but a strategic instrument to gain sustainable industrial performance.

CHAPTER 06: LIMITATIONS AND FUTURE RESEARCH DIRECTION

6.1 Study Limitations

Despite its contributions, this study has certain limitations. First, while the research utilizes authentic financial and operational data from firms, the industry-wide emissions employed for benchmark calculations are derived from projected estimates from an external study instead of verified emissions at the plant level. This may influence the accuracy of benchmark stringency and the outcomes of allowance allocation. Second, the empirical analysis is confined to the cement sector, which limits the immediate applicability of the findings to other high-emission industries. Third, due to constraints related to time and data, the study does not include EBITDA-based profitability indicators, which restricts a more thorough evaluation of the short-term financial effects of participation in the ETS on firms. Finally, the design of the ETS is examined under a fixed-price allowance mechanism, while other market structures are not assessed empirically.

6.2 Future Research Direction

Future investigations ought to focus on creating verified plant-level emissions datasets for the entire cement sector in Pakistan, which will facilitate the establishment of more precise and reliable benchmarks. The suggested ETS framework has the potential to be applied to other high-emission industries, such as steel production and electricity generation, to evaluate its cross-sectoral relevance. Subsequent research should analyze various ETS market structures, especially auction-based and hybrid models, to assess their effectiveness in comparison to free allocation and fixed-price systems. Moreover, future studies should integrate EBITDA and other financial performance metrics to gain a deeper insight into the profitability and competitive effects of participating in the ETS system. Longitudinal research could investigate how the implementation of the ETS aids Pakistan in achieving its objectives related to SDG 13 and commitments under the Paris Agreement by the year 2030.

6.3 Purposed Framework for Government

The successful implementation of an Emissions Trading System for Pakistan requires a specific implementation plan which should be both strategic and active. The strategy needs to start with ETS-enabling legislation passage followed by national climate target definition and selection of a qualified regulatory body. The assigned authority would need to establish system boundaries and service areas and decide which local offset programs qualify and how they should function while developing a revenue distribution plan that supports national goals and follows international best practices.

6.3.1 ETS Enabling legislation

Given that Pakistan political system demonstrates support for ETS markets, as evidenced by the political assessment, the government should enact enabling legislation to facilitate effective implementation. Such legislation should establish clear climate targets and ensure alignment with Pakistan NDCs, the Paris Agreement, and the national carbon market policy.

6.3.2 Scope and Sector Coverage

After passing the legislation, regulatory body, namely, the Ministry of Climate Change and Environmental Coordination will set the scope of ETS system in terms of gases cover. They will define which gases will be covered under ETS in first phase and in next phase. Calculations of emissions will be based on defined scope. After defining the scope entity must be announced sector coverage under ETS system and then define companies cover in that system based on emission intensity and financial highlights.

6.3.3. Define offset Procedures

Regulatory bodies will be responsible for defining rules for domestic emission offsets. In Pakistan, despite the presence of a clear policy framework, participation in voluntary carbon markets remains limited, with only a small number of actors currently involved in the sale of carbon credits. Introducing domestic offset options under ETS could open new avenues for green business development, including investments in environmentally sustainable projects, while simultaneously contributing to emissions reduction. Domestic credits should therefore be allowed for verified emission reductions within the country, with the most suitable options including credit generated from waste management, reforestation, and community-based projects.

6.4.4. International linkages with other ETS System

China is a strategic and key economic partner of Pakistan and has consistently supported Pakistan growth and development. China established its national ETS which began operations in 2021. The facility operates at full capacity while maintaining its position as one of the three leading polluters because of its broad operations. industrial base. The Pakistan ETS system needs to connect with China carbon market operations through the implementation of offset arrangements which enable Pakistan to use its generated offsets would establish a new capability. revenue stream. This method would create a path for foreign currency to enter the system. The initiative works to build up Pakistan's national reserve funds

6.2. Conclusion

The research shows that Pakistan faces its climate crisis because the country lacks an effective system which would turn environmental policies into quantifiable financial results. The research investigates the cement industry because it represents a major source of carbon emissions which drives economic growth in the country. A well-designed ETS helps the cement industry to reduce its environmental impact through sustainable industrial operations which defend natural resources and maintain business profitability. The research indicates that Pakistan's industrial emissions exist because of production inefficiencies and delayed technology advancements and insufficient carbon pricing mechanisms. The proposed ETS system solves these problems by creating economic value which represents how well organizations perform regarding their emissions. The system gives additional allowances to businesses which operate more efficiently but require producers who fail to meet efficiency standards to reach performance targets. The process enables carbon efficiency to develop into a strategic financial asset. The project implements functional design principles which make it stand out from other projects. The system implements international ETS models which follow worldwide best practices, but the system modifies these models to match Pakistan institutional strengths and its current economic situation and restricted data availability.

The phased implementation method together with benchmark-based allocation and disciplined banking rules and fixed-price allowance mechanism provides regulatory credibility and market stability and predictable public revenue. The system enables regulators to develop their technical abilities while the industry can execute operational shifts using a transition approach which minimizes major economic disruptions. The ETS operates as a financial tool which simultaneously acts as a development instrument. The revenue generated from allowance sales creates a domestic funding stream which supports climate adaptation and resilience efforts and upcoming decarbonization initiatives while reducing the need for international climate funding and ensuring environmental policies align with national economic objectives. Climate-related disasters continue to harm the nation through repeated economic destruction which has led to essential changes in climate action funding and management systems. The research demonstrates how Pakistan has moved its climate response from theoretical objectives to practical execution. A well-designed ETS system serves as a link between environmental protection and economic performance which enables Pakistan to build its industrial base while decreasing its carbon footprint. The Emissions Trading System operates as a growth restriction only when it does not adapt to local requirements, but it achieves emission reduction through efficient market mechanisms which convert environmental risks into financial stability. The research indicates that Pakistan requires an ETS system because it functions as a fundamental economic framework which extends its benefits past environmental conservation objectives.

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