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Effects of Carbon Markets Pricing on Competitiveness of Key Industries in Kenya

Powel Murunga

PhD Student, University of Nairobi
***Email of the author: powelmurunga@gmail.com**

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Abstract

Carbon markets aim to reduce greenhouse gas emissions, but their effects on industry and the economy are not fully understood in Kenya. This study examines the societal and economic impacts of carbon markets in Kenya, focusing on carbon emissions costs and their effects on industrial competitiveness. The study analyzes 8 key industries which together contribute over 60% of Kenya's GDP and a large portion of formal sector employment. These sectors are both emission-intensive and trade-exposed, making them sensitive to carbon cost variations. In this study, the benchmark price of US$43 per metric ton will represent the average voluntary-market transaction value. This rate provides a realistic proxy for Kenya's near-term pricing environment before the formal Carbon Emissions Trading System (CETS) becomes operational. The study applies an evaluation model and scenario analysis to assess sectoral risks. Findings show minimal impact at the current carbon trading price of US$43 per metric ton. However, if carbon costs exceed 5% of sectoral value-added surpassing the global threshold or prices rise above US$1300 per ton, competitiveness will decline sharply. Under realistic price paths (US$35–55), most sectors remain below the 5% competitiveness threshold. The study recommends gradually increasing carbon prices while considering industries' capacity to adapt, balancing emission reduction goals with economic sustainability. Integrating the CETS with complementary energy policies such as petroleum levies will help reduce emissions. These findings provide policymakers with evidence for implementing the Kenya's Climate Change (Amendment) Act 2023, designing the CETS framework, and formulating green fiscal policies that balance decarbonization goals with industrial competitiveness.

Key Terms: *Carbon Trading, Industry competitiveness, GDP, carbon emissions, Carbon market price; Carbon emissions cost*

1.0 Introduction

Carbon markets are systems for trading carbon credits, where companies or individuals buy credits to offset their greenhouse gas emissions (UNEP, 2022). Each credit represents one tonne of carbon dioxide or an equivalent amount of another greenhouse gas reduced, sequestered, or avoided. Once used as an offset, the credit is retired and cannot be traded further. Emissions trading systems (ETS) operate on a "cap-and-trade" model, where governments issue permits to cap total emissions. Entities exceeding their limits buy permits from those with surplus allowances. Established in 1997 under the Kyoto Protocol, the Clean Development Mechanism (CDM) allowed developing countries to generate carbon credits for industrialized nations to meet emission targets. The European Union launched the first international ETS in 2005, followed by China's creation

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of the world's largest ETS in 2021, covering one-seventh of global fossil fuel emissions. Today, numerous national and regional ETS programs are active or emerging.

The potential of carbon credit market provides Kenya with an opportunity to leverage its abundant natural resources and unlocking economic value. This, in turn, can contribute to promoting sustainable industrialization, economic transformation and diversification across the nation. The growing importance of carbon markets in incentivizing greenhouse gas reduction has drawn attention to their broader impacts on society and the economy. To this end, Kenya aims to develop the voluntary carbon credit market, aligning with the Bottom-Up Economic Transformation Agenda (BETA) to create value, drive climate action, and uplift communities. Despite its minimal global contribution to greenhouse gas emissions (less than 0.1% in 2021), Kenya has enacted policies to pursue a low-carbon, climate-resilient development pathway in line with Vision 2030. Recently, with the collaboration of the Swedish Development Cooperation Agency (SIDA), USAID has contributed to the creation of Kenya's Carbon Markets Activation Plan 2023. This plan ensures transparency, equity, and integrity in carbon projects across the country. For example, through partnerships like Power Africa, USAID has facilitated the development and activation of 691 megawatts (MW) of clean energy generation in Kenya. This includes projects like the Lake Turkana Wind Power project (310 MW), Olkaria V Geothermal Power Plant (158 MW), Olkaria I Unit 6 Geothermal Power Plant (83 MW), Kipeto Wind Power Project (100 MW), and Malindi Solar Photovoltaic Power Project (40 MW). The above initiatives are likely to be marketed both domestically and internationally, facilitating the generation of carbon credits for Kenya's individuals and entities. Although Kenya remains a low carbon emitter, CO2 emissions per capita have shown a gradual increase over the years, rising from 0.261 tons in 2000 to a peak of 0.347 tons in 2017, before slightly declining to 0.329 tons in 2021 as shown in figure 1 below. This trend is a proof of the importance of continued efforts to mitigate emissions and transition to more sustainable energy sources to curb the impacts of climate change.

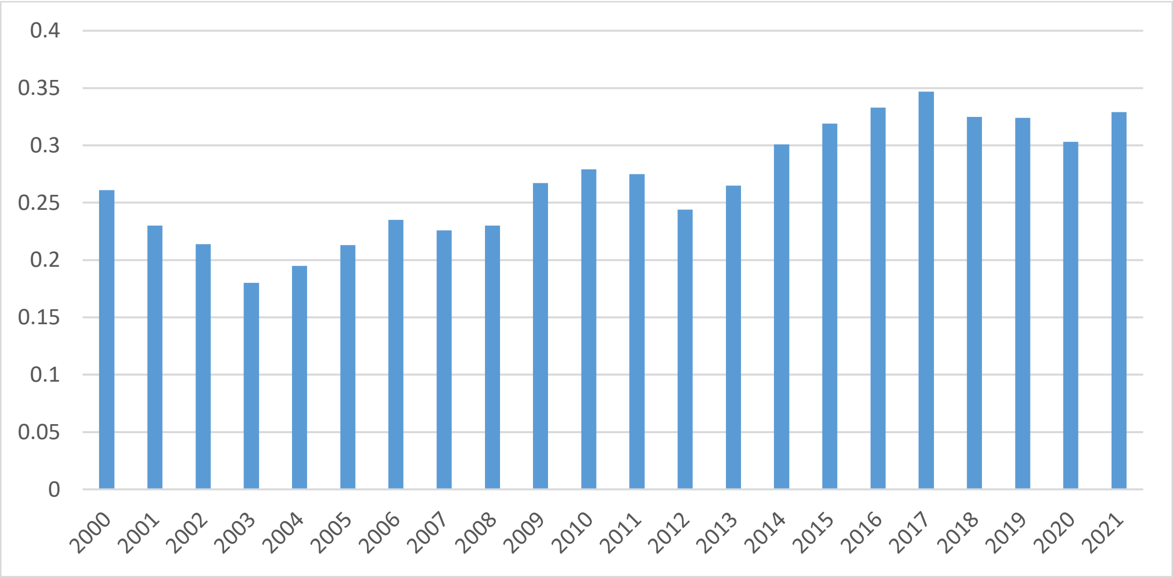

Figure 1: CO2 emissions per capita, Kenya Units (tCO2 / Capita

Data source: IEA, GOK, 2021

Source: Own Compilation

Embracing a low-carbon growth trajectory could position Kenya to contribute to global decarbonization efforts and enhance competitiveness in green markets and low-carbon supply chains. Kenya, categorized as a lower-middle-income developing nation and a low emitter/contributor to greenhouse gas emissions, has taken steps to reduce its industrial emissions (World Bank, 2021). Policy frameworks such as the Low Emissions Development Strategy 2022-2050, Climate Change Framework Policy, Climate Change Act, and Climate Change Finance Policy have been established. Recent developments include the drafting of the Climate Change (Amendment) Bill in 2023, aiming to integrate carbon markets into existing legislation and establish a unified Carbon Emissions Trading System (CETS). This amendment is expected to impact carbon projects within Kenya and pave the way for a more structured carbon trading system. The implementation of market mechanisms is critical for controlling carbon emissions and promoting green and low-carbon economic development. While the CETS plays an important role in reducing emissions and optimizing resource allocation, assessing its impact on society and the economy remains a significant issue, particularly regarding the industrial competitiveness of related industries.

1.1 Problem statement

Kenya's carbon market remains largely voluntary and supported by forestry, renewable energy and community projects such as *Mikoko Pamoja initiatives*, with credits traded at an average price of US$43 per metric ton and sold to organizations seeking to offset emissions beyond legal requirements (Kairo, Hamza, & Wanjiru, 2018). Unlike the EU or China's compliance markets that impose mandatory emission caps (World Bank, 2024), Kenya's system doesn't have binding regulation as it prepares to operationalize its Carbon Emissions Trading System (CETS) under the Carbon Markets Activation Plan (2023). However, the potential effects of carbon pricing on industrial competitiveness remain unclear. As Kenya transitions toward a regulated market, understanding how carbon costs influence production, trade performance, and value addition across sectors is critical. This study provides the first systematic analysis of these dynamics in eight key industries namely Electricity Supply, Manufacturing, Transport, Residential, Commercial, Agriculture, Waste and Water Management, and Mining which together account for over 60% of Kenya's GDP and formal employment. These sectors are both emission-intensive and trade-exposed, making them vulnerable to price shocks. Through examining competitiveness risks under varying price scenarios, this study addresses a critical policy gap of how to design Kenya's CETS framework to advance decarbonization without eroding industrial resilience or economic growth under the Climate Change (Amendment) Act 2023.

1.2 Objective of the Study

The Climate Change (Amendment) Act of Kenya enacted in 2023 aims to reduce emissions, promote energy efficiency, and optimize resource use. However, its real-world effects require careful analysis. This study specifically investigates the impact of Kenya's potential carbon trading market on the competitiveness of 8 key industries. Understanding how the carbon market might affect these industries is crucial for its successful implementation and improvement. The findings of this study will be valuable not only for Kenyan policymakers but also for cities around the world considering similar initiatives. Specifically, this study will investigate the impact of Kenya's potential carbon trading market on the competitiveness of 8 key industries. The study will also explore how different carbon pricing levels affect the economic burden on industries, and implications for their competitive positioning.

2.1 Theoretical Literature

The theories anchoring this study were aligned with the objectives of the study and they include the Coase Theorem and monopolistic competition theory. The Coase Theorem and monopolistic competition theory explain the relationship between policies and market dynamics in carbon trading. Institutional policies have positioned carbon markets as a key tool in combating climate change.

2.1.1 Coase Theorem

The Coase Theorem, proposed by economist Ronald Coase in 1960, asserts that under certain conditions, private parties can resolve externalities, such as pollution, without government intervention. If property rights are clearly defined and transaction costs are low, individuals or businesses can negotiate an efficient solution to manage the externality. For example, in the case of carbon emissions, a polluting company and the affected parties could negotiate compensation or emission reductions. The theorem relies on key conditions: clearly defined property rights, low transaction costs, and perfect information for all parties. Entities can internalize the cost of emissions through carbon trading systems, which incentivize them to reduce their environmental impact.

2.1.2 Monopolistic Competition Theory

Monopolistic competition theory, introduced by Edward Chamberlin (1930s), describes a market where many firms sell differentiated products, allowing them some pricing power. Firms in monopolistic competition compete on both price and differentiation, such as quality or branding. Empirical studies in various sectors, like retail and tech, show that while firms can charge higher prices due to differentiation, this power is limited by the availability of close substitutes. As more firms enter the market, differentiation's value diminishes, leading to increased price competition and lower profits. In carbon markets, monopolistic competition explains how firms in carbon-intensive industries might respond to carbon pricing. Firms that can reduce emissions and differentiate their products as more sustainable may gain a competitive advantage, while those struggling to cut emissions may face competitive challenges, shifting market dynamics over time. While firms can adjust to changes in carbon prices, their ability to compete may be hindered if the costs become too high and reduce profitability, especially in carbon-intensive industries.

2.2 Empirical Literature

Since the inception of carbon trading markets, various studies have examined their influence on social and economic development. Scholars typically consider carbon trading markets to have a greater impact on energy related sectors, especially power industries. In Europe, a persistent cointegration exists among the European Union Emissions Trading System (EU ETS) carbon price, electricity price, and energy price, with a weak link between carbon price and electricity price (Freitas & da Silva, 2015). Previously, the EU Emissions Trading System (EU ETS) had a significant impact on Spain's wholesale power price, prompting French and German power companies to impose limitations when integrating the EU ETS carbon price into their expenses. Additionally, the EU carbon trading system influenced the French electricity distribution price (Kirat & Ahamada, 2011).

The consensus suggests that carbon trading systems, such as the European Union Emissions Trading System (EU ETS), have had minimal direct impacts on non-energy sectors like aviation. Studies indicate that integration into the EU ETS led to modest cost increases for airlines, with

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minimal effects on output and macroeconomic indicators (Anger, 2010; Malina & Waitz, 2012). Similarly, research on the American aviation sector shows resilience to the EU ETS, maintaining its growth trajectory despite carbon price fluctuations (Malina et al., 2011). In Italy, while EU ETS raised airlines' direct costs, the increase remained modest (Meleo & Pozzi, 2016). Furthermore, Cui et al. (2016) analyzed data from 18 international airlines from 2008 to 2014 using the Data Envelopment Analysis (DEA) method, finding that airlines adapted in the long run to meet carbon trading requirements.

However, the evidence is mixed on the socioeconomic impact of carbon trading systems. Rogge et al. (2011) investigated the EU ETS's effects on German companies' research, development, deployment, and organizational changes, concluding that the system lacked rigor and predictability. They also found that the EU ETS had minimal influence on corporate innovation, failing to adequately incentivize innovative activities. Furthermore, research indicates that the EU ETS lacks objectivity in efficiency and responsibility, with EU leaders showing reluctance to address these concerns (Dirix & Sterckx, 2015). Additionally, EU ETS affects corporate investment decisions, with most managers overestimating carbon prices, which are deemed insufficient to stimulate new low-carbon investments (Brohé & Burniaux, 2015).

Importantly, no study has investigated the impact of carbon trading systems on industrial competitiveness in Kenya, especially in sectors that are both emission-intensive and trade-exposed. While studies on China's carbon emissions trading system (CETS) indicate that industries such as water production, mining auxiliary services, and electric power production were highly sensitive to the policy, experiencing notable changes in profitability (Yan & Wang, 2017), such research is lacking in the Kenyan context. This gap is significant, as Kenya's industrial sectors contribute over 60% of GDP and a large portion of formal sector employment. Understanding how carbon pricing might affect production costs, trade performance, and value-addition capacity in these key sectors is therefore critical to designing an effective and equitable pricing framework.

To conclude, while existing literature have evidence into the effects of carbon trading systems on non-energy sectors and innovation in developed economies, there is less empirical research on their impact in developing countries like Kenya. This study aims to fill this gap by systematically assessing how carbon pricing may influence sectoral competitiveness in Kenya, providing critical evidence for policymakers implementing the Climate Change (Amendment) Act 2023, designing the Carbon Emissions Trading System (CETS) framework, and formulating green fiscal policies that balance decarbonization goals with industrial competitiveness.

3.0 Methodology

This study adopted and refined the industry competitiveness evaluation model originally developed by the German Federal Environmental Agency (Graichen et al., 2008) and later applied by Lu, Xu, and Wang (2021) to assess the influence of carbon trading systems on industrial competitiveness. It measured the immediate impact of Kenya's carbon emissions trading system by calculating the carbon emissions cost (CEC) per unit of industry value added (IVA). This cost was determined by multiplying direct and indirect CO_2 emissions by the prevailing carbon market price and dividing the result by the added value generated in each industry.

The formula for carbon emission cost per unit of value added is expressed as:

$$CEC = \frac{(DCO2+IDCO2)xBEA}{IVA} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

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Hence, DCO2 * BEA represents the direct carbon emissions costs, and IDCO2*BEA denotes the indirect carbon emissions costs for a specific industry.

3.2 Variable Descriptions and Data Sources

Table 1 presents the key variables used in assessing the impact of Kenya's carbon emissions trading system on industrial competitiveness, including their abbreviations, definitions, and primary data sources.

Table 1: Variable Descriptions and Data Sources

Variable	Symbol / Abbreviation	Meaning / Measurement	Data Source
Carbon Emission Cost	CEC	Ratio of total carbon emission cost to industry value added	Computed by author using Eq. (1)
Direct Carbon Dioxide Emissions	DCO_2	CO_2 emissions from fossil fuel consumption within the industry	IEA, KNBS Energy Balance Statistics (2010–present)
Indirect Carbon Dioxide Emissions	$IDCO_2$	CO_2 emissions from electricity and heat consumption	IEA, World Bank Energy Data
Carbon Market Price / Quota Price	BEA	Benchmark carbon trading price (USD 43 per ton of CO_2)	Mikoko Pamoja (Newton, 2023); KNBS Exchange Rates
Industry Value Added	IVA	Total value added by each sector (KES, constant prices)	KNBS Economic Survey, World Bank National Accounts
Energy Consumption by Fuel Type	E_i	Total energy used by each industry, disaggregated by source	KNBS Energy Surveys; IEA Energy Statistics
Net Calorific Value	NCV_i	Average energy content per unit of fuel consumed	IEA Energy Balances (2024 Edition)
Carbon Emission Factor	CEF_i	Amount of CO_2 emitted per unit of energy consumed	IPCC (2006) Guidelines for National GHG Inventories
Carbon Oxidation Factor	COF_i	Fraction of carbon oxidized during fuel combustion	IPCC (2006); Ministry of Environment Guidelines
Industry Sector Classification	IND	Eight major sectors: Electricity, Manufacturing, Transport, Residential, Commercial, Agriculture, Waste/Water, Mining	KNBS Economic Survey, Author's Compilation

Source: Author Own Compilation

Direct emissions arose from fossil fuel consumption, while indirect emissions resulted from heat and electricity usage. Direct CO_2 emissions were estimated following the Intergovernmental Panel on Climate Change (IPCC) National Greenhouse Gas Inventories Guide (2006), which accounted for energy consumption, calorific value, carbon emission coefficients, and oxidation factors. Indirect emissions were determined using the Guidelines for Greenhouse Gas Emissions Accounting and Reporting (2019), linking energy consumption in heat and electricity to their respective emission factors as outlined in the model below:

$$DCO2 = \sum_i CO2,i = \sum_i Ei \; X \; NCV_i \; x \; CEF_i \; X \; COF_I \; X \; (44/12) \quad \ldots\ldots\ldots(2)$$

Eight sectors were selected based on their large contribution to national GDP of up to 60%, energy consumption intensity, and potential exposure to carbon pricing: electricity supply, manufacturing, transport, residential (real estate and construction), commercial (finance and insurance), agriculture, other energy industries (mining), and final consumption not specified (waste and water). Excluded sectors such as public administration, education, and health were omitted due to their relatively low fossil energy dependence and limited direct emissions, though their inclusion could marginally alter aggregate competitiveness estimates by 1–3%.

Data were primarily obtained from the Kenya National Bureau of Statistics (KNBS), the International Energy Agency (IEA), the World Bank, FAOSTAT, and Kenya's Ministry of Environment and Energy. Fossil fuel calorific values, carbon coefficients, and oxidation factors were sourced from IEA and national guidelines. To contextualize carbon pricing in Kenya, the study referenced Mikoko Pamoja's certified carbon credit sales, which achieved a trading price of approximately US$43 (KES 5,690) per ton of CO_2. Using this price benchmark, the study calculated both direct and indirect emissions from 2013 to 2016 for the selected industries. These estimates enabled the evaluation of how carbon trading costs affected sectoral competitiveness, providing a framework to understand whether the Kenyan carbon market influenced industrial cost structures and economic performance.

All data were subjected to a multi-step cleaning process to ensure accuracy and comparability across sources. Consistency checks were first conducted to align sectoral classifications from KNBS, IEA, and World Bank datasets. Missing values for minor years were addressed through linear interpolation using three-year moving averages when sectoral continuity was confirmed. Duplicate entries were removed, and sector codes were aligned with ISIC Rev.4 standards. To ensure uniformity, all energy consumption data were converted to gigajoules (GJ) prior to emission estimation. Adjustments for calorific values and oxidation factors were applied following IEA (2020) standards to standardize energy-to-carbon conversion across different fuel types. Finally, outliers exceeding ±2 standard deviations from historical mean emissions were capped to maintain realistic and stable estimates for each sector.

Robustness was evaluated through several complementary tests. First, alternative carbon price benchmarks for example US$35 and US$55 per metric ton was applied to assess sensitivity to price volatility in voluntary and emerging compliance markets. Second, a revised competitiveness threshold (e.g., ±10% change in sectoral value-added share) was tested to examine how variations in sectoral performance affect emission cost exposure. Finally, simple sensitivity checks was conducted by revising sectoral value-added data to account for potential reporting errors or revisions in KNBS datasets, ensuring that findings remain stable under alternative data scenarios.

4.0 Findings

This section presents the study's findings on how carbon pricing affects industrial competitiveness of 8 key industrial sectors in Kenya. The section highlights sectoral variations in carbon cost intensity, trends over time, and the implications of different carbon price scenarios for competitiveness and policy design.

4.1 Impact of Kenya's Carbon Market on Industry Competitiveness

Figure 2 illustrates carbon emission trends across the eight selected industries in Kenya from 2000 to 2021. The data has identified two distinct phases: the pre-2014 period (before the inception of the voluntary carbon trading system) and the post-2014 period (after the establishment of the voluntary Carbon Emissions Trading System). Total emissions increased steadily from 7,879.7 kilotons (kt) in 2001 to 19,446.8 kt in 2021, with a sharp surge between 2012 and 2014, peaking at 20,097.2 kt in 2017 representing a 16% rise. Following the introduction of voluntary trading system, emissions declined to 19,253.9 kt in 2018 after a 4% reduction. Minor rebounds in 2019–2020 likely correspond to adjustment delays and enterprise-level responses to changing carbon regulations.

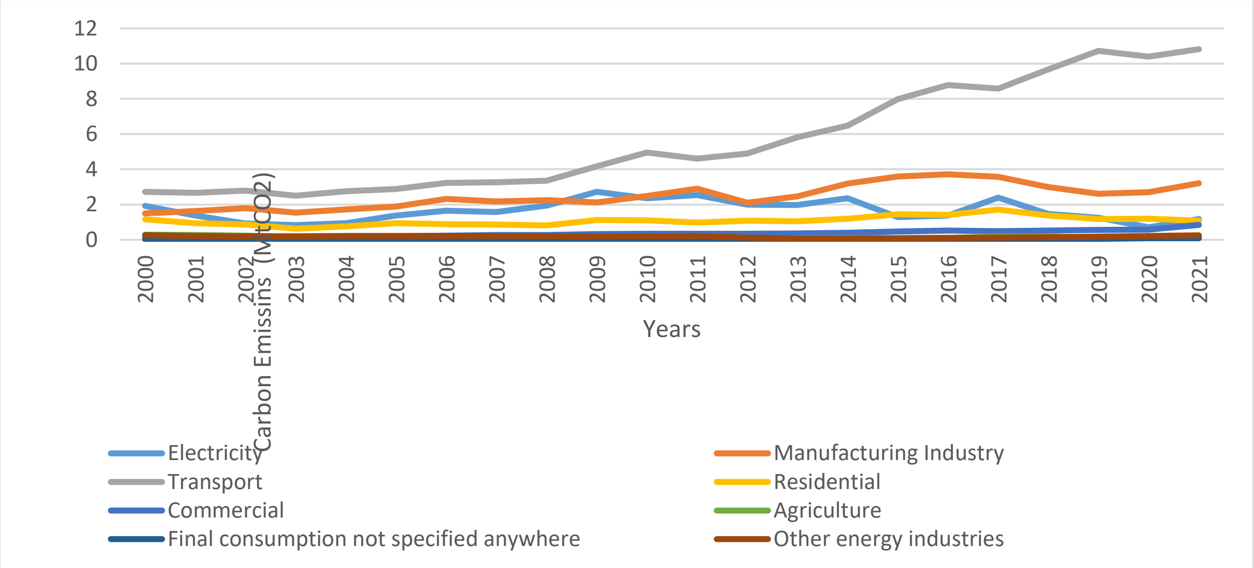

Figure 2: Total carbon emission changes in the 8 selected Kenya industries/sectors from 2000 to 2021

Source: Own Compilation

Data Source: IEA, Kenya Emissions

Figure 4 below illustrates Kenya's CO_2 emissions distribution across 8 sectors in 2021. The Electricity and Transport sectors accounted for the largest shares since they heavily rely on fossil fuels. Manufacturing contributed moderately, while Agriculture, Residential, and Commercial sectors emitted relatively lower volumes due to less direct fuel use.

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Figure 1: CO2 emissions by sector, Kenya, 2021

Data Source: IEA, 2023

Source: Own Compilation

Figure 5 below shows a steady rise in Kenya's CO_2 emissions from 2001 to 2020, driven by economic growth and energy demand. Emissions peaked around 2017, followed by a slight stabilization attributed to emerging policy effects and gradual adoption of cleaner energy technologies.

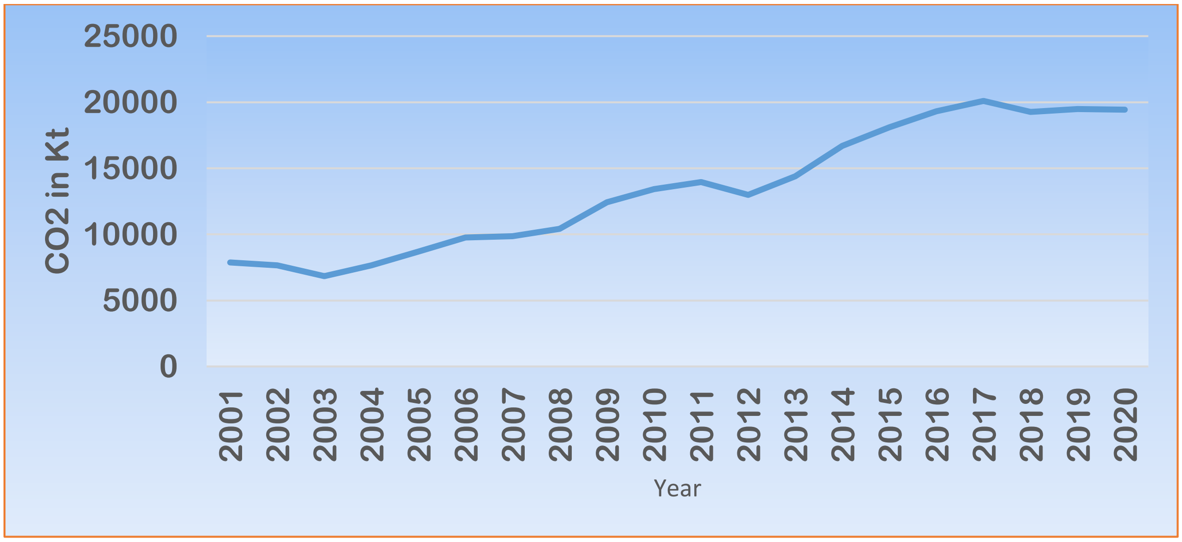

Figure 2: Trend in Kenya's carbon emissions CO2 emissions (kt), 2001-2020

Source: Own Compilation

Data Source: World Bank Indicators *(Climate Watch Historical GHG Emissions (1990-2020)*

4.2 Estimation of the Carbon Market Impact on Industry Competitiveness

This section estimates the direct and indirect costs incurred under Kenya's slow introduction of the voluntary Carbon Emissions Trading System across eight key industries and evaluates their implications for competitiveness. The estimation multiplies direct and indirect sectoral emissions (as shown in Table 5) by the prevailing carbon price (USD 43/ton CO_2) and relates the resultant costs to sectoral value added using the competitiveness estimation formula (1). Figures 6–9

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visualize these results for the period 2013–2016, where the blue segments represent direct costs from fossil fuel combustion, light red shows indirect costs from electricity and heat consumption, and the black line marks total carbon cost per unit of value added.

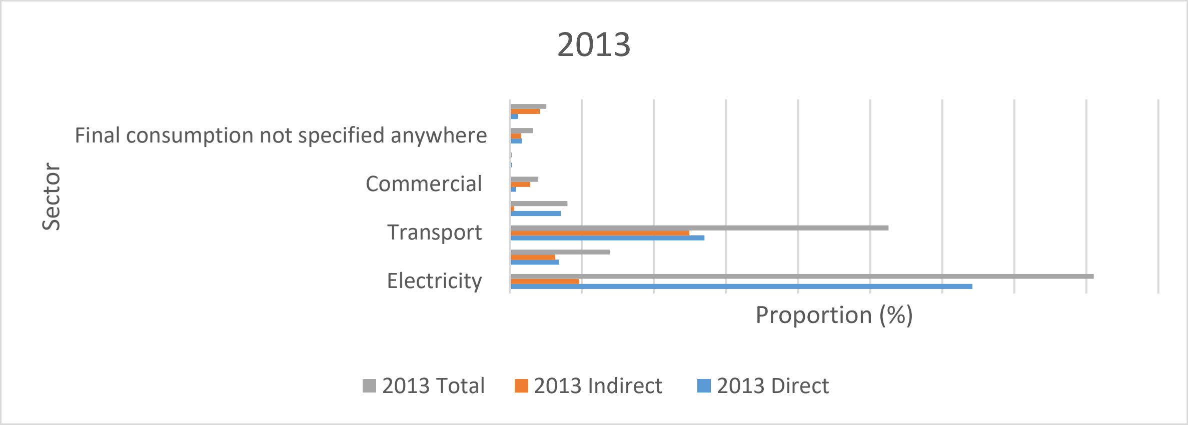

Figure 6: Direct and indirect carbon costs across eight industries, 2013

Source: Author's compilation; Data: KNBS, 2012–2017

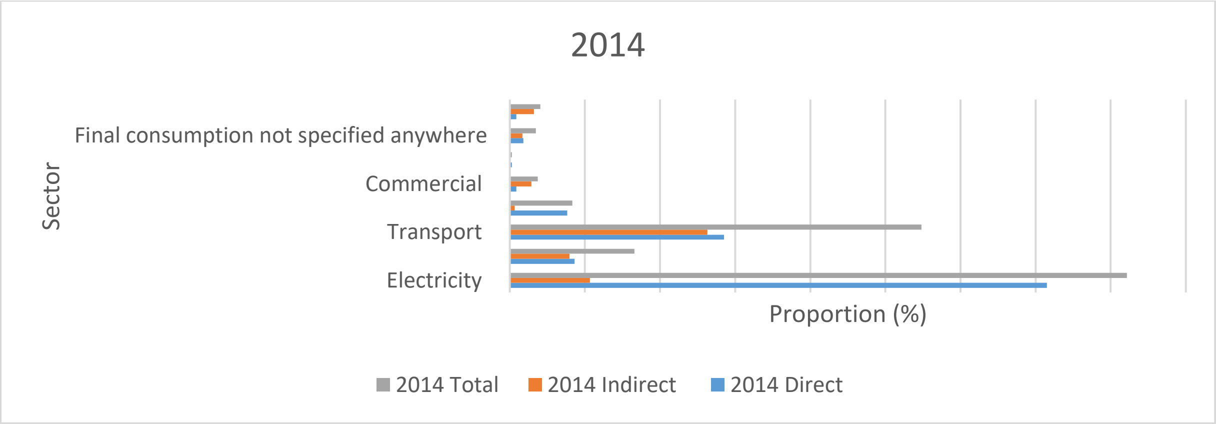

Figure 7: Direct and indirect carbon costs across eight industries, 2014

Source: Author's compilation; Data: KNBS, 2012–2017

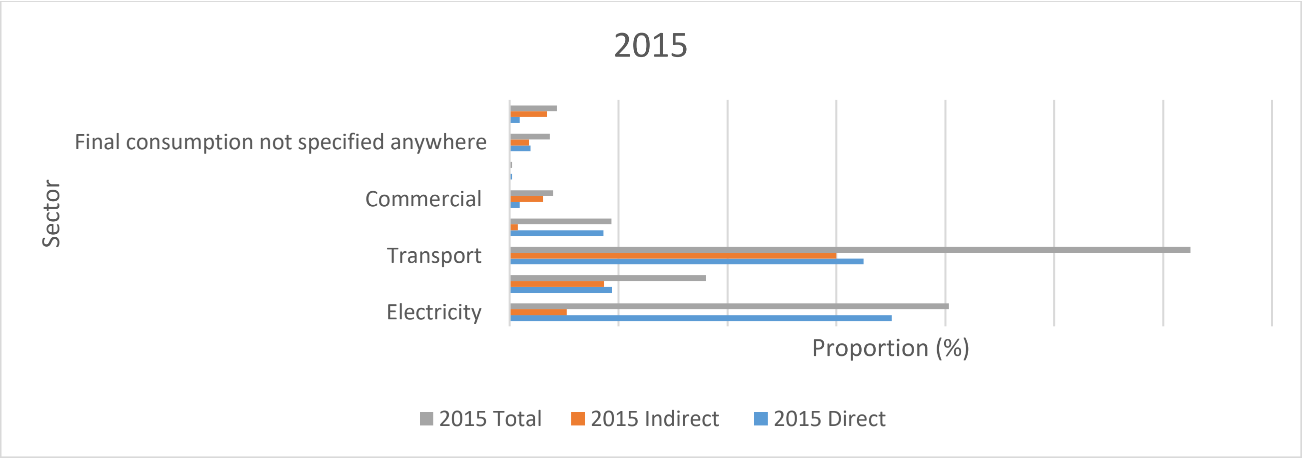

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Figure 8: Direct and indirect carbon costs across eight industries, 2015

Source: Author's compilation; Data: KNBS, 2012–2017

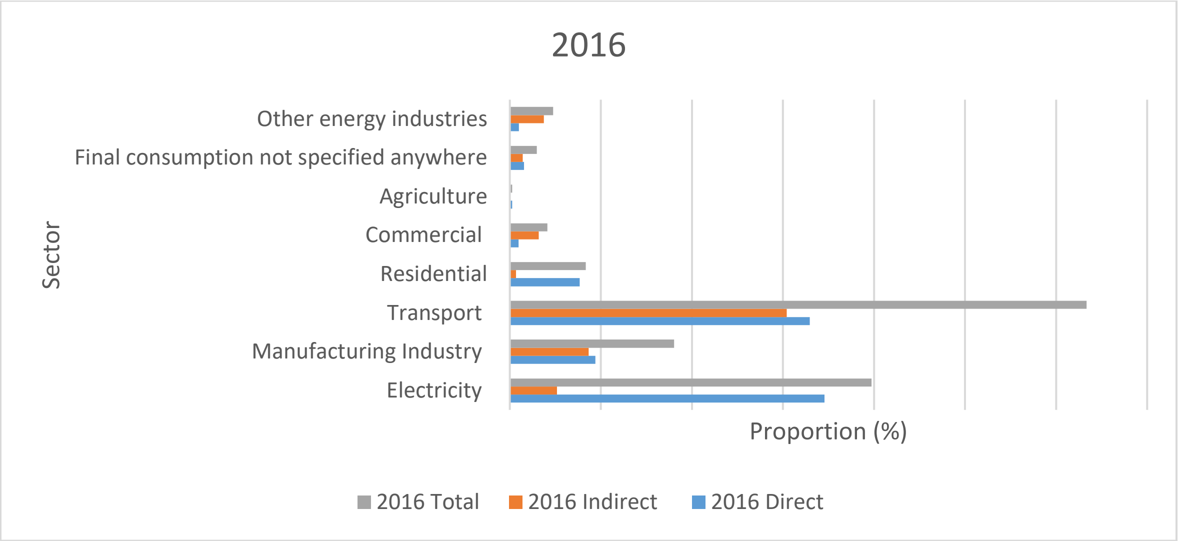

Figure 9: Direct and indirect carbon costs across eight industries, 2016

Source: Author's compilation; Data: KNBS, Economic Survey, 2012–2017

Across all years, Figures 6–9 show consistent dominance of carbon cost exposure in Electricity Supply (Industry 1), Transport (Industry 3), and Manufacturing (Industry 2) consistent with their fossil-fuel intensity. Electricity Supply had the highest carbon-cost-to-value-added ratio at 0.16% in both 2013 and 2014, declining to 0.08% in both 2015 and 2016 attributed to efficiency improvements and fuel diversification. Transport costs rose modestly from 0.11% in 2013 to 0.13% in 2016 as a result of increasing fuel dependence. Manufacturing costs grew slightly from 0.03% to 0.04%, consistent with industrial energy demand expansion. Other sectors such as Residential, Commercial, Agriculture, and Mining remained largely unaffected, recording ratios below 0.02% throughout the period.

Table 5: Carbon Emission Costs Relative to Added Value at USD 43/ton CO_2

	2013	**2014**	**2015**	**2016**
Electricity	0.16%	0.16%	0.08%	0.08%
Manufacturing Industry	0.03%	0.03%	0.04%	0.04%
Transport	0.11%	0.11%	0.12%	0.13%
Residential	0.02%	0.02%	0.02%	0.02%
Commercial	0.01%	0.01%	0.01%	0.01%
Agriculture	0.00050%	0.00%	0.00%	0.00%
Final consumption not specified anywhere	0.01%	0.01%	0.01%	0.01%
Other energy industries	0.010%	0.008%	0.009%	0.010%
Average proportion	0.0420%	0.0434%	0.0356%	0.0354%

Source: Author's computation (KNBS, 2012–2017)

All observed values are far below the 5% competitiveness impact threshold used internationally (EU ETS standard), implying that Kenya's voluntary carbon trading system has had minimal short-term effects on industry competitiveness. The average carbon cost-to-value-added ratio ranged between 0.035% and 0.043% implying low exposure. The percentages are derived by dividing the total cost of carbon by the value added of respective industries as seen in equation 1. Furthermore, the analysis indicate that the transport sector has the highest proportion of carbon emission costs to added value at 0.13% for the year 2016 and still possess negligible impact on industry competitiveness.

4.3 Scenario Analysis at Alternative Carbon Prices

Scenario analysis using 2015 data simulated price levels from US$43 (current average for Kenya's voluntary carbon market price) to US$8,043 per ton and a $20 interval on industry competitiveness. Competitiveness effects remain negligible up to US$ 1,350, but the Transport sector crosses the 5% threshold at US$1,443 per ton, followed by Electricity at US$2,243, and Manufacturing beyond US$5,400. At the extreme level of US$ 8,043 per ton, three sectors (Electricity, Transport, Manufacturing) exceed the threshold and they collectively represent 23.1% of GDP. When the price increases to US$1443 per ton, the value added for affected sectors account for 1.41% of Kenya's GDP but when price increases to US$2243 per ton, their value-added rise to 15.1% of Kenya's GDP. However, such prices are implausible within Kenya's current economic and policy context, where the average effective carbon price (OECD, 2022) is estimated at US$56 per ton. Each US$200 per ton increase in carbon prices raises the competitiveness impact by approximately 1.7%,

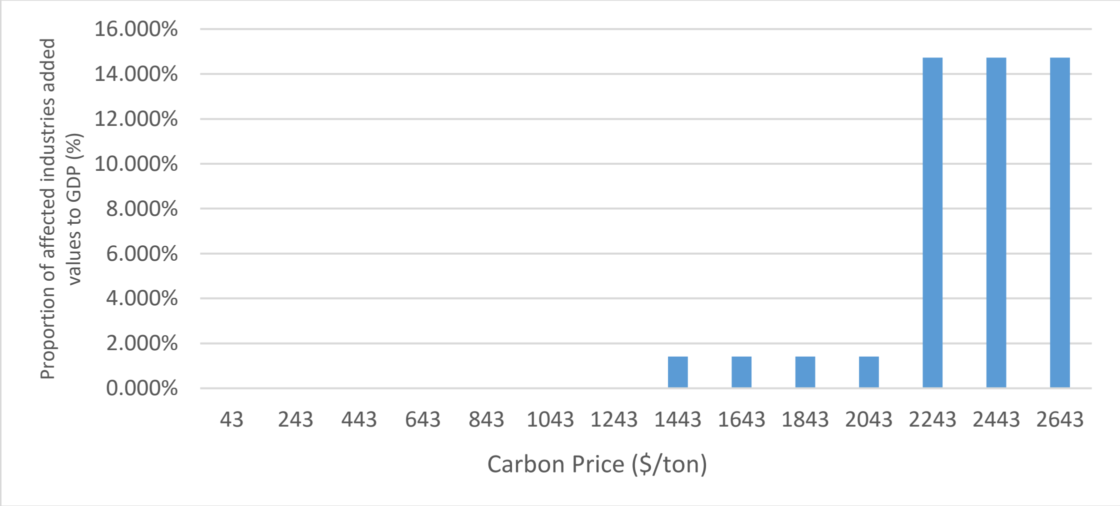

Figure 10: Sensitivity analysis under impact standard of 5%

Source: Own Compilation

4.4 Global Carbon Price Comparisons on Industry Competitiveness

World Bank estimated that to achieve the temperature target of the Paris Agreement, the global carbon price should range between $40 and $80 per ton by 2020. Using the World Bank (2017) global benchmark of US$40–80 per ton, Kenya's industries remain below the 5% impact threshold. When considering the upper limit price, the impact of Kenya's carbon trading system on industry competitiveness is evident. Four industries are affected within the price range of $1443 to $13443 per metric ton using the values of year 2013. However, at theoretical high prices between US$81,443–13,443, Electricity and Transport reach 32.87% and 60.87%, respectively (figure 11 & 12), which are levels that would be implausible under Kenya's current voluntary or emerging compliance markets. At realistic price levels (US$35–55), sectoral impacts remain negligible, with total affected GDP share near zero.

4.3 Industry Competitiveness and Carbon Pricing Trends in Kenya

Figures 11 and 12 illustrate the impact of specific carbon prices on industry competitiveness across key sectors in Kenya for 2013 and 2016. They compare changes in carbon emission costs relative to value added and identifies sectoral differences and how shifts in energy use and pricing affected competitiveness over time.

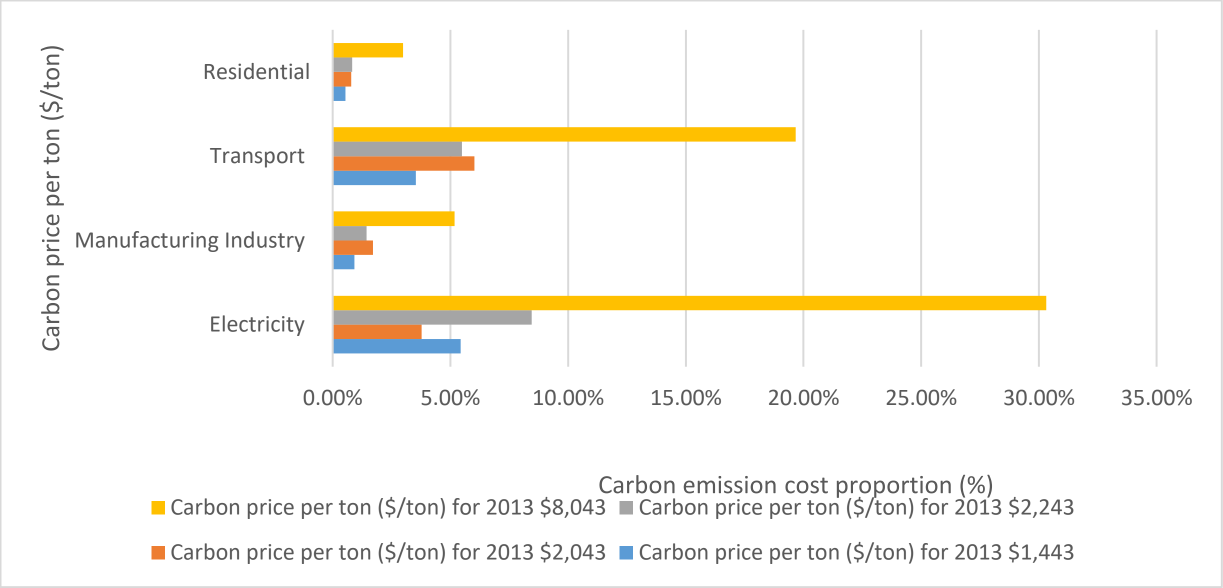

Figure 31: Industry competitiveness impact for various carbon prices for 2013

Source: Own Compilation

Between 2013 and 2016, there were fluctuations in the proportion of carbon emission costs to added value across various sectors. For instance, in the Electricity sector, the proportion decreased from 5.44% in 2013 to 2.67% in 2016, but for Manufacturing, it increased slightly from 0.93% to 1.21% during the same period. Transport sector saw an increase from 3.53% to 4.25%, while Residential sector experienced a slight rise from 0.54% to 0.56%. In 2016, these trends shifted again, with electricity rising significantly to 7.70%, Manufacturing slightly decreasing to 1.32%, Transport decreasing to 4.99%, and Residential also experiencing a slight drop to 0.76%. It is evident the sectors responded differently to changes in carbon price per ton.

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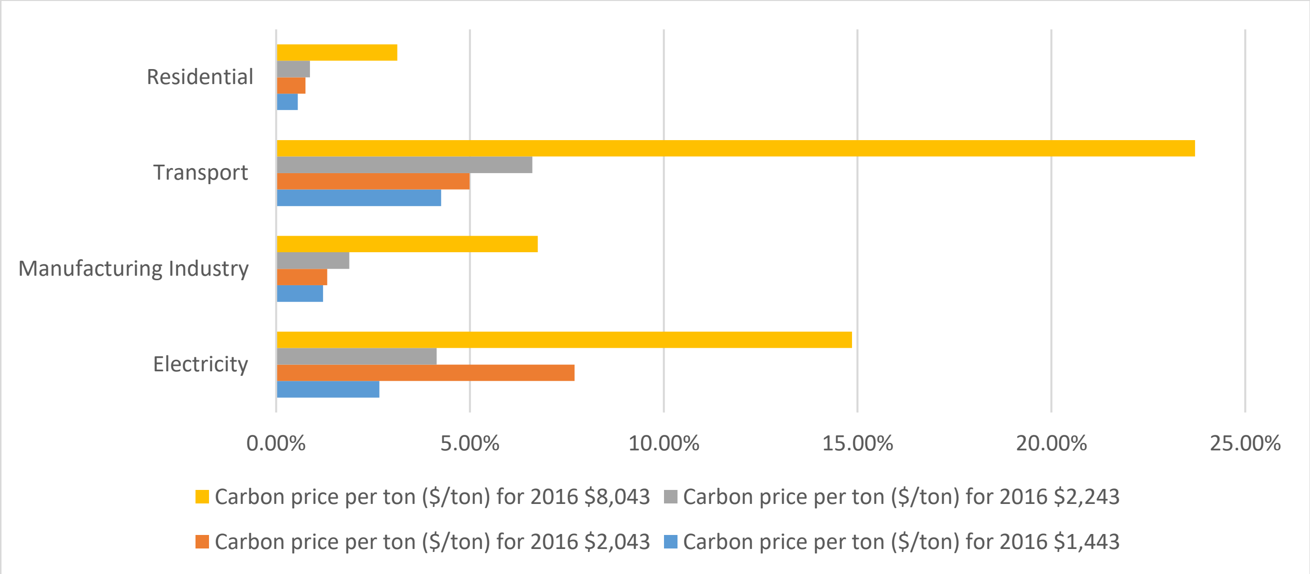
Figure 42: Industry competitiveness impact for various carbon prices for 2016



Source: Own Compilation

4.5. Competitiveness Threshold Estimation

Scenario analysis indicates that an initial rise in the carbon price primarily affects the Transport sector. Thus, to ensure that Kenya's carbon market has a minimal impact on the competitiveness of the 8 selected industries, the carbon price threshold can be determined using the Transport sector as a measure. Therefore, using 2016 data, the Transport sector will define the upper limit of competitiveness sensitivity. A carbon price below US$1,700 per ton yields negligible effects for all sectors, while Transport surpasses the 5% threshold at this level. Thus, USD 1,700 per ton represents a theoretical ceiling for Kenya's CETS to maintain industrial competitiveness under current structures assuming other conditions remain unchanged.

4.6 Sectoral Exposure and Threshold Summary

At US$43 per ton, all sectors remain below 0.2% exposure, far from the global 5% benchmark. Only under extreme price scenarios (above US$1,654) would the Transport and Electricity sectors experience competitiveness risks. This evidence confirms that, at prevailing carbon prices, Kenya's major industries operate far below the vulnerability threshold. Manufacturing, Transport, and Electricity supply sectors, though relatively more exposed, remain competitive due to low effective carbon prices and early energy diversification efforts.

Table 6: Sectoral Exposure to Carbon Costs under Alternative Price Scenarios

Sector	Share of GDP (2016)	Carbon cost / value-added at US$ 43 (2016)	Price (USD/ton CO_2) where 5% threshold is crossed
Electricity supply	9.7%	0.08%	$2,688
Manufacturing industry	11.0%	0.04%	$5,375
Transport (transport, warehousing, postal)	10.0%	0.13%	$1,654
Residential (real estate & construction)	9.0%	0.02%	$10,750
Commercial (financial & insurance)	10.0%	0.01%	$21,500
Agriculture	21.0%	0.00%	N/A
Final consumption not specified (waste & water)	1.3%	0.01%	$21,500
Other energy industries (mining)	2.0%	0.01%	$21,500

Source: Author Own Compilation

5.0 Discussions

This section interprets the findings, explaining how carbon pricing influences Kenya's industrial competitiveness. It assesses sectoral differences, underlying drivers such as energy mix and efficiency, and discusses the broader policy implications for balancing decarbonization with economic growth. The study findings confirm that Kenya's current carbon pricing levels (US$ 35–55 per ton) have negligible effects on industrial competitiveness. The effective carbon cost per sector is less than 0.2% of value added, far below the 5% benchmark used in EU ETS competitiveness studies. The high theoretical price thresholds (US$1,650–2,700 per ton) required to breach the competitiveness benchmark are implausible within Kenya's current policy and market context. Such high carbon prices levels would considerably weaken industry competitiveness and impose severe economic strain and are unlikely within the foreseeable policy horizon. Kenya's carbon market is still voluntary and developing within a low-carbon transition framework that prioritizes efficiency, innovation, and green finance rather than punitive pricing. Therefore, price paths around US$50–US$100 per ton are more realistic and consistent with international guidance on the social cost of carbon and Kenya's developmental trajectory. Moreover, recent reports postulated that the efficient carbon price in Kenya is approximately $56 per ton, according to the social cost of carbon (SCC) analysis by the OECD in 2022. With this price, the impacted industries still fall below the 5% impact standard, and their added values account for 23.1% of Kenya's GDP, low impact on the economy and insignificant for the early development of Kenya's carbon markets. Maintaining a lower carbon price below $1700 is essential to safeguard industry competitiveness and minimize adverse effects on economic development during the initial stages of the carbon market in Kenya. However, to align with international standards and ensure competitiveness relative to other developed countries, Kenya could consider adopting a threshold below 5% as observed in the EU. Given that the majority of global carbon markets operate below $10 per ton, this study utilizes $43 per ton as a reference price for subsequent analyses in the Kenyan carbon market.

The study simulations indicate that fluctuations in the proportion of carbon emission costs to value added in Kenya's electricity sector between 2013 and 2016 is attributed to changes in both energy generation structure and pricing dynamics. The initial decline from 5.44% in 2013 to 2.67% in 2016 can be attributed to the rapid expansion of renewable energy sources (geothermal and wind) which reduced reliance on fossil fuel–based generation. Kenya commissioned several geothermal plants during this period, including Olkaria IV (140 MW) and Menengai projects, which lowered emissions intensity per unit of electricity generated (KenGen, 2016; IEA, 2017). However, the sharp increase to 7.70% in 2016 likely due to higher operational costs and intermittent droughts that reduced hydropower output, compelling utilities to use more thermal generation to meet rising demand. This temporarily increased the carbon cost burden relative to value added. Moreover, Kenya's growing electricity consumption from industrialization and household connectivity expanded generation requirements, amplifying emission cost exposure when fossil-based plants were dispatched to stabilize the grid.

Direct carbon costs, primarily from fossil fuel use in Electricity and Transport, constitute the main competitiveness channel, while indirect costs, linked to electricity consumption in residential and commercial activities, remain minor. These patterns align with evidence from other emerging carbon markets (e.g., India and Vietnam), where industrial exposure is initially low due to limited price transmission and weak compliance enforcement. While manufacturing and transport showed a higher relative exposure due to fossil-fuel intensity and logistics dependence, their absolute burden remains marginal. The Electricity sector's declining cost share indicates early adaptation through power mix changes and efficiency gains consistent with studies by Li & Qin (2025) postulating that Electricity sector's carbon-cost share can decline with efficiency gains and cleaner power sources. These results are consistent with study by China's provincial carbon emission trading policy (2024) which found that implementation of Emission Trading Strategy significantly reduces emissions and that sectors with high energy intensity (Electricity, Transport) show more exposure. Agriculture which is the largest GDP contributor recorded an almost negligible cost ratio, which further implies that the current carbon pricing does not threaten Kenya's macroeconomic competitiveness. At the inception of voluntary carbon trading system in 2014, regulated industries primarily included cement, petrochemicals, electricity, and transport, consistent with global patterns where emission-intensive and trade-exposed sectors face initial regulation. Over time, indirect cost transfers, generated through electricity used in commercial and residential activities, added minor burdens, though still below global thresholds. Therefore, voluntary carbon trading in Kenya had an insignificant impact on the industry competitiveness of regulated industries.

Policy-wise, the results support the need for a gradual price escalation strategy integrated with complementary levers such as energy efficiency upgrades in manufacturing and transport fleets; Fuel switching to lower-carbon alternatives such as natural gas and biofuels; and Power mix diversification through renewable energy integration. Such measures will enhance competitiveness resilience as Kenya transitions toward a regulated carbon market under the Climate Change (Amendment) Act 2023. Maintaining prices below USD 1,700 per ton during the early CETS phase will safeguard industrial performance while signaling credible progress toward decarbonization. Furthermore, if done right, carbon credits present a fresh economic opportunity. The amendment Act 2023 governing the production of carbon credits will ensure that carbon credit revenues are transparent, equitable, and create good jobs (Pagop & Savard, 2024; Brookings, 2024). These will further support blue-carbon projects in Kenya that underpin voluntary market pricing and local revenues (Keys et al., 2015; Reach Alliance, 2023)

6.0 Conclusion

This study analyzed Kenya's carbon market and its impact on industrial competitiveness using data from eight key industries namely manufacturing, transport, energy, construction, agriculture, services, trade, and mining from the period 2013 to 2016. These sectors account for over 60% of GDP and more than 90% of national emissions. Manufacturing, energy, and transport were identified as the most carbon-intensive sectors due to heavy fossil fuel reliance, while agriculture and services showed minimal exposure. At the benchmark carbon price of US$ 43 per ton, carbon costs represented less than 0.2% of sectoral value added across all sectors, which is well below the 5% competitiveness risk threshold. Sensitivity tests showed that competitiveness would only be threatened under very high prices: transport at USD 1,650/ton, electricity at USD 2,700/ton, and manufacturing at USD 5,400/ton. These findings contrast with Wei & Wang (2025) implying transport was not first to cross the 5% threshold in China when prices rise steeply. These figures imply that Kenya's current voluntary market poses negligible short-term competitiveness risks. Maintaining carbon prices below USD 1,700/ton will safeguard industries as the market matures. Sectoral variations were evident. Electricity, manufacturing, transport, and residential sectors showed mild sensitivity to carbon cost fluctuations, contributing roughly 39.7% of GDP. Agriculture, contributing 21% of GDP, remained largely unaffected which further confirms the limited macroeconomic impact of Kenya's nascent carbon trading framework. Direct costs were higher in energy, transport, and utilities, while indirect costs were notable in manufacturing, mining, and services due to electricity and heat use.

To sustain competitiveness, three measures are essential. First, integrate the voluntary carbon emissions trading system with complementary energy policies such as fuel levies to enhance efficiency and leverage synergies with fuel, electricity, and industrial reforms. Second, align carbon prices with sectoral resilience, maintaining them below USD 1,700/ton and introducing differentiated pricing for industries and regions to prevent economic strain. Third, apply the principle of common but differentiated responsibilities, adapting global carbon pricing norms to Kenya's development context. Policy recommendations include: (i) gradual carbon price increases aligned with sector capacity, (ii) targeted sector-specific interventions such as energy efficiency upgrades and electrification of transport, (iii) transitional free allowances and offset programs, (iv) support for innovation in clean technologies, and (v) continuous monitoring to ensure competitiveness.

We can conclude by saying that Kenya's carbon pricing, at current levels, exerts minimal pressure on industry performance. A gradual, well-calibrated carbon pricing pathway, integrated with energy, fiscal, and industrial strategies, will enable Kenya to achieve low-carbon growth without compromising competitiveness or economic resilience.

7.0 Limitations and Future Research

This study is limited by its reliance on secondary data and modeling assumptions that approximate carbon prices and industry competitiveness under Kenya's emerging carbon market framework.

The absence of a fully operational Carbon Emissions Trading System (CETS) restricts the availability of empirical data on actual trading behavior, firm-level emissions, and compliance costs. Moreover, the use of benchmark pricing scenarios (USD 35–55) may not assess long-term market volatility, cross-border credit dynamics, or technological adaptation within firms. Future research should integrate firm-level data once Kenya's CETS becomes functional, incorporate dynamic modeling of carbon leakage and innovation effects, and examine how complementary fiscal policies such as green subsidies or energy tax reforms can mitigate competitiveness risks while accelerating industrial decarbonization.

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