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Strategic Adaptation to Carbon Border Adjustments Mechanism: A Case Study of Tata Steel

Dr. Ekta Kumawat[1*] | Prof. Shurveer Singh Bhanawat[2]

[1]Assistant Professor, Faculty of Commerce, Parul University, Vadodara, Gujarat, India.
[2]Head and Dean, Department of Accountancy and Business Statistics, University College of Commerce and Management Studies, MLSU, Udaipur, Rajasthan, India.

[*]Corresponding Author: ektakumawat38@gmail.com

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ABSTRACT

This study explores Tata Steel's strategic response to the European Union's proposed regulation Carbon Border Adjustment Mechanism that will charges levied on imported goods based on their carbon emissions during their production. This study employs case study method to assess Tata Steel's CBAM-aligned strategic, technological, and supply-chain adaptations. The findings suggest that switching to more carbon-efficient methods, such as EAF-based technology (0.6–1.7 tCO_2/t), from BF-BOF (2.3–2.6 tCO_2/t), when carbon prices of €60–€100 per tonne become effective, can significantly mitigate CBAM cost risk. It also finds that low-carbon investments will help develop long-term resilience for Tata Steel but greater dependence on technology to reduce carbon emissions will increase its export costs by about 25-45%.

***Keywords**: CBAM, Decarbonization, Strategy, BF-BOF, EAF, CO2 Emission.*

Introduction

The European Union's Carbon Border Adjustment Mechanism (CBAM) represents a transformative development in international climate policy, primarily changing competitive dynamics in carbon-intensive industries (European Commission, 2021). CBAM is charges levied on imported goods based on the carbon emission during their production. It designed to prevent carbon leakage by ensuring imported products face carbon costs equivalent to domestic production. CBAM initially applies to imports of six carbon-intensive goods at highest risk of carbon leakage i.e. cement, iron and steel, aluminium, fertilizers, electricity and hydrogen (European Commission, 2024). CBAM requires careful attention to ensure that extra costs faced by these industries in the European Union do not cause relocation of production to regions with little or no cost of emitting CO2.

The steel industry is a significant contributor to global carbon emissions, making up about 7 to 9% of total GHG emissions. In India the steel industry's emission intensity is quite high, averaging 2.55 tCO_2 per tonne of crude steel. The figure exceeds the global average of 1.85 tCO_2 per tonne of crude steel. Around 27% ($2.7 billion) of India's iron ore pellets, iron, steel, and aluminium products are destined for EU markets. According to the World Bank's CBAM Exposure Index, India ranks at the top among affected countries due to its high volume of steel exports to the EU and high greenhouse gas emissions intensity of steelmaking (Maliszewska, Chepeliev, Fischer, & Jung, 2023).

This study examines Tata Steel Limited's strategic adaptation to CBAM requirements through case study. The reason for selection of Tata Steel is as it is one of India's largest steel manufacturers achieved a record of 20.8 million tonnes of crude steel production for the fiscal year 2023-2024 (Tata Steel, 2024). It is position as a major global steel producer with dual exposure to CBAM requirements, both as an exporter to and producer within the EU. The company is also committed to reducing its CO_2 emissions intensity below 2 tCO_2 per tonne of crude steel by 2025, and to achieve net zero emissions by 2045. These ambitious targets signal the proactive action Tata Steel is taking toward matching international standards on sustainability and changing trade policies such as the CBAM. This research helps in strategic management by showing dynamic capabilities and resources-based sustainability transitions, and it also offers useful practical insights for industry experts and policy maker.

Research Objectives

- To assess Tata Steel's CBAM-aligned strategic, technological, and supply-chain adaptations.
- To examine its low-carbon investment strategy and innovation portfolio.
- To evaluate the financial implications of CBAM on its competitiveness and resilience.
- To analyse its stakeholder engagement and industry leadership in carbon-regulated markets.
- To develop evidence-based recommendations that strengthen competitive position while adapting global decarbonization pressures.

Theoretical Framework

This research implements Institutional Theory with Strategic Adaptation Theory. By adopting these theories this case study addresses the Tata Steel's strategic decisions for policy commitment to reduce the intuitional pressure for low-carbon steel-making, supply chain management and carbon-constrained global market.

Review of Literature

- **Carbon Border Adjustments in International Trade Policy**

Carbon border mechanisms address carbon leakage concerns arising from asymmetric climate policies across jurisdictions (Cosbey et al., 2019). Some empirical studies show that certain approaches can help reduce carbon leakage, but these approaches raise concerns about trade restrictions and their impact on economic growth (Mehling et al.,2019). Recent policy developments reflect the expansion of global adoption of carbon border adjustments beyond the EU, with the UK planning implementation by 2027 and other jurisdictions considering similar measures. This ensures that strategic planning is essential for multinational enterprises operating in different regulatory environments.

- **Steel Industry Decarbonization**

The steel industry accounts for producing approximately 7-9% of total CO2 emissions, therefore climate policy interventions are crucial (World Steel Association, 2023). The methods to decarbonise steel production include improving energy efficiency and production processes through alternative energy sources and technologies such as hydrogen direct reduction and carbon capture and utilisation (Bataille et al., 2018).

The steel sector will require substantial capital investment and a long time to develop and implement new production technologies. The lag between development of regulations/standards and commencement of capital investment by steelmakers further emphasizes the need for significant strategic decisions.

- **Regulatory Strategy**

Multinational corporations function in many regulatory contexts and are faced with strategic choice decisions in relation to the allocation of resources, technology adoption and positioning in the marketplace (Kostova & Zaheer, 1999).

The regulatory strategy literature emphasizes active engagement with regulatory processes and the development of organizational competencies for managing compliance across multiple jurisdictions (Bonardi et al., 2005). Recent research shows the importance of regulatory arbitrage opportunities as well as the ability to build transferable competencies that generate value across various institutional contexts.

Research Gap and Need for Case Study

Existing studies focus on the macroeconomic modelling aspect of CBAM rather than emphasis on how companies will respond operationally and how they are considering technology and strategic adjustments. (Bellora 2023; Amendola 2025). This gap encourage research on how established multinational steel producers particularly Tata Steel, will comply with the CBAM Policy through technological adoption and strategic restructuring as their pattern of responses might provide insight how globally integrated producers manage to reduce carbon emissions while maintaining competitiveness.

Research Methodology

This research uses a qualitative case study methodology with a single-case underlying design with multiple units of analysis. Data were collected from various sources, including corporate sustainability reports, regulatory filings, investor communications, press releases, industry reports, and Tata Steel's regulatory guidance documents. The analytical framework uses process-tracing methodology to investigate the sequence of strategic decisions and organisational change made by Tata Steel in their adaptation to CBAM legislation.

Case Study: Tata Steel

- **Organizational Context and Strategic Position**

Tata Steel Limited, founded in 1907, operates as one of the world's most geographically diversified steel producers with operations throughout India, Europe and Southeast Asia, with an annual production of 35 million tonnes in India (13+ million), Europe (10.5+ million) and SEA (1.8 million). Tata Steel's global presence brings unique strategic challenges for CBAM compliance across multiple authorities.

The company's strategic positioning reflects its innovation from a cost-focused emerging market producer to a quality-oriented global leader with strong sustainability credentials. Tata Steel has been recognized by World Steel as a Steel Sustainability Champion 2024 for the seventh succeeding year, indicating industry leadership in environmental performance (Tata Steel, 2024).

- **CBAM Regulatory Framework and Compliance Requirements**

The implementation of the CBAM occurs in two phases. The transitional period (October 2023-December 2026) requires CBAM reporting on a quarterly basis and no financial obligation during that time. The full implementation phase (January 2027 onwards), mandatory purchase of CBAM certificate based on the amount of carbon embedded.

Steel products that CBAM covers, includes hot-rolled flat products, cold-rolled flat products, stainless steel products, coated flat products, and the merchant bars as classified based on the Combined Nomenclature (CN) system. For CBAM compliance, Tata Steel requires to calculate the total amount of embedded carbon emissions from the production include all Scope 1 (direct) emissions related to the production process and Scope 2 (indirect) emissions related to the electricity consumed during production. Thus, it will result in an additional cost for Tata Steel related to its steel exports to the EU.

- **Current Carbon Footprint and Technology Assessment**

Tata Steel utilise diverse technologies to produce steel, with different carbon intensity levels. In India, Tata Steel produces steel using blast furnace-basic oxygen furnace (BF-BOF) technology, which has an estimated carbon intensity of 2.2-2.5 tonnes of CO_2/ tonne of crude steel produced. European operations combine BF-BOF and electric arc furnace (EAF) technologies achieving lower carbon intensity of 1.8-2.1 tCO_2/tonne through higher recycled steel inputs and EU ETS integration. The company reports emission intensity based on World Steel Association guidelines derived from GHG Protocol methodology, enabling comparison with industry benchmarks and CBAM default values (Tata Steel, 2024). Corporate commitments include net-zero emissions by 2045, intermediate targets of <2 tCO_2/tonne crude steel by 2025, and regional differentiation with European operations targeting 30-40% emission reductions by 2030.

Strategic Framework

- **Organizational Adaptation**

As part of its plans for the EU's CBAM starting in 2026, Tata steel has built a robust carbon governance framework based largely on its current reporting commitments to embedded emissions from India and other countries. In preparation for the CBAM, Tata has developed several carbon accounting and transition plans based on feedback from their Sustainability Committee and Net Zero Task Force. Tata Steel also developed an Internal Carbon Price (ICP) plan that priced carbon at levels they expect the EU CBAM Certificates to trade at, between €60 and €90/tCO2 (IEA, 2023). And Tata's Climate Change report 2023-24 indicates total consolidated emissions of 56.01 $MtCO_2$ (Scope 1), 7.02 $MtCO_2$ (Scope 2) and 18.43 $MtCO_2$ of emissions from accurately measured at a CBAM baseline emitter having a 'standard' carbon intensity of 2.23 tCO_2/t crude steel (Tata Steel, 2024).

- **Technology Portfolio and Innovation Strategy**

Technological decarbonization stands at the centre of the CBAM alignment route to sustainability of Tata Steel. Tata is shifting from BF-BOF technologies to EAF and hydrogen-based direct reduced iron (H_2-DRI) technologies to convert emissions during steel production. In March of 2024, Tata executed a €1.25 billion agreement with Tenova S.p.A, for a €3 MTPA EAF facility at Port Talbot (UK), which is expected to decrease emissions at the site by ~90% from legacy operations (Reuters, 2024). At its Jamshedpur Works, Tata Steel has also begun to investigate pilot trials of BF injection with hydrogen enrichment and CCUS and aims to achieve a carbon emissions reduction of 1 $MtCO_2$ per annum by 2030 (Tata Steel 2024). In addition, Tata Steel has designed a new digitally-enabled monitoring, reporting and verification (MRV) systems using AI and IoT technologies (with blockchain traceability), that will combine with ISO 14067 life cycle assessment approaches in order to enable verifiability and transparency for the information included in the CBAM (World Steel Association 2024). Tata Steel becomes the first Indian steel maker to introduce ***biochar*** to lower carbon emissions, demonstrating commitment to innovative decarbonization approaches (Tata Steel, 2024).

- **Supply Chain Integration**

The corporation's green procurement strategy focuses on sourcing low embodied carbon gasses (DRI, scrap and green coke), while also forming a partnership with John Cockerill India to ensure hydrogen generation and DRI plant engineer related engineering occurs locally, instead of being reliant on carbon intensity intermediaries imported into India (John Cockerill, 2025). Furthermore, Tata Steel is also trialling bio-LNG and green methanol based maritime transport and aims to have a 15-20% reduction in the CO_2 intensity of logistics by FY2026 (Tata Steel, 2024).

- **Investment Strategy and Innovation Portfolio**

Tata Steel pursues decarbonization through capital restructuring and technology transitions designed to reduce CBAM exposure while aligning with national climate policy. For this purpose, Tata Steel announced a decarbonization investment of £1.25 billion at Port Talbot in the United Kingdom, with a £500 million grant from the UK Government. This investment will involve transitioning from their legacy blast furnace-basic oxygen furnace facilities toward a 3 MTPA electric arc furnace operation in FY 2027-28, (Tata Steel, 2024). This asset transformation is expected to produce an emissions reduction of 4.5-5 $MtCO_2$ directly, and ultimately will reduce carbon intensity at the site by ~90% versus baseline operations. Additionally, Tata Steel Nederland's Green Steel Plan (€2.3 billion) involves the implementation of H_2-DRI technology with the EAFs to reduce 5 $MtCO_2$ by 2030, supported by the EU Innovation Fund and Dutch government. In India, it is building a new EAF facility at Ludhiana, which will be scrap based (0.75 MTPA), while also increasing existing renewable energy projects (with plans for 70 MW of solar energy) to decrease Scope 2 emissions. The company operates an Internal Carbon Pricing (ICP) mechanism—running at approximately $50-100 per tCO_2 for capital allocation purposes—this will be applied to all high-transition risks.

- **Financial Impact Assessment**

Tata Steel is planning to invest substantial capital in CBAM compliance and future savings from a cost perspective. According to Tata Steel's 2023-24 Integrated Report, sustainability-linked capital expenditures during the period under report were ~₹16,911 crore (~€1.9 billion), of which 28% was directed at emission reductions and circular economy efforts (Tata Steel, 2024). For example, Tata Steels global GHG intensity is ~2.23 tCO_2/t crude steel, meaning a carbon embedded cost for export steel of €190-€220/t at a CBAM carbon price of €85/tCO_2. If EAF and H_2-DRI technology is implemented, costs are expected to be lowered to ~€60-€90/t, which would increase EU export competitiveness by ~35-45%. The risks associated with the transition to EAF and H_2-DRI may lie in the price of hydrogen, availability of hydrogen, and thereby loss of value of the asset when the bifurcated BF retirements qualify. Financial modelling revealed by the company to its investors in 2024 indicates that decarbonization will yield NPV benefits, via avoided penalties and market access preserved through EU public procurement policies mandating low carbon materials, for CBAM, of 8-12% (Tata Steel, 2024 and Reuters 2024).

- **Stakeholder Engagement and Industry Leadership**

Tata Steel has positioned itself as a leader in CBAM preparedness through active collaboration, policy advocacy, and value chain integration. The company works with international organizations as its members such as the Step-Up Programme (World Steel), Responsible Steel, and the WEF Net Zero Industry Accelerator, on issues such as developing transparency and standardizing data related to emissions and producing carbon footprints for products to conform with EU Regulation 2023/956. The company further collaborates with leading technology providers such as SMS Group, Tenova, and John Cockerill on pilot projects generally involving hydrogen steel-making, carbon capture technology and electric steelmaking. Tata Steel is actively involved with European and UK government bodies, including DG-CLIMA (EU), DESNZ (UK), and the Ministry of Steel India, in addition to representing the Indian iron and steel industries through industry organizations such as CII, FICCI, and EUROFER, to create a balanced carbon policy and provide strategies for carbon leakage risk. Tata Steel has established both an Environmental Product Declaration (EPD) and Vendor Sustainability Index (VSI), which encompass more than 65% of Tata Steel suppliers, placing the company in a position to drive consistent carbon accounting and sustainable collaboration throughout its global value chain.

Discussion

Tata Steel is focusing its CBAM strategy in three main areas, including decarbonizing processes, integrating digital monitoring-reporting-verification (MRV), along with optimizing the costs associated with carbon. Tata Steel will reduce its CO^2 emissions 45-55% by using Direct Reduced Iron (DRI) or Hydrogen Direct Reduced Iron (HDRI) instead of traditional Blast Furnace/ Basic Oxygen Furnace (BFBOF), which produces 2.3-2.6 Metric Tons of CO^2/Tonne of Steel produced. Tata Steel will leverage synergies with other initiatives such as carbon capture utilisation and storage (CCUS), waste heat recovery and renewable electricity substitution through MRV compatible systems.

By reducing the carbon emissions to nearby 2.35 tCO_2/t, which is below the global average of 2.6 tCO_2/t, Tata Steel can achieve an approximate exposure of ₹25 per tonne of carbon emissions under the current price of carbon at €100. This will enhance Tata Steel's competitiveness in the export market by leveraging GreenPro certification along with blockchain technology that tracks carbon and linking environmental, social, and governance (ESG) compliance to its operations. The Internal Carbon Pricing (ICP) serves as a key driver of Tata Steel's success; through the implementation of shadow carbon pricing in capital budgeting and pricing processes.

Conclusion

Tata Steel's response to the proposed EU CBAM demonstrates how regulatory compliance, technology innovation, and competition amongst carbon-constrained economies are interconnected. By utilizing complex emissions accounting systems such as digital MRV systems and adopting hydrogen-based DRI–EAF methods, Tata Steel is utilizing CBAM alignment as a means of strategic innovation instead of being a cost of compliance. Additionally, Tata Steel's strategic alignment with CBAM is partially articulated through their participation in various policy themes centred on harmonization with many jurisdictions and the use of ICP and product-level embedded emissions accounting indicate their capacity for institutional learning/adaptive governance with regard to the complexities of carbon border issues. Collectively, the data supports that CBAM compliant industry strategies embedded within data driven decarbonization systems provide a first mover advantage in carbon efficiency, transparency of supply chains, and regulatory credibility. Therefore, Tata Steel serves as a potential model for multinational businesses looking to account for trade exposure, emission intensity and compliance costs in relation to compliance requirements pertaining to carbon adjusted global trade systems.

Practical Implications

This case study provides effective methods to industry practitioners that can assist when preparing a strategic plan in an uncertain regulatory environment, such as investment strategies for technology portfolios, an engagement plans for stakeholders, as well as developing capabilities within an organization. The study also highlights the need of compatible Emissions Trading System (ETS) and carbon credits recognition to prevent double counts of carbon credits.

Limitations and Future Research

This study is limited in time, scope, and its ability to generalize because it was based solely on publicly-available data. Subsequently, future studies should examine case studies across different emerging markets as well as conduct quantitative modelling to estimate the carbon costs, cost of decarbonisation, and technology diffusion through a global carbon trading system.

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