



# Climate Change and Supply Chain Crossroads: Thailand's Carbon Footprint Dilemma in Global Trade

Yuan Li <sup>a</sup>, Liwei Liu <sup>a</sup>, Lu Guo <sup>a, b, c 3</sup>

<sup>a</sup> School of materials and energy, Yunnan University, Kunming 650091, China


<sup>b</sup> School of engineering, Yunnan University, Kunming 650091, China.

<sup>c</sup> Yunnan Key Laboratory of Carbon Neutrality and Green Low-carbon Technologies, Yunnan University, Kunming 6500504, China.

**Abstract:** As a critical node in global supply chains, Thailand confronts intensifying dual challenges in its export-driven economic growth and carbon-intensive industrial structure: fulfilling its 2050 carbon neutrality pledge while maintaining export competitiveness under international climate policies. This study systematically investigates Thailand's dual challenges in reconciling international trade imperatives with climate change mitigation obligations while proposing an institutional framework to navigate carbon trade barriers. The analytical framework

<sup>3</sup> Corresponding email: luguo@ynu.edu.cn (L. G). Lu Guo, Yuan Li and Liwei Liu contributed equally to this work.

comprises three specific interlocking strategic pathways: (1) establishing carbon data sovereignty to resolve epistemic asymmetry; (2) implementing industrial symbiosis mechanisms for circular network transition; (3) forging south-south climate governance coalitions to reshape global norms. These strategies aim to reconcile economic sovereignty with climate accountability, offering a framework for emerging economies navigating supply chain repositioning under net-zero transitions.



**Keywords:** Carbon neutrality, global supply chains, carbon footprint, climate change, **decarbonization**

Climate change stands as an existential crisis confronting all humanity, destabilizing ecosystems, economies, and livelihoods with unprecedented speed and scale (Urban, 2024; Yang et al., 2024). In response to this planetary emergency, Thailand announced its decarbonization strategy during COP26 (the 26th United Nations Climate Change Conference) in Glasgow, outlining phased targets: reaching peak carbon emissions before 2030, transitioning to carbon-neutral status by mid-century (2050), and ultimately realizing net-zero emissions across all greenhouse gases by 2065 (Pongthanasawan et al., 2023; Rajbhandari et al., 2022; Rajbhandari et al., 2023). Thailand has undertaken proactive steps to mitigate climate consequences by operationalizing multilateral environmental commitments. This includes executing a strategic Nationally Determined Contribution (NDC) implementation plan aligned with Paris Agreement obligations, developing sector-specific Nationally Appropriate

Mitigation Action (NAMA) frameworks for emissions reduction, and enhancing adaptive capacities across societal domains (Chontanawat et al., 2020a; Pongthanasawan et al., 2023; Rajbhandari et al., 2022). While, as a critical node in global supply chains, Thailand faces intensifying dual challenges in reconciling its international trade-driven economic growth with its carbon-intensive industrial framework, particularly in areas such as agriculture, automotive, and electronics (Raihan et al., 2023; Rajbhandari et al., 2023). Nowadays, amid the profound restructuring of the global climate governance system, international carbon barriers have evolved into a novel strategic instrument in trade competition. Hence, reconciling Thailand's responsibilities in carbon emission reduction and climate change mitigation with its economic growth through international trade has emerged as a pressing challenge demanding immediate strategic solutions.

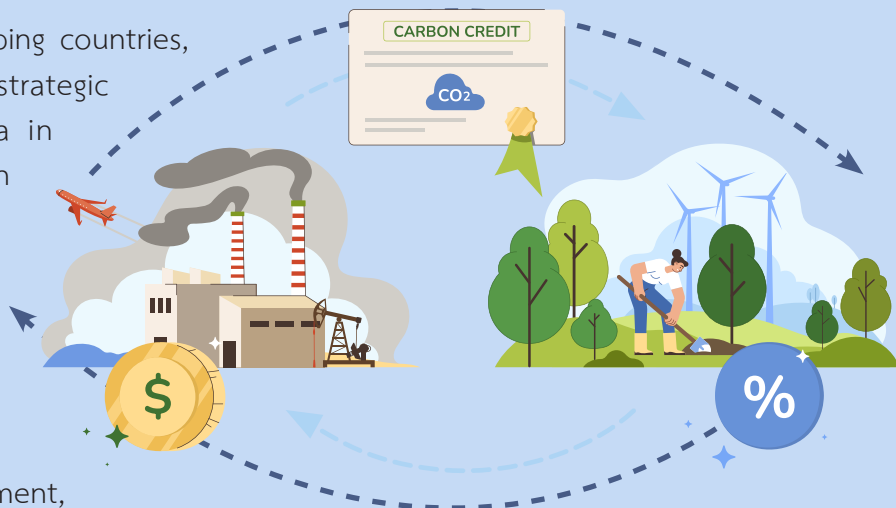


## 1. The diploma between sustaining international trade growth and fulfilling Thailand's carbon neutrality commitment

As with most developing countries, Thailand confronts a strategic governance dilemma in reconciling climate action imperatives with trade expansion objectives. To operationalize its 2050 carbon neutrality pledge

under the Paris Agreement,

the nation has instituted a multi-pronged decarbonization framework comprising six strategic priorities: (1) energy efficiency enhancement; (2) electrification acceleration; (3) renewable energy infrastructure scaling; (4) green hydrogen deployment; (5) bioenergy with carbon capture and storage (BECCS) integration; and (6) socio-technical transition facilitation through behavioral interventions (Adebayo et al., 2024; Chontanawat et al., 2020b; Raihan et al., 2023). Research indicates that Thailand's participation in global trade has played a pivotal role in stimulating its economic development. However, the nation's increasing integration into the global economy has been found to exert measurable impacts on carbon emission patterns (Hussain et al., 2021). Comprehensive analysis reveals that the combined influence of globalization processes and natural resource utilization demonstrates complex, non-linear relationships with environmental indicators. These interconnections may inadvertently undermine climate change mitigation efforts, particularly when considering threshold effects in ecological systems (Rajbhandari et al., 2022).







Besides, the full implementation of the Carbon Border Adjustment Mechanism (CBAM) signifies the advent of a new era in international trade rules characterized by the “embedded climate dimension” (Goldthau & Hughes, 2020). Carbon footprint metrics have emerged as a critical determinant of trade competitiveness, with their influence expanding exponentially since the Paris Agreement’s ratification. This paradigm shift is epitomized by the CBAM, which has necessitated carbon footprint transparency across 12 industrial sectors, potentially affecting most of Thailand’s manufacturing exports, including the automotive industry, electronics sector, and related supply chains. Consequently, establishing systematic carbon footprint accounting and certification mechanisms has emerged as a strategic priority for Thailand, not only to enhance the global competitiveness of its export-oriented products but also to align with international climate governance frameworks.



## 2. Thailand’s international trade and carbon footprint barriers: key challenges

### 2.1 Data silos and certification barriers

This challenge primarily stems from two systemic deficiencies: fragmented carbon accounting systems across Thailand’s supply chains (particularly in agricultural and manufacturing sectors), coupled with inadequate international mutual recognition mechanisms for carbon certification. The lack of a standardized national carbon footprint database can be attributed to three core insufficiencies: (1) inconsistent data collection protocols across supply chain tiers; (2) Opaque corporate emission reporting with limited auditability; (3) Absence of accredited

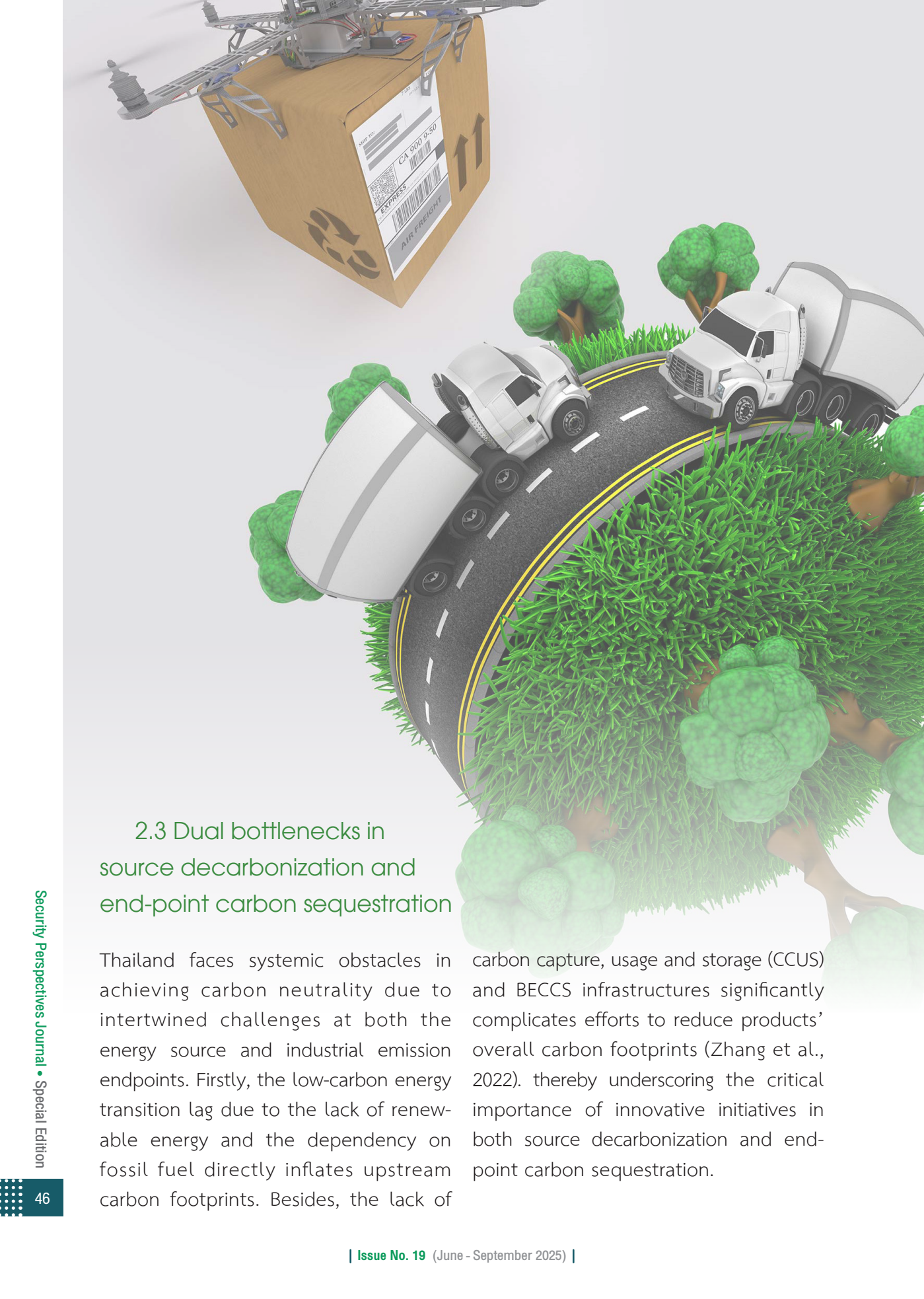
third-party verification infrastructure. This systemic fragmentation prevents Thailand’s carbon accounting outcomes from achieving interoperability with dominant frameworks like the EU CBAM, thereby amplifying green trade barrier risks. Compounding this challenge, most of Thai exporters currently depend on foreign databases (e.g., ecoinvent) that embed regionally biased emission factors, resulting in distorted carbon cost allocations unfavorable to Thailand’s trade competitiveness.

## 2.2 Lack of innovation in low-carbon technology and circular economy

Thailand faces critical challenges in advancing its circular economy due to insufficient innovation in low-carbon technologies. The delayed adoption of cutting-edge green technologies has exacerbated industrial transition bottlenecks of Thailand, particularly in sectors positioned as national priorities. While Thailand aspires to become a regional hub for electric vehicle (EV) production, its reliance on imported technologies and slow pace of industrial upgrading threaten to erode competitiveness in the global green trade arena. The EV industry, a cornerstone of Thailand's economic strategy, struggles with technological dependency, limiting its ability to meet evolving international standards for carbon efficiency and recycled material integration. Simultaneously, Thailand's circular economy framework suffers from systemic

innovation gaps in critical resource recovery systems. For example, lithium battery and plastic recycling technologies remain underdeveloped. These shortcomings not only hinder domestic sustainability goals but also expose export-oriented industries to emerging trade barriers. Major markets, including the EU and North America, are increasingly mandating recycled content thresholds and stringent carbon footprint certifications for imported goods, requirements that Thailand's current technological capacity struggles to fulfill. Therefore, strategic investments in localized R&D, cross-sector collaborations, and policy frameworks aligning industrial growth with circular principles will be essential to transform these constraints into competitive advantages.





### 2.3 Dual bottlenecks in source decarbonization and end-point carbon sequestration

Thailand faces systemic obstacles in achieving carbon neutrality due to intertwined challenges at both the energy source and industrial emission endpoints. Firstly, the low-carbon energy transition lag due to the lack of renewable energy and the dependency on fossil fuel directly inflates upstream carbon footprints. Besides, the lack of

carbon capture, usage and storage (CCUS) and BECCS infrastructures significantly complicates efforts to reduce products' overall carbon footprints (Zhang et al., 2022). thereby underscoring the critical importance of innovative initiatives in both source decarbonization and end-point carbon sequestration.





### 3. Navigating the dual imperatives: pathways for Thailand to balance international trade dynamics and climate action

#### 3.1 Establish a national carbon data sovereignty system


Firstly, developing a comprehensive carbon footprint factor database covering agriculture, manufacturing, energy, and other related sectors. Track carbon emission data flows of key industrial products to create a regionalized baseline factor database for Thailand's priority products and promote international mutual recognition. Developing localized carbon accounting methodologies for featured products in Thailand. Creating product category rules (PCRs) tailored to tropical agriculture (e.g., rice cultivation), cross-border electricity (Laos hydropower with ecological weighting factors), and rubber supply chains. Aim to establish international standards to strengthen the export competitiveness of Thai products. Meanwhile, building a blockchain traceability system. Implement digital carbon passports for export goods to record carbon trajectories from raw material extraction to end consumption. The establishment of a credible life cycle carbon footprint database will significantly reduce the complexity of international carbon data mutual recognition, thereby enhancing the international trade competitiveness of Thai export products.

Besides, lead regional carbon standard mutual recognition alliance. Collaborate with ASEAN nations to harmonize product categories (e.g., automobiles, focusing on: (1) cross-border renewable



carbon accounting rules for key electronics, agriculture products), energy accounting via applying





ecological impact adjustment factors for Laos hydropower, distinct from conventional grid emission factors; (2) tropical agricultural carbon offsets: integrate rainforest conservation carbon sinks into the carbon footprint deduction systems for palm oil, rubber, and other products.

### 3.2 Low-carbon closed-loop restructuring of key industries

Constructing a leading industrial symbiosis network: the EV production chain as an example. Establish battery recycling clusters in the Eastern Economic Corridor (EEC), adopting advanced lithium battery recycling technologies (e.g., hydrometallurgical and electrochemical processes). Implement a battery passport system to trace critical mineral sources (lithium, cobalt, nickel). Promote chemical recycling innovations for plastics and agricultural waste reuse technologies (Niyommaneerat et al., 2023). Partner with countries like China to establish an ASEAN Green Technology Transfer Center, focusing on battery recycling and manufacturing or recycling related technologies (Yue et al., 2021).





### 3.3. Forging south-south climate governance coalitions to reshape global norms.

Collaborate with Southeast countries to innovate cross-border green power certification systems. Adjust hydropower carbon intensity values based on dry/rainy season generation variations, incorporating cross-border transmission losses with a dynamic carbon factor algorithm. Attach digital certificates to each megawatt-hour of hydropower, documenting ecological conservation investments and community compensation data to enhance blockchain traceability. Develop AI-powered cross-border power dispatch models to predict Laos hydropower fluctuations, optimize supply-demand matching for Thai industrial zones, and reduce coal-fired backup power usage. Besides, provide subsidies for upgrading technologies critical to reducing carbon footprints. Leverage carbon finance, trading, and insurance tools to incentivize corporate emission reductions. Encourage banks to issue special bonds for circular economy projects. Expand training programs for “carbon peaking and neutrality” professionals.



## 4. conclusion

Thailand’s predicament highlights the systemic challenges faced by developing countries under evolving climate governance frameworks when confronting international trade barriers. In conclusion, achieving carbon neutrality in developing economies necessitates a dual-response mechanism: (1) domestically, constructing industrial symbiosis networks to reduce transition costs through cross-sector resource sharing and technological collaboration; (2) internationally, advancing regional standard alliances to counter carbon-related trade restrictions and

reshape global rulemaking. By prioritizing data sovereignty development, fostering industrial co-innovation, and strengthening South-South climate alliances, Thailand can transform its carbon neutrality commitments into opportunities for supply chain modernization. This transition

demands not only technological breakthroughs but also a fundamental reconfiguration of existing carbon governance frameworks, paving a viable low-carbon development pathway for the developing countries.



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