Social Science Journal of Prachachuen Research Network
Volume 7 Issue 2 (May - August 2025)

TRANSITIONING TO A LOW-CARBON ECONOMY IN THAILAND'S CONSTRUCTION SECTOR: CHALLENGES AND OPPORTUNITIES

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Received 15 October 2024
Revised 20 December 2024
Accepted 31 January 2025

Abstract

The construction sector plays a pivotal role in Thailand's economic development while being a significant contributor to national greenhouse gas emissions. Transitioning to a low-carbon economy within this sector is essential to achieving Thailand's climate commitments under the Paris Agreement and its goal of net-zero emissions by 2065. This study examines the challenges, opportunities, and strategic pathways for fostering sustainable transformation in the Thai construction industry. Drawing on policy analysis, case studies, and international best practices, the research identifies key barriers such as high initial investment costs, limited access to advanced low-carbon technologies, workforce capacity gaps, and inconsistent regulatory enforcement. Conversely, notable opportunities include the expansion of the green building market, integration of innovative low-carbon materials and technologies, fiscal and market incentives such as the T-VER carbon credit scheme, and growing regional demand for sustainable infrastructure. The findings underscore the necessity of coordinated action among government, industry, and academia to align economic growth with environmental stewardship. Policy recommendations focus on strengthening sector-specific emission reduction targets, enhancing human capital development, fostering multi-stakeholder collaboration, and expanding financial and market mechanisms. By embedding low-carbon principles into the regulatory, technological, and

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operational fabric of the construction sector, Thailand can position itself as a regional leader in sustainable construction, generating both environmental and socio-economic benefits.

Keywords: Low-Carbon Economy, Sustainable Construction, Carbon Emissions, Construction Innovation, Thailand

Introduction

The global necessity for battling climate change has placed considerable pressure on many sectors to decrease their carbon emissions, with the construction industry identified as a crucial area for management (Huang et al., 2018). The construction sector is a significant contributor to greenhouse gas emissions, responsible for over 39% of global energy-related CO_2 emissions. This data highlights the pressing necessity for a shift to a low-carbon economy within the business, especially in swiftly developing countries such as Thailand. The construction business in Thailand has been fundamental to the nation's economic prosperity, making substantial contributions to both GDP and jobs. This rise has incurred an environmental cost since the industry's carbon-intensive operations significantly contribute to the nation's total emissions (Supasa et al., 2017). The Thai government, acknowledging the importance of sustainable growth, has established dedicated objectives to diminish greenhouse gas emissions by 20–25% from anticipated business-as-usual levels by 2030. Realizing these objectives requires a comprehensive overhaul of the construction industry, which poses considerable problems and offers unparalleled opportunity. The transition to a low-carbon economy in Thailand's construction sector entails a complex interaction of technology innovations, regulatory frameworks, economic factors, and social dynamics (Sanquist et al., 2012). This transition necessitates the use of sustainable building practices and materials, as well as a comprehensive restructuring of the entire construction value chain, encompassing design, procurement, construction techniques, and waste management (Wong et al., 2016). Low-carbon economy has appeared initially in the UK government white paper entitled “Our Future: Creating a Low-Carbon Economy” in 2003, and it is a low-carbon development model of low consumption, low pollution, and low emissions. The white paper presents a new combination of energy innovation, emissions reduction technology, industrial structure innovation and human society development. It is an ideal economic model for reducing greenhouse gas emissions, realizing reductions targets, confronting global warming, and decoupling the connection between economic growth, energy consumption and carbon emissions (Shen & Sun, 2016)

The urgent global challenge of climate change has placed substantial pressure on various sectors to reduce carbon emissions, with the construction industry recognized as a significant contributor to the carbon footprint. Globally, the buildings and construction sector accounts for approximately 21% of global greenhouse gas emissions, primarily through energy-intensive construction and material production (United Nations Environment Programme & Global Alliance for Buildings and Construction, 2025). Thailand’s commitment to the Paris Agreement’s goal of achieving net-zero emissions by 2065 underscores the need for a fundamental transformation in construction practices and policies. This shift supports circular economy principles—emphasizing

resource efficiency, waste reduction, and sustainable material usage throughout the construction life cycle. Technological innovations, such as Building Information Modeling (BIM), low-carbon materials, and energy-efficient design, offer viable pathways to reduce emissions when enabled by supportive policy frameworks and stakeholder engagement. Moreover, international collaboration and knowledge exchange can help Thailand adapt global best practices to its unique socio-economic landscape, positioning the country as a regional leader in sustainable construction.

In October 2024, The Thailand Cement Manufacturers Association (TCMA) has released the 2050 Net Zero Cement & Concrete Roadmap, outlining strategies to achieve net-zero emissions through efficiency improvements, carbon capture, and sustainable practices. The plan targets phased reductions in emissions from design and construction, concrete and clinker production, decarbonized electricity, and material savings, aiming for significant cuts by 2030 and full net-zero by 2050. Key actions include reducing emissions by 30.3Mt CO_2 by 2050, with major contributions from carbon capture (13.7Mt CO_2) and enhanced efficiency across production stages. Total CO_2 emissions will be limited to 17.5Mt by 2030 and reduced to 8.8Mt by 2040, demonstrating a commitment to innovation and sustainability in Thailand's cement industry as a following illustration.

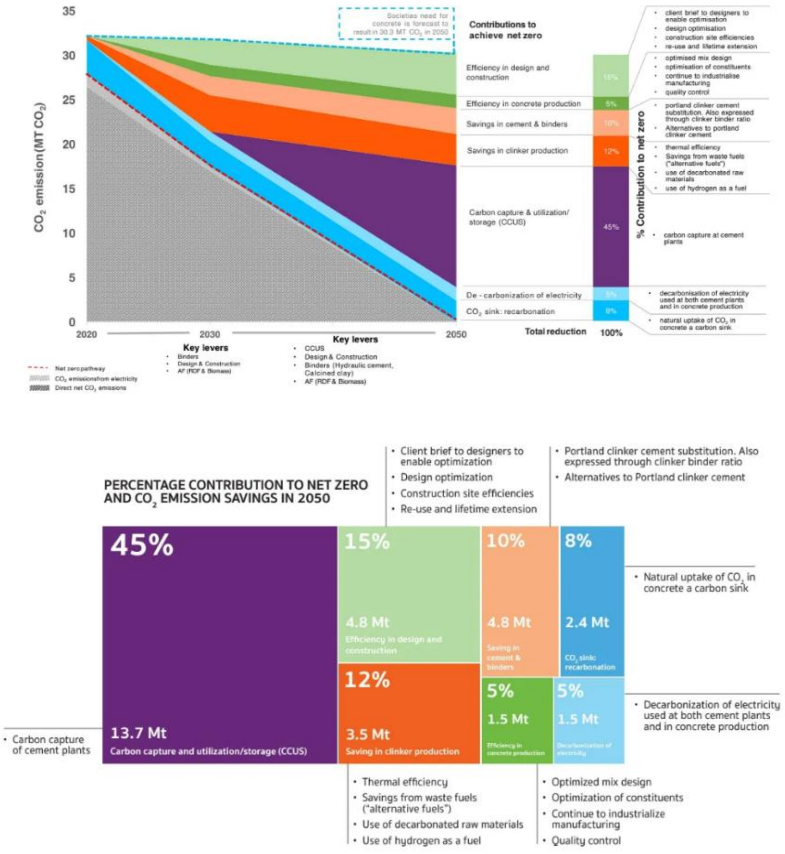

Figure 1. Thailand 2050 Net Zero Cement and Concrete Roadmap
(Thai Cement Manufacturers Association, 2023)

This article aims to examine the challenges and opportunities in transitioning Thailand's construction sector to a low-carbon economy, with particular focus on regulatory frameworks, educational initiatives, and technological innovation. By analyzing current practices, identifying barriers to implementation, and proposing strategic recommendations, this research seeks to contribute to the development of a comprehensive roadmap for sustainable transformation in Thailand's construction industry. The findings and recommendations presented here are intended to support policymakers, industry practitioners, and academic institutions in their collective efforts to achieve Thailand's climate commitments while fostering economic growth and social development. Moreover, we aim to provide insights into the obstacles that need to be overcome and the potential benefits that can be achieved. Our analysis will utilize international best practices and case studies, contextualizing them within Thailand's specific socio-economic and environmental framework. The study aspires to enhance the controversy on sustainable development in the construction sector, providing significant insights for policymakers, industry professionals, and scholars. By emphasizing the challenges and possible benefits of this transition, we aim to cultivate a comprehensive awareness of the pathway toward a more sustainable and resilient construction industry in Thailand.

Low-Carbon Economy and Its Implementation in the Construction Industry

The concept of a low-carbon economy emphasizes the simultaneous pursuit of economic growth and the reduction of greenhouse gas emissions, particularly carbon dioxide, which is a key contributor to climate change (Wikipedia contributors, 2025). This globally recognized framework involves several crucial components, including efficient energy consumption, the advancement of clean energy, the encouragement of green innovation and technologies, and the transition towards sustainable production and consumption practices (Singapore Economic Development Board, 2025).

Implementation of the Low-Carbon Economy in Construction

The implementation of a low-carbon economy within the construction sector plays a pivotal role in reducing greenhouse gas emissions, as the industry significantly contributes to global and national carbon footprints through the manufacture, transportation, and utilization of construction materials (Supasa et al., 2017). A central strategy in this transition is the development and adoption of low-carbon construction materials. The incorporation of

concrete with supplementary cementitious materials (SCMs), for instance, can substantially diminish emissions associated with cement manufacturing, thereby reducing the overall carbon footprint of construction projects (Mehta & Monteiro, 2014).

Energy-efficient building design constitutes another crucial component. Applying passive design strategies alongside renewable energy systems throughout the building lifecycle can significantly lower operational energy demand and associated emissions. In Thailand, regulatory frameworks such as the Ministerial Regulation on Building Energy Code B.E. 2563 provide guidelines for integrating energy conservation measures into building design and construction (Ministry of Energy, Thailand, 2020). Technological advancements, particularly the use of Building Information Modelling (BIM), further enhance design precision, improve resource utilization, and minimize construction waste, thereby contributing to lifecycle carbon reduction (Arayici & Aouad, 2011).

Waste management and recycling practices also support low-carbon goals by reducing the need for virgin material extraction and lowering energy consumption in material production. International case studies highlight the potential of comprehensive low-carbon strategies in the built environment. For example, Singapore’s Green Mark Scheme has driven substantial improvements in building energy performance, with certified projects achieving significant reductions in energy use compared to conventional buildings (Building and Construction Authority Singapore, 2020). Similarly, Shenzhen’s International Low Carbon City demonstrates how integrating renewable energy, sustainable transportation systems, and energy-efficient buildings within an urban development framework can yield large-scale emissions reductions (C40 Cities, 2023).

Global best practices also emphasize innovation and adaptive reuse. The World Economic Forum (2025) reports examples such as the Enterprise Centre at the University of East Anglia, which uses locally sourced, low-carbon materials to minimize embodied carbon, and the One Westside Office Campus in Los Angeles, where adaptive reuse strategies achieved a 33% reduction in embodied carbon compared to new construction. These cases illustrate that combining material innovation, energy-efficient design, and circular economy principles can transform the environmental performance of the construction sector.

In conclusion, advancing a low-carbon economy in construction requires coordinated efforts among government agencies, private sector stakeholders, and academic institutions to develop and implement effective policies, technologies, and training programs

(Ministry of Energy, Thailand, 2020). Such collaboration is essential for fostering innovation, enhancing competitiveness, and meeting national and international climate commitments.

Current Situation of Thailand's Construction Industry in the Low Carbon Context

Thailand's construction industry functions as an important economic sector, though precise statistical figures vary across sources. As a result, clear, publicly available data on its exact share of GDP is currently limited. Nonetheless, the critical impact of the built environment on climate change is evident: globally, the buildings and construction sector accounts for approximately 23% of energy-related CO_2 emissions (United Nations Environment Programme & Global Alliance for Buildings and Construction, 2025), highlighting the need for sustainable construction practices universally, including in Thailand. Under its updated Nationally Determined Contribution, Thailand commits to reducing GHG emissions by 30–40% by 2030 compared with the business-as-usual scenario (United Nations Framework Convention on Climate Change, 2022). Demonstrative projects—such as Thailand's SCG 100th Year Building (The Siam Cement Public Company Limited, 2020) and the WHIZDOM 101 development (Magnolia Quality Development Corporation Limited, 2019)—showcase local progress toward greener construction, though broader systemic changes remain essential.

Key Drivers for Transitioning to a Low-Carbon Economy in Thailand's Construction Industry

The transformation of Thailand's construction industry toward a low-carbon economy is being shaped by four interrelated drivers: environmental awareness, technological innovation, corporate environmental strategies, and supportive government policies.

1. Environmental Awareness and Capacity-Building

Environmental awareness in Thailand's construction sector has grown steadily, driven by both global sustainability trends and domestic urbanization pressures. The Asia Low-Carbon Buildings Transition (ALCBT) program—led by the Global Green Growth Institute (GGGI) in collaboration with the Department of Alternative Energy Development and Efficiency (DEDE)—provides tools, training, and policy templates to help the building sector reduce emissions through sustainable design, energy efficiency, and low-carbon materials (Global Green Growth Institute, 2025a; Global Green Growth Institute, 2025b; Global Green Growth Institute, 2025c). These initiatives directly support Thailand's target to reduce greenhouse gas (GHG) emissions by up to 40 % by 2030 and achieve carbon neutrality by 2050.

2. Innovation and Low-Carbon Construction Technologies

Technological innovation is a key driver for reducing emissions. In 2024, Siam City Cement Public Company Limited (SCCC) developed hydraulic cement that produces up to 50 % lower CO_2 emissions than ordinary Portland cement, while increasing its alternative fuel substitution rate to 28.5 % (Siam City Cement Public Company Limited, 2024a).

Also in 2024, in partnership with Pruksa Real Estate, SCCC's INSEE Petch Easy Flow cement—certified with a carbon footprint label by the Thailand Greenhouse Gas Management Organization (TGO)—was used in 327 low-rise housing projects, reducing emissions by nearly 5 million kg CO_2e (Siam City Cement Public Company Limited, 2024b).

3. Corporate Environmental Strategies

In 2025, SCCC was recognized in the ESG100 list by the Thaipat Institute for its sustainability performance. The company integrates ISO 14001 environmental management systems, sets measurable GHG reduction targets, and embeds ESG principles into corporate governance to strengthen its competitiveness in green markets (Siam City Cement Public Company Limited, 2025).

4. Government Policies and Incentives

Thailand's second nationally determined contribution (NDC), updated in 2022, commits to reducing GHG emissions by 30 % from business-as-usual (BAU) levels by 2030, and up to 40 % with international support. The ALCBT program supports these targets by building industry capacity and providing standard-setting tools (Global Green Growth Institute, 2025b). Government measures, such as national green building standards and renewable energy incentives, complement these international collaborations.

Impact of Low-Carbon Practices in the Construction Industry

Low-carbon practices in the construction industry generate substantial benefits across three critical dimensions: project efficiency and quality, environmental sustainability, and business competitiveness. The integration of advanced technologies and sustainable methods has transformed conventional construction processes into more resource-efficient and environmentally responsible practices.

In terms of project efficiency and quality, the adoption of modular and prefabricated construction methods has been shown to shorten construction timelines significantly while maintaining high standards of workmanship. In Thailand, modular construction techniques can reduce project durations by 30–50% compared to conventional

methods, while also cutting costs by 10–20% through enhanced process efficiency (Market Research Thailand, 2025). Similarly, the application of lightweight insulated sandwich wall panels has been demonstrated to reduce on-site construction time by approximately 30 days when compared to traditional solid concrete casting (SWITCH-Asia, 2023). These approaches not only accelerate project completion but also improve material use efficiency and quality control through factory-based manufacturing processes.

From an environmental perspective, low-carbon construction practices directly contribute to reducing greenhouse gas (GHG) emissions, resource consumption, and waste generation. Off-site construction, for example, has been reported to lower construction waste and emissions by up to 50% due to precision manufacturing and reduced on-site activities (Wikipedia, 2025). In Thailand, a case study of a six-storey reinforced concrete building revealed that over 92% of its total embodied CO_2 emissions originated from the manufacturing phase of building materials, underscoring the importance of addressing material choices and production methods to achieve emission reductions (Liwthaisong et al., 2025). These findings highlight that targeted interventions in material production and construction processes can yield substantial environmental benefits.

Economically, low-carbon practices can enhance business competitiveness, even though they may involve higher initial investment costs. Strategic policy research emphasises that tools such as carbon pricing, green building mandates, and subsidies can incentivise adoption while strengthening competitiveness in the transition to a green economy (Thailand Development Research Institute, 2023). Although precise national statistics on cost premiums or market value uplifts for green buildings in Thailand remain limited in publicly accessible reports, international and regional trends consistently show that environmentally certified buildings often achieve higher market valuations and offer significant operational cost savings over their lifecycle. For Thai construction firms, the ability to demonstrate environmental responsibility can also improve corporate image and expand opportunities in export and international markets, where sustainability credentials are increasingly a requirement.

In summary, low-carbon construction practices offer a multi-dimensional impact: they enhance efficiency and quality through modern building technologies, reduce environmental burdens by targeting material-related emissions, and strengthen competitiveness by aligning with emerging market and policy trends. However, successful implementation requires coordinated action from industry stakeholders, policymakers, and research institutions to balance initial cost challenges with long-term economic and environmental gains.

Challenges in Advancing a Low-Carbon Economy in Thailand's Construction Sector

Although Thailand has made progress in promoting a low-carbon economy, significant challenges remain that hinder the large-scale adoption of sustainable practices in the construction sector. These challenges include limited access to appropriate technologies, financial constraints, workforce capacity gaps, supply chain readiness, and policy consistency.

One major challenge is the limited access to advanced low-carbon technologies, which affects many industries, including construction. High capital costs and the need for technical expertise often discourage small and medium-sized enterprises (SMEs) from adopting energy-efficient materials and innovative systems. Moreover, Thailand's domestic research and development (R&D) capacity in low-carbon technologies remains limited, resulting in dependence on imported solutions that may be costly and less suited to local contexts (Thailand Development Research Institute, 2023). Addressing this challenge requires greater investment in domestic innovation, effective technology-transfer mechanisms, and strong public–private research partnerships.

Workforce readiness is another critical barrier. The Global Green Growth Institute (GGGI), through its Asia Low-Carbon Buildings Transition (ALCBT) program, has identified a shortage of professionals trained in low-carbon building design, energy modeling, and sustainable project management. The program emphasizes the importance of targeted training for architects, engineers, and contractors, as well as integrating low-carbon construction modules into vocational and university curricula to address these skills gaps (Global Green Growth Institute, 2025a).

Financial barriers also slow adoption. Thailand Development Research Institute (2023) notes that the high upfront costs of low-carbon materials and technologies, combined with uncertain payback periods, reduce investment confidence. Recommended measures include providing low-interest green loans, subsidies, and tax incentives to encourage adoption.

Supply chain adaptation poses additional challenges. The Global Green Growth Institute (2025b) reports that the domestic market for certified low-carbon construction materials is still small, leading to limited availability and higher prices. Expanding demand through public procurement policies and private-sector commitments can help scale production, reduce costs, and improve supply chain resilience.

Finally, policy and regulatory issues persist. While Thailand has national greenhouse gas reduction targets and strategies to promote green buildings, The Global Green Growth Institute (2025a) notes that inconsistent enforcement and limited financial incentives create uncertainty

for investors and slow industry transformation. Achieving sustained progress will require clearer policy frameworks, long-term regulatory stability, and better alignment between government agencies, industry, and academia.

Opportunities and Future Trends in Thailand's Low-Carbon Construction Industry

Despite notable challenges, Thailand's construction sector has multiple opportunities to accelerate its transition toward a low-carbon economy. These opportunities align with the country's policy targets, technological advancements, and regional market trends.

1. Expansion of the Green Building Market and Smart City Development

The adoption of green building practices in Thailand has grown steadily, supported by certification schemes such as the Thai Rating of Energy and Environmental Sustainability (TREES) and LEED. The government's Smart City Development Plan, coordinated by the Office of Digital Economy Promotion (DEPA), aims to establish smart cities nationwide, with pilot projects in key regions including the Eastern Economic Corridor (EEC) (Office of Digital Economy Promotion, 2020). This policy framework encourages construction solutions that integrate low-carbon technologies.

2. Business Opportunities from National Climate Commitments

Thailand's updated Nationally Determined Contribution (NDC) under the Paris Agreement commits to reducing greenhouse gas emissions by 20–25% by 2030 (Ministry of Natural Resources and Environment, 2020). This commitment creates market potential for retrofitting existing buildings for energy efficiency and for expanding green infrastructure projects such as clean-energy public transportation.

3. Technological and Material Innovation for Low-Carbon Construction

Innovation in low-carbon construction is a growing focus of national research and development efforts. Government agencies such as the Department of Alternative Energy Development and Efficiency (DEDE) have promoted alternative building materials and energy-efficient technologies in line with national energy strategies (Department of Alternative Energy Development and Efficiency, 2020). Such innovations can reduce lifecycle emissions and support the competitiveness of the Thai construction industry.

4. Regional Export Potential in Sustainable Construction

Thailand has identified opportunities to export sustainable construction expertise and green technologies to neighboring CLMV countries (Cambodia, Lao PDR, Myanmar, and Viet

Nam), where demand for sustainable infrastructure is rising alongside rapid economic growth (Department of International Trade Promotion, 2020).

Policy Recommendations and Development Strategies

A successful transition toward a low-carbon economy in Thailand's construction sector requires coordinated action across policy, technology, finance, and human resource development. Based on verified national policies and official statistics, the following strategic recommendations are proposed.

1. Strengthening Policy Frameworks and Incentives

Thailand's updated Nationally Determined Contribution (NDC) commits to a 20–25% reduction in greenhouse gas (GHG) emissions by 2030 relative to business-as-usual projections (United Nations Framework Convention on Climate Change, 2022). Achieving this target within the construction sector necessitates sector-specific emission reduction targets supported by detailed action plans.

Fiscal and market-based incentives should be expanded. In 2024, the Ministry of Finance announced new tax measures to encourage green investment, followed by Cabinet approval in 2025 of comprehensive tax incentives for renewable energy and energy-efficiency adoption (Bangkok Post, 2024; Mahanakorn Partners Group, 2025). These instruments should be tailored to enable small and medium-sized enterprises (SMEs) to access low-carbon technologies and materials.

The Thailand Greenhouse Gas Management Organization (TGO) administers the Thailand Voluntary Emission Reduction (T-VER) program, which certifies projects for carbon credit generation. As of April 2024, the T-VER market had traded over 3.25 million tCO_2e, valued at approximately THB 292 million (Kasikorn Research Center, 2024). Greater integration of construction projects into this framework could provide additional revenue streams and enhance project feasibility.

2. Advancing Human Capital and Research Capacity

A skilled workforce is essential to enable technological adoption. Universities and vocational institutions should integrate low-carbon construction principles into engineering, architecture, and construction management curricula.

Public research bodies, including the National Science and Technology Development Agency (NSTDA) and the Department of Alternative Energy Development and Efficiency (DEDE), are already conducting applied research on materials such as carbon-

absorbing concrete and bio-composites derived from agricultural residues (National Science and Technology Development Agency, 2023; Department of Alternative Energy Development and Efficiency, 2020). Scaling these initiatives and encouraging collaboration with international leaders such as Japan, Singapore, and Germany can accelerate technology transfer and contextual adaptation.

3. Enhancing Multi-Stakeholder Collaboration

Cross-sectoral cooperation is critical for policy alignment and innovation diffusion. Industry bodies such as the Federation of Thai Industries and the National Innovation Agency have initiated low-carbon innovation networks connecting policymakers, businesses, and researchers.

Pilot projects by agencies such as the National Housing Authority can serve as demonstrators, providing empirical evidence of technical feasibility, cost implications, and social benefits to the broader market.

4. Expanding Financial and Market Mechanisms

Green finance instruments, including concessional green loans and extended-term credit lines, should be developed to reduce investment barriers for low-carbon construction projects.

Public sector leadership through green public procurement—mandating certified low-carbon materials and energy-efficient technologies in government projects—can stimulate domestic market demand (Comptroller General's Department, Thai Government Procurement, 2024).

Moreover, linking construction projects to the T-VER carbon credit mechanism can monetise verified emission reductions, improving return on investment and encouraging broader private-sector participation.

Conclusion

This study has examined the challenges, opportunities, and strategic pathways for transitioning Thailand's construction sector toward a low-carbon economy. The evidence underscores the sector's central role in achieving national climate objectives—most notably the commitment to reduce greenhouse gas emissions by 20–25% by 2030 under the Paris Agreement and to attain net zero by 2065. Realising these ambitions will require a comprehensive transformation of the construction value chain, encompassing material production, design innovation, construction practices, and waste management.

The findings reveal that the transition is impeded by high capital costs, limited technological access for small and medium-sized enterprises, supply chain constraints, and inconsistent policy enforcement. However, these challenges are counterbalanced by notable opportunities: the expansion of the green building market, advancements in low-carbon materials and technologies, targeted fiscal and market incentives such as the T-VER carbon credit scheme, and increasing regional demand for sustainable infrastructure solutions. Case evidence from corporate initiatives and national programmes demonstrates that low-carbon practices can simultaneously improve resource efficiency, reduce environmental impacts, and enhance competitiveness.

Policy recommendations emerging from the analysis emphasize four interrelated priorities: establishing sector-specific emission reduction targets and strengthening incentive mechanisms; advancing human capital development and applied research; fostering multi-stakeholder collaboration to accelerate innovation uptake; and expanding financial instruments and market frameworks to stimulate demand for sustainable construction. A coordinated approach integrating these elements offers a viable pathway for aligning economic growth with environmental stewardship.

By embedding low-carbon principles into the regulatory, technological, and market fabric of the construction sector, Thailand can position itself as a regional leader in sustainable construction. Such alignment will not only contribute to the fulfilment of national and international climate commitments but also generate enduring socio-economic benefits, reinforcing the sector's role as a driver of sustainable development in the decades ahead.

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