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The Challenges of Fulfilling RE100 in High-Tech Product Export Countries: The Case of Taiwan

Howard (Chia-Hao) Chou *

EcoStrategy, Managing Director, Taipei, *TAIWAN*

Abstract

The RE100 initiative, which advocates for businesses to transition to 100% renewable electricity, presents substantial challenges for high-tech export nations such as Taiwan. As a leading global semiconductor manufacturing hub, Taiwan encounters significant structural, policy, and infrastructural constraints that impede its transition to a fully renewable energy-powered economy. This article examines these challenges through six key perspectives: (1) a comparative analysis of renewable energy development between developed nations, e.g., the United Kingdom, and Taiwan; (2) the limitations inherent in Taiwan’s energy transition, including geographic constraints, economic and political complexities, and regulatory hurdles in achieving RE30 by 2030; (3) the risk of Taiwan's high-tech industry losing its competitive edge in global supply chains due to renewable energy deficits; (4) the potential of global carbon asset circulation as a viable strategy for reconciling sustainability with industrial growth; (5) an assessment of global sustainability trends, including COP29 outcomes, EU and US policies, and their implications for Taiwan’s renewable energy strategy; and (6) an evaluation of Taiwan’s renewable energy roadmap and the projected challenges the country will face by 2030. To address these challenges and propose a scalable decarbonization strategy, this study applies the Resource-Based View (RBV) and Dynamic Capability (DC) perspectives, argues that a shift in global sustainability discourse, from RE100 to carbon neutrality,

* Ph.D. in Marketing, Strathclyde University, United Kingdom. The author may be contacted via howard@strategyesg.com.

supported by structured carbon asset circulation, offers a more pragmatic and equitable solution for high-energy manufacturing economies. By integrating carbon trading with industrial sustainability strategies, this approach aligns ecological sustainability with global trade competitiveness, fostering a resilient, market-driven, and inclusive carbon economy.

Keywords: carbon neutrality, RE100, renewable energy, carbon credit, carbon asset circulation, Taiwan, sustainability strategy, carbon emissions reduction, energy policy

I. Introduction

The RE100 initiative, led by the Climate Group in partnership with Carbon Disclosure Project, seeks to drive the transition of major global corporations toward 100% renewable electricity (RE 100). While this commitment is crucial in mitigating climate change, it presents significant feasibility challenges for industrially intensive economies reliant on high energy consumption. Taiwan, a pivotal node in the global semiconductor supply chain, exemplifies these challenges. The nation faces an energy transition dilemma that, if unresolved, may lead to economic repercussions, particularly in the form of trade exclusions, supply chain disruptions, and regulatory risks associated with evolving global carbon reduction policies, such as EU's Carbon Border Adjustment Mechanism (CBAM) and *US Clean Competition Act* (CCA) (European Commission, 2025; Senate of the United States, 2022).

To contextualize these challenges and develop an alternative decarbonization strategy, this study employs the Resource-Based View (RBV) and Dynamic Capability (DC) perspectives to underpin the analysis of Taiwan's energy transition constraints and propose a scalable pathway for achieving carbon neutrality. The RBV framework suggests that carbon credit markets, decarbonization technologies, and clean energy investments should be treated as strategic resources that nations and enterprises can leverage for long-term competitive advantage. Meanwhile, the DC framework emphasizes the necessity for manufacturing economies to sense, seize, and transform their sustainability strategies, integrating carbon asset circulation into global trade and industrial policies. This study explores the feasibility constraints Taiwan faces in achieving RE100 and proposes alternative frameworks, such as carbon neutrality through global carbon asset circulation, as a more viable pathway for long-term sustainability.

1.1 Renewable Energy Growth in Developed Economies in the United Kingdom

The United Kingdom has successfully transitioned towards renewable energy by leveraging comprehensive policy frameworks, industrial incentives, and strategic investments. As of 2023, renewable energy accounted for approximately 39.5% of the UK's electricity generation, with low-carbon energy sources contributing 56% of the national energy mix. Wind energy, particularly offshore wind farms, has been the linchpin of the UK's transition, supported by extensive government subsidies, capacity auctions, and feed-in tariffs.

The UK's renewable energy policies have been designed to complement industrial competitiveness, ensuring that manufacturing remains viable even as carbon-intensive energy sources are phased out. Through long-term power purchase agreements (PPAs) and clean energy mandates, British manufacturers have successfully integrated renewable energy into supply chains without significant disruption to economic performance. Moreover, the UK's grid modernization efforts and energy storage investments have enhanced grid reliability, mitigating the risks of intermittent renewables.

Despite these achievements, the UK's economic structure is markedly different from Taiwan's. The manufacturing sector contributes only 17.5% to the UK's gross domestic product (GDP), with a majority of the economy driven by services and finance. As a result, the energy transition poses fewer risks to British industrial competitiveness compared to Taiwan, where manufacturing accounts for 60% of GDP and 94% of exports.

1.2 Taiwan's Renewable Energy Status and Associated Challenges

Taiwan's energy transition remains fraught with infrastructural and economic limitations, creating vulnerabilities in its ability to comply with international carbon reduction policies such as the CBAM and the CCA. Unlike the UK, Taiwan relies on fossil fuel imports for 98% of its energy supply, a dependency that presents challenges for both energy security and carbon reduction commitments.

As of 2023, Taiwan’s energy mix included: Coal 42.24%, Natural Gas 39.57%, Renewable Energy 9.47%. Nuclear Power 6.31%. Fuel Oil 1.34%, and Pumped Hydropower 1.08%. By looking at the figures of Taiwan’s current energy portion, the barriers to Taiwan’s renewable energy transition are revealed in the following points. Firstly, it is the geographic and infrastructure constraints. Taiwan’s land scarcity and high population density limit large-scale solar and wind power development. Meanwhile, Unlike the UK, Taiwan’s deep coastal waters increase the cost and complexity of offshore wind expansion. In addition, the country’s energy grid remains underdeveloped for large-scale renewable energy integration, increasing intermittency risks. Second point is the regulatory and policy gaps. The slow and fragmented policy implementation has delayed renewable energy projects, deterring foreign investment. Furthermore, lack of market liberalization restricts competition and innovation in Taiwan’s energy sector. The third is the industrial energy dependence and global supply chain risks. Taiwan’s manufacturing sector—particularly its semiconductor and electronics industries—requires stable, high-load electricity, which intermittent renewable sources currently cannot guarantee.

In addition, with global corporations such as Amazon/Google mandating RE100 compliance for suppliers by 2030, Taiwan’s manufacturing sector is at serious risk of non-compliance, jeopardizing its role in the global supply chain. In the meantime, Taiwan’s RE30 goal falls short of international expectations, further raising concerns about carbon taxation and trade penalties under CBAM and CCA regulations.

1.3 The Strategic Implications of Energy Policy on Industrial Competitiveness

A direct comparison of Taiwan's and the UK's energy strategies reveals stark contrasts in the policy impact on industrial competitiveness, i.e., energy transition and industrial dependence. The UK's renewable energy policies align well with its industrial composition, as its manufacturing sector is a smaller portion of GDP (17.5%). In comparison, Taiwan's export-driven economy (60% of GDP from manufacturing) is at much greater risk of economic destabilization due to high energy costs and supply chain exclusions if energy policy reforms are not accelerated. In terms of trade and carbon policy: The UK's proactive approach to low-carbon energy investments reduces the risk of economic penalties under CBAM and CCA policies. However, Taiwan, by contrast, faces significant exposure to carbon taxation due to its high emissions intensity in manufacturing and lagging renewable energy adoption.

The comparative analysis between Taiwan and the UK highlights the critical role energy policy plays in industrial sustainability and global market positioning. While the UK's service-heavy economy allows for a seamless transition to renewable energy, Taiwan's manufacturing-dominant economy faces severe risks if its energy policies remain misaligned with international sustainability mandates. Without urgent policy innovation, Taiwan risks carbon taxation penalties, trade disadvantages, and exclusion from high-value supply chains. Thus, a paradigm shift is to prioritize the following is essential:

- Accelerated renewable infrastructure investments tailored to Taiwan's geographic constraints.
- Market liberalization to attract private sector investment in clean energy.
- Strategic participation in global carbon asset circulation as a complementary mechanism to renewable energy development.

Ultimately, carbon neutrality through global carbon asset circulation presents the most viable alternative to address Taiwan's energy constraints without compromising industrial competitiveness. This shift would enable Taiwan to align with international trade policies while safeguarding its economic growth in an increasingly decarbonized global economy.

II. Taiwan's Renewable Energy 30% Target by 2030: Challenges and Constraints

Taiwan's commitment to achieving a 30% renewable energy share (RE30) by 2030 represents a strategic goal within its broader energy transition framework. However, the feasibility of this objective by three primary constraints, geographic and physical limitations; incongruities between central and local government policies; and the ambiguous nature of the RE30 roadmap within the broader context of Taiwan's energy dependency and trade exposure, is challenged. This section examines these constraints with empirical data and policy analysis to illustrate the fundamental challenges of Taiwan's energy transition.

2.1 Geographic and Physical Limitations

Taiwan's geographic and topographical characteristics pose substantial obstacles to the expansion of renewable energy infrastructure. Unlike larger economies with abundant land for large-scale solar and wind farms, Taiwan's land scarcity and geological conditions significantly limit feasible deployment areas.

- Land Availability and Population Density: Taiwan's total land area is 36,197 square kilometers, with over 70% of the terrain classified as mountainous or hilly. Only 31% of the land is considered usable for urban, agricultural, and industrial purposes, making the allocation of additional land for renewable energy projects highly competitive. Taiwan also has a population density of 673 people per square kilometer, ranking 10th highest globally, which further restricts available space for energy infrastructure development.

- Offshore Wind Potential and Technical Barriers: While Taiwan possesses strong offshore wind potential, particularly in the Taiwan Strait, deep waters (exceeding 50m in depth in some areas) make the deployment of floating wind turbines significantly more costly than fixed-bottom turbines used in shallower waters (e.g., North Sea wind farms in the UK). Engineering costs for floating offshore wind projects can be 2–3 times higher than conventional offshore wind projects.
- Solar Energy Limitations: Taiwan receives an annual average solar irradiation of approximately 1,200–1,700 kWh per square meter, comparable to parts of Southern Europe. However, limited land availability and competing land use reduce the scalability of large-scale solar farms. By 2023, solar power contributed approximately 7% of Taiwan's total electricity generation, and further expansion will require significant policy and investment incentives.

These structural limitations underline the challenge of achieving a diversified and scalable renewable energy mix capable of meeting Taiwan's energy-intensive industrial demand.

2.2 Policy Execution Challenges: Central vs. Local Government Discrepancies

The execution of Taiwan's renewable energy policies is hindered by inconsistencies between central and local governments, affecting project approval processes, policy implementation, and long-term sustainability planning. The absence of unified regulatory frameworks and conflicting priorities between central directives and local governance structures has delayed the deployment of key renewable energy projects.

- Conflicting Policy Priorities: While Taiwan's central government has actively promoted renewable energy expansion, local governments have resisted projects based on environmental concerns, land-use disputes, and socio-economic factors. For example, in 2024, Yunlin County temporarily halted offshore wind energy projects, citing concerns over fisheries disruptions and insufficient environmental impact assessments (Chen & Hou, 2024).
- Variations in Permitting Processes: Unlike the UK, where a single national regulatory body oversees renewable energy permits, Taiwan's fragmented approval process requires multiple levels of authorization, often leading to administrative bottlenecks. Developers frequently encounter delays exceeding 12-24 months for project approvals due to redundant local government assessments.
- Lack of Grid Infrastructure Coordination: Taiwan's renewable energy expansion has outpaced its grid modernization efforts. Several local governments have raised concerns over the capacity limitations of existing grid infrastructure, particularly in accommodating intermittent renewable energy sources like wind and solar. The Taiwan Power Company (Taipower) has acknowledged that grid overload risks could necessitate curtailment of renewable energy generation, further complicating RE30 implementation.

These policy inconsistencies highlight the challenges in achieving a coherent national energy strategy, ultimately affecting investor confidence, slowing project timelines, and increasing overall transition costs.

2.3 The Uncertainty and Feasibility of Taiwan's RE30 Roadmap

Taiwan's renewable energy roadmap remains vague and lacks concrete mechanisms to ensure the successful attainment of RE30 by 2030. The following factors underscore the uncertainty surrounding this goal:

- Current Energy Composition and Dependency on Fossil Fuels: As of 2023, coal and natural gas accounted for 81.8% of Taiwan's total energy consumption, while renewable energy sources contributed only 9.47% (Ministry of Economic Affairs, 2024). Given that Taiwan's energy demand is projected to increase by 2.5% annually, achieving RE30 requires an unprecedented acceleration in renewable energy deployment, raising questions about feasibility.
- Projected Shortfalls and Economic Costs: Based on the current expansion rate of Taiwan's renewable energy sector, projections indicate that Taiwan will likely achieve only 22-25% renewable energy penetration by 2030, falling short of the RE30 target. Closing this gap would require $50–70 billion in additional infrastructure investments, including grid storage solutions and upgraded transmission networks.
- Energy Security Concerns and Carbon Import Dependencies: Taiwan imports over 98% of its energy supply, making it highly vulnerable to external energy shocks, geopolitical risks, and fluctuations in global fuel prices. Taiwan's reliance on fossil fuel imports contrasts sharply with its sustainability ambitions, suggesting that renewable energy independence remains an elusive goal within the given timeframe.

In brief, Taiwan's ambition to achieve RE30 by 2030 faces critical structural barriers that question the feasibility of the current roadmap. For instance, the structural Barriers to RE30 and the need for alternative strategy geographic limitations significantly restrict the scalability of renewable energy infrastructure, policy execution disparities between central and local governments create inefficiencies, and Taiwan's dependence on imported fossil fuels remains a fundamental challenge to energy independence.

Given these constraints, a more realistic strategy would involve. A balanced energy transition framework, integrating carbon neutrality mechanisms such as carbon credit trading and emissions offset projects to complement renewable energy expansion. Furthermore, enhanced policy coordination between central and local governments to streamline permitting processes, create clear regulatory guidelines, and attract foreign investments in renewable energy infrastructure. Final but not the least important, diversification of clean energy sources, including investments in next-generation nuclear energy, hydrogen energy, and advanced battery storage technologies to ensure grid stability and industrial energy security.

In addition, while RE30 remains an aspirational goal, Taiwan must re-evaluate its renewable energy strategy within the broader context of economic resilience and global trade competitiveness. The transition to carbon neutrality through global carbon asset circulation presents a more pragmatic and economically viable alternative, ensuring that Taiwan remains competitive in the face of international trade regulations such as the EU's CBAM and the US's CCA. Without structural reforms and alternative energy mechanisms, Taiwan risks falling behind in the evolving global energy landscape, jeopardizing both its industrial sector and long-term economic stability.

From the RBV perspective, carbon markets, green energy investments, and decarbonization technologies serve as strategic resources, allowing Taiwan to optimize industrial competitiveness while aligning with global carbon assets circulation. However, effective implementation hinges on enhanced central-local policy coordination to streamline regulatory processes, attract foreign investment, and foster institutional adaptability, a crucial aspect of Dynamic Capability (DC). Moreover, diversifying clean energy sources, including nuclear, hydrogen, and battery storage technologies, is essential for energy security and industrial sustainability. This portfolio approach ensures that Taiwan's energy transition remains resilient to external shocks, reinforcing its competitive positioning in the global low-carbon economy.

III. Global Carbon Asset Circulation as a Strategic Approach to Achieving Carbon Neutrality

As nations and industries strive for decarbonization, a key challenge remains: how to balance economic growth with climate commitments while ensuring global supply chain resilience. This paper has established that RE100, while an ambitious and necessary initiative, presents significant feasibility challenges for manufacturing-heavy economies like Taiwan. The alternative approach of carbon neutrality through global carbon asset circulation offers a more flexible, scalable, and economically sustainable pathway for emissions reduction. This section argues that a structured global carbon asset circulation mechanism, underpinned by the Resource-Based View (RBV) and Dynamic Capability theories, provides a pragmatic and competitive solution for industrial economies transitioning to carbon neutrality.

3.1 Theoretical Underpinning: Resource-Based View and Dynamic Capability in Carbon Markets

The resource-based view suggests that firms and nations derive competitive advantage from unique resources that are valuable, rare, inimitable, and non-substitutable (Barney, 1991: 2001). When applied to the global carbon asset circulation mechanism, carbon credit markets, decarbonization technologies, and green energy investments become strategic resources that nations and firms can leverage for sustainable competitive advantage. Carbon Credits as a Strategic Resource: Nations or firms with access to large-scale carbon sequestration projects (e.g., afforestation, direct air capture, and carbon storage) can monetize excess credits, providing financial incentives to reinvest in sustainable practices. Stated differently, countries rich in renewable energy can export clean energy or tradable carbon credits to industrially dependent nations, thus creating an equilibrium in the carbon reduction burden.

As with the dynamic capability framework, Teece, et al. (1997) and Teece (2018) argue that organizations must continuously sense, seize, and transform their resources and capabilities to adapt to changing market conditions. In the context of global decarbonization, dynamic capabilities enable firms and nations to proactively engage with evolving carbon market regulations and trade policies. Sensing market trends: As international carbon markets expand, with agreements such as COP29's carbon market standardization, countries and industries that anticipate regulatory shifts can adjust policies to integrate carbon trading into their decarbonization strategies. seizing competitive opportunities: By leveraging carbon asset circulation, manufacturing-intensive nations can offset emissions while remaining competitive in global supply chains, ensuring continued compliance with CBAM, CCA, and corporate carbon neutrality mandates. Transforming business models for long-term resilience: Carbon market integration fosters green finance innovation, allowing firms to diversify revenue streams through carbon credit sales, sustainability-linked financial instruments, and climate-conscious supply chain investments. In brief, the RBV and DC perspective enlighten another path for ecology and enterprise sustainability alignment.

3.2 The Global Carbon Asset Circulation Mechanism: A Pragmatic Solution for Industrial Economies

A structured global carbon asset circulation mechanism addresses the primary limitations of RE100 and provides a scalable framework for industries and nations to transition to carbon neutrality without disrupting economic stability. This mechanism includes the following dimensions:

1. **Cross-Border Carbon Trading Integration**:

- Establishing internationally **standardized carbon markets** where high-emission economies can purchase credits from carbon-abundant regions.
- Encouraging **bilateral carbon offset agreements**, such as Taiwan collaborating with Southeast Asian nations for reforestation and carbon capture storage investments.

2. **Sector-Specific Carbon Pricing and Offset Mechanisms**:

- Allowing high-energy industries, e.g., semiconductors, steel, cement, to partially offset emissions while gradually transitioning to cleaner production methods.
- Enabling firms to use carbon pricing models that reflect industry-specific technological limitations.

3. **Integration with International Trade Policies and Corporate Supply Chains**:

- Ensuring compatibility with CBAM and CCA regulations, allowing carbon-neutral firms to bypass border tariffs on high-emission goods.
- Aligning with Google, Apple, and Amazon’s carbon neutrality mandates, providing incentives for suppliers to invest in decarbonization without facing immediate cost burdens.

3.3 Comparative Effectiveness: RE100 vs. Carbon Neutrality Through Carbon Asset Circulation

By comparing the RE100 and carbon neutrality, the practical employment and deployment of global carbon assets reveal the realistic issue of the durability of these two approaches showing in the table below:

Table 1: Comparison of Taiwan's Policy Alignment vs. Global Sustainability Trends

Factor	RE100 (100% Renewable Energy Commitment)	Carbon Neutrality (Global Carbon Asset Circulation)
Feasibility for Manufacturing Economies	Low—Requires full transition to renewables, which is logistically and financially challenging.	High—Enables gradual decarbonization through a combination of direct reductions and offset strategies.
Economic Competitiveness	High cost burden on industries; potential risk of supply chain exclusion due to energy transition limitations.	Enhances flexibility—firms maintain access to carbon-neutral supply chains without immediate renewable transition.
Adaptability to Trade Policies	Vulnerable to carbon tariffs under CBAM and CCA.	Aligns with global carbon pricing mechanisms, reducing tariff exposure.
Scalability and Investment Incentives	Requires direct capital expenditure on renewables.	Encourages diverse green finance options, including carbon credit monetization and international trade integration.

3.4 Global Carbon Asset Circulation as the Strategic Decarbonization Model

In summary, the structural limitations of RE100 and the economic risks posed by rigid renewable mandates, global carbon asset circulation provides an adaptable, scalable, and competitive approach for carbon neutrality. By leveraging the RBV and DC perspectives, this mechanism ensures that: 1. Manufacturing economies like Taiwan can maintain competitiveness while meeting global decarbonization targets. 2. Industries can strategically allocate resources to optimize sustainability investments and trade alignment. 3. Carbon neutrality becomes an inclusive global initiative rather than an exclusive benchmark favoring renewable-rich nations.

This approach ensures the alignment of ecological sustainability with enterprise competitive advantage, reinforcing that climate action and economic resilience must evolve in tandem rather than in opposition. By facilitating carbon asset circulation at an international level, nations and industries can successfully balance economic growth with long-term climate commitments, fostering a sustainable and equitable industrial landscape.

IV. The Case for Carbon Neutrality and Global Carbon Asset Circulation

In the context of global climate governance and industrial sustainability, two major frameworks have emerged: RE100 and carbon neutrality. While RE100 focuses on the exclusive adoption of renewable energy sources, carbon neutrality incorporates a broader, more flexible approach that allows for emissions reduction through carbon offset mechanisms, technological advancements, and international carbon asset circulation. Given Taiwan's structural constraints and industrial composition, this chapter argues that carbon neutrality provides a more pragmatic, economically viable, and globally inclusive solution for mitigating global warming while maintaining competitiveness in international supply chains.

4.1 The Approaches of Carbon Emission Reduction

The comparison between RE100 and carbon neutrality, as outlined in Table 1, highlights the diverse pathways available for carbon emission reduction. This analysis aims to identify a more practical and sustainable approach for manufacturing-oriented countries, considering economic feasibility, industrial competitiveness, and long-term adaptability in the global decarbonization landscape.

The international supply chain and value chain perspective further illustrates why carbon neutrality is a more inclusive and sustainable approach compared to RE100.

- Manufacturing Competitiveness: High-energy industries such as semiconductor production, electronics manufacturing, and heavy industrial processing require stable, high-load electricity supply. The feasibility of RE100 is challenged by the intermittency of renewables and the lack of storage solutions. Carbon neutrality, by contrast, allows manufacturers to maintain production stability while gradually reducing net emissions through efficiency gains and offsets.
- Global Carbon Pricing and Regulatory Compliance: The implementation of the EU's CBAM in 2026 and the US's CCA will impose carbon tariffs on high-emission imports, increasing costs for non-compliant nations. Under RE100, economies struggling to transition fully to renewable energy face a competitive disadvantage in international trade. Carbon neutrality, however, offers a pathway for businesses to meet emissions targets through internationally recognized offset mechanisms.

- Technology and Market Adaptability: While RE100 mandates a rigid transition, carbon neutrality supports dynamic technological innovation. Industries can integrate next-generation carbon capture technologies, green hydrogen applications, and AI-driven energy optimization to reduce their footprint without immediate energy source disruptions.

Table 2: Comparative Analysis: RE100 vs. Carbon Neutrality in Industrial Sustainability

Factor	RE100 (100% Renewable Energy Commitment)	Carbon Neutrality (Balanced Emission Offsetting)
Primary Objective	Full transition to renewable energy sources	Achieve net-zero emissions through a mix of renewable energy, carbon trading, and offsets
Adoption Feasibility	High capital expenditure, long transition timeline, energy intermittency challenges	More flexible approach with structured decarbonization mechanisms
Industrial Impact	High risk of energy supply instability, particularly in high-tech manufacturing	Ensures energy security while allowing technological adaptation
Economic Competitiveness	Requires extensive subsidies and infrastructure overhaul	Leverages global carbon markets to offset emissions efficiently
Geopolitical Implications	Favours energy-rich economies, creating structural disadvantages for import-dependent nations	Enables global trade inclusivity by integrating carbon asset circulation into the value chain

4.2 The Role of Global Carbon Asset Circulation

International carbon markets have gained significant traction as a cost-effective solution for achieving emissions reduction targets. The establishment of cross-border carbon trading mechanisms, such as those formalized in COP29, enables developing economies to participate in global decarbonization efforts without jeopardizing industrial growth.

Global Carbon Markets can be developed in the following key perspectives:

- COP29's Agreement on International Carbon Market Standards: The newly formalized global carbon trading standards aim to enhance transparency and credibility in offsetting emissions while ensuring that carbon credits contribute to actual, verifiable reductions in greenhouse gases (*United Nations Framework Convention on Climate Change*, UNFCCC, 2024).
- EU's Carbon Pricing Mechanisms and Electricity Tariff Adjustments: The EU is expanding carbon pricing into electricity markets, which impacts energy-intensive industries reliant on imported power sources (Chang, 2025).
- Indonesia's Carbon Market and Global Buyers: Indonesia has emerged as a key supplier of certified carbon credits, attracting corporate buyers from Japan, the US, and the EU who seek compliance with net-zero mandates while maintaining operational efficiency (Lin, 2025).

Integrating carbon neutrality into the global supply chain cab be accomplished through following manners. First of all, multinational corporations such as Apple, Microsoft, and Tesla are increasingly prioritizing carbon-neutral suppliers over those simply adopting RE100. The ability to offset emissions efficiently is becoming a competitive advantage in global procurement policies. Secondly, developing economies with high industrial activity, such as Taiwan, South Korea, and Malaysia, are leveraging carbon neutrality strategies to comply with sustainability standards without sacrificing economic output. Thirdly, financial institutions and investment funds are shifting towards carbon credit-backed financing, allowing enterprises to monetize emissions reductions as tradable assets.

4.3 The Industrial and Economic Rationale for Carbon Neutrality

Taiwan’s industrial sector, which constitutes 60% of GDP and accounts for 94% of exports, must align with international sustainability frameworks to maintain global market access. Given that 80% of Taiwan’s energy mix remains carbon-intensive, an immediate transition to RE100 is logistically and economically unfeasible. Carbon neutrality, however, presents an economically viable and globally integrated pathway to compliance.

There are three aspects for the projected economic and carbon emission benefits. They are cost savings, supply chain resilience, and trade advantages, respectively. As with cost savings is the implementation of carbon neutrality through global carbon markets can reduce compliance costs by 30-50% compared to full-scale renewable energy overhauls. The supply chain resilience is to utilize international carbon asset circulation, Taiwanese manufacturers can maintain supply chain stability while progressively decarbonizing operations. The trade advantages are about the carbon-neutral certification enhances export competitiveness in regulated markets such as the EU, US, and Japan.

4.4 Conclusion: The Necessity of a Balanced Approach

While RE100 remains an important long-term sustainability goal, its rigid application presents fundamental challenges for economies with high industrial energy dependence and limited renewable infrastructure. The analysis in this chapter demonstrates that:

- Carbon neutrality provides a more flexible, cost-effective, and scalable solution for mitigating industrial emissions while maintaining economic stability and trade competitiveness.
- Global carbon asset circulation enhances inclusivity, allowing economies with high energy demands to participate in decarbonization efforts without disrupting industrial growth.
- The integration of carbon neutrality strategies into international supply chains ensures compliance with emerging carbon pricing regulations such as CBAM and CCA, safeguarding Taiwan's role in global trade.

Ultimately, the transition towards carbon neutrality via structured carbon markets is not just an alternative approach—it is a necessary evolution in global sustainability efforts. Taiwan, along with other industrially intensive economies, must embrace this paradigm shift to navigate the challenges of climate policy, energy security, and economic competitiveness in an increasingly carbon-regulated world.

V. Integrating Carbon Neutrality into Global Manufacturing Supply Chains: Challenges and Strategic Imperatives

The accelerating global shift toward sustainability presents both opportunities and challenges for manufacturing-exporting nations. Taiwan, as a leader in semiconductor production and high-tech exports, faces immense pressure to align with international supply chain sustainability mandates. However, structural limitations, policy gaps, and geopolitical risks complicate its ability to meet these demands. This chapter synthesizes prior discussions and expands on the role of international sustainability standards, corporate supply chain requirements, and the potential of carbon neutrality through global carbon asset circulation as a viable alternative to RE100.

5.1 Challenges for Manufacturing-Exporting Countries in the Global Sustainability Transition

The global sustainability transition is increasingly supply chain-driven, with major multinational corporations imposing strict environmental standards on their suppliers. Taiwan's manufacturing sector, which contributes over 60% of its GDP and accounts for 94% of exports, is deeply embedded in global supply chains. However, Taiwan's dependence on imported fossil fuels for 80% of its energy consumption presents a substantial challenge in meeting RE100 commitments. This challenges in Taiwan and similar manufacturing-exporting nations will remain critical until those high energy consumption countries or regions can find the approach to fulfill the goal of ecology and enterprise sustainability simultaneously.

Taiwan's electricity generation is dominated by coal (42.24%) and natural gas (39.57%), making it one of the most carbon-intensive economies in Asia. The carbon intensity of Taiwan's electricity sector is 530 gCO_2/kWh, significantly higher than the global average of 450 gCO_2/kWh, complicating emission reduction efforts. By contrast, economies like Germany and the UK, which have already phased out coal power, operate at much lower carbon intensities of 240 gCO_2/kWh and 180 gCO_2/kWh, respectively. Compliance with Global Corporate Sustainability Initiatives: Google aims to achieve net-zero carbon emissions across its supply chain by 2030, requiring suppliers to transition to clean energy sources (Google, 2024). Apple mandates its global suppliers achieve 100% carbon neutrality by 2030, influencing semiconductor and electronics supply chains in Taiwan (Apple, 2024). Amazon has pledged to power all its operations with renewable energy by 2025, pressuring logistics and hardware suppliers to meet similar goals (Amazon, 2024).

Failure to comply with these corporate sustainability mandates risks Taiwanese manufacturers losing contracts with major international buyers, weakening Taiwan's competitive position.

5.2 Evaluating Policy Alignment: Where Taiwan Stands in Global Supply Chain Sustainability

Taiwan's current renewable energy policies and industrial strategies do not fully align with the aggressive decarbonization targets set by international buyers and trade partners. While the government has pledged to reach RE30 by 2030, this remains significantly below the RE100 standard required by global supply chain leaders.

Table 3 Comparison of Taiwan's Policy Alignment vs. Global Sustainability Trends

Policy Focus	Taiwan	EU (CBAM)	US (CCA)	Corporate Mandates (Apple, Google, Amazon)
Renewable Energy Goal	RE30 by 2030	Net-Zero by 2050	Clean Energy Standard	100% Renewable Energy/Carbon neutrality
Carbon Pricing	Voluntary Offset Markets	Carbon Border Tax (CBAM)	Clean Competition Act	Supplier-Specific Carbon Goals
Energy Dependency	80% Fossil Fuel-Based	40% Renewable	45% Renewable	Renewable & Low-Carbon Energy Mandates
Compliance Risks	High	Medium	Medium	High (Supplier Risk)

Taiwan's limited progress in transitioning to renewable energy poses risks under the EU's CBAM, which will begin imposing tariffs on high-carbon imports starting in 2026. Similarly, the US's CCA is expected to introduce carbon pricing for imported goods, further impacting Taiwanese exports if rapid decarbonization is not achieved.

5.3 The Potential and Impact of a Global Carbon Asset Circulation Mechanism

Given Taiwan's structural and policy constraints, the establishment of a global carbon asset circulation mechanism could serve as an effective strategy to bridge the sustainability gap between manufacturing-exporting nations and international trade standards.

Key developments in global carbon asset circulation are highlighted as follows:

- The integration of carbon neutrality strategies into international supply chains ensures compliance with emerging carbon pricing regulations such as CBAM and CCA, safeguarding Taiwan's role in global trade.
- COP29 International Carbon Market Standards: The new international carbon market framework of UNFCCC aims to expand cross-border carbon trading and enhance transparency (UNFCCC, 2024).
- Indonesia's Carbon Market and Global Buyers: Indonesia has emerged as a major supplier of certified carbon credits, attracting corporate buyers from Japan, the US, and the EU (Lin, 2025).
- EU's Expanding Carbon Pricing Mechanisms: European nations are implementing carbon-adjusted electricity pricing, which affects manufacturing costs for industries reliant on imported fossil fuel-based power (Liberty Times, 2024).

By participating in global carbon markets, Taiwan's industries could: Offset emissions while maintaining trade competitiveness. Avoid supply chain exclusion from sustainability-focused multinational corporations. Leverage carbon credits to finance industrial decarbonization projects.

VI. Conclusion: The Global Policy Shift from RE100 to Carbon Neutrality

The evolution of industrial sustainability frameworks has reached a critical juncture. While RE100 has set an ambitious vision for corporate and national decarbonization, its rigid application creates structural, economic, and geopolitical barriers that disproportionately impact manufacturing-intensive economies like Taiwan. As demonstrated in this study, a transition towards carbon neutrality through global carbon asset circulation presents a more adaptive, equitable, and competitive alternative to conventional renewable energy mandates. The core contribution of this research lies in reframing sustainability strategy through the lens of global carbon markets, resource allocation, and industrial policy. By integrating Resource-Based View (RBV) and Dynamic Capability Theory, this study illustrates that carbon assets are not merely compliance instruments, but strategic economic resources that nations and enterprises can leverage to optimize both sustainability and industrial competitiveness.

Unlike RE100, which imposes unilateral renewable energy adoption, carbon asset circulation expands the pathways to carbon neutrality by enabling cross-border emissions trading, offset strategies, and investment in decarbonization technologies. This mechanism bridges the gap between carbon-intensive manufacturing economies and sustainability-driven global trade policies in three key ways:1. Strategic Resource Allocation for Decarbonization: Carbon credits function as tradeable financial assets, creating an incentive-based model for emissions reduction rather than an imposed regulatory burden. Countries with abundant renewable energy and sequestration capacity, e.g., Indonesia, Brazil, can monetize carbon assets, while industrial nations, e.g., Taiwan, South Korea, can offset emissions while modernizing energy infrastructure. 2. Resilience Against Trade and Regulatory Risks: Carbon neutrality frameworks allow firms to bypass carbon tariffs imposed under CBAM and CCA, mitigating the risk of trade exclusion for high-emission economies. Participation in standardized carbon trading platforms, e.g., those formalized under COP29, ensures that industrial nations retain access to global supply chains while meeting emissions reduction commitments. 3. Scalability and Investment Diversification: Unlike RE100, which requires direct capital investment in renewables, carbon asset circulation leverages international financial markets to fund sustainability transitions through carbon-linked investment instruments. The expansion of green finance, sustainability-linked bonds, and decarbonization venture capital accelerates emissions reduction without imposing disproportionate costs on emerging economies.

A structured global carbon asset circulation mechanism represents the next evolutionary step in sustainability policy. For Taiwan and similar economies, integrating into a globally standardized carbon market is no longer an option—it is a strategic necessity: 1. National Policy Implications: Taiwan must expand its carbon trading infrastructure to actively participate in global emissions offset markets, ensuring compliance with CBAM and CCA without disrupting industrial output. Apart then that, a hybrid energy transition strategy, integrating renewables with carbon market participation, will provide a more resilient path to decarbonization. 2. Corporate Supply Chain Strategy: Multinational corporations such as Apple, Google, and Amazon are moving beyond RE100 mandates, shifting towards supply chain-wide carbon neutrality—an opportunity for industrial nations to position themselves as preferred low-carbon suppliers.

Firms that integrate carbon asset circulation into business models will gain a competitive advantage in sustainability-driven procurement policies.

The sustainability agenda must evolve beyond prescriptive RE100 mandates to recognize carbon neutrality as the dominant framework for industrial economies. By facilitating structured global carbon asset circulation, nations can redefine the economics of sustainability—turning carbon emissions from a liability into a tradable asset that fuels economic resilience, trade compliance, and long-term industrial growth.

As the international regulatory landscape moves toward carbon pricing, trade-adjusted emissions policies, and corporate sustainability governance, economies that proactively engage with carbon asset circulation will lead the transition towards a balanced, equitable, and strategically aligned climate policy framework. Taiwan and similar economies must seize this opportunity to embed carbon neutrality into industrial strategy, ensuring continued participation in global supply chains while driving meaningful emissions reductions at scale.

The pathway to sustainable industrial policy does not rest solely in energy transformation; it lies in the creation of an interconnected, market-driven carbon economy. Differently put, facilitating the evolution from renewable energy mandates to carbon-assets circulation globally.

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高科技產品出口國家實現 RE100 的挑戰與機會──以台灣為例

周家豪*

益珂環能總經理，台北，台灣

摘 要

近年來，國際上以「RE100 倡議」來推動企業 轉向 100%再生能源，但對於以製造業出口為主的國家（如台灣）而言，此舉面臨嚴峻挑戰。作為全球半導體與高科技產品供應鏈的重要節點，台灣在能源結構、政策法規與基礎建設等層面上皆面臨重大制約。本研究從六個關鍵面向探討台灣在 RE100 實踐過程中的挑戰：(1) 台灣與已開發國家（如英國）的可再生能源發展比較；(2) 台灣能源轉型的局限性，包括地理條件、經濟與政治因素、以及達成 RE30 的政策障礙；(3) 台灣高科技（製造）產業，可能會因再生能源供應不足，而失去在全球供應鏈中的競爭力；(4) 全球碳資產流通機制作為可行的解決方案，平衡可持續發展與產業競爭力；(5) COP29、歐盟與美國政策對台灣可再生能源策略的影響；(6) 台灣再生能源發展藍圖的評估及 2030 年前的挑戰。結果顯示，雖然台灣在再生能源推動方面已有進展，但若要符合 RE100 標準（如 AMOZON 及其供應鏈），仍需進一步的系統性改革。本文以資源基礎觀點與動態能力理論為理論基礎以進行討論，主張從 RE100 轉向碳中和，並透過全球碳資產流通機制，來建立更具可行性與流通性的全球產業減碳模式，以促進高能源消耗製造經濟體的永續發展需求與全球碳排放總量管制的目標。

關鍵詞：碳中和、RE100、可再生能源、碳資產流通、台灣、永續發展策略、工業碳排放減量、能源政策

* 行銷學博士，英國斯特拉斯克來德大學。howard@strategyesg.com。