Sustainable Strategic Resource Circulation

Background

To achieve the 2050 Net-Zero emission target, Taiwan has designated ten key items, including electronic equipment, energy storage and electric vehicle batteries, and solar panels, within the "Resource Circulation Zero Waste" Strategic Action Plan, establishing a materialization strategy for metal waste. However, with a 100% import dependency on metal minerals since 2021, Taiwan's energy and high-tech sectors face severe challenges:

(1) surging global demand linking critical minerals to international supply chains and national security

(2) geopolitical vulnerabilities arising from the highly concentrated and non-renewable nature of these minerals

(3) significant overseas leakage of critical metal waste generated by domestic strategic industries due to insufficient local refining capacity.

To ensure a stable supply of critical resources for Taiwan’s advanced industries amid profound global geopolitical shifts, it is imperative to rapidly implement strategic resource circulation initiatives to secure a competitive advantage.

Current Status of Domestic and International Development

Globally, nations are accelerating strategic resource protection. The EU’s 2023 Critical Raw Materials Act (CRMA) mandates ≥25% recycled consumption and caps single-country supply at 65%. The U.S. has initiated material flow inventories and promoted international green finance. In Asia, Japan has optimized waste import regulations to expand domestic refining capacity and established a 60-day strategic reserve; South Korea has set a 20% recycling target by 2030 and joined the Minerals Security Partnership (MSP).

Domestically, Taiwan generates approximately 370000 tons of waste that contain critical metal are generated annually. Despite R&D progress, inadequate regulatory mandates and insufficient market incentives have hindered commercialization, resulting in the annual loss of approximately 50,000 tons of high-value rare and precious metals overseas. Comprehensive domestic policy and regulatory frameworks are urgently required to address this long-term reliance on international supply chains.

Developing strategic resource circulation is vital for securing economic stability and achieving Net-Zero targets. Diversifying development and retaining domestically generated waste resources can ensure a secure supply of critical raw materials while balancing carbon reduction with industrial development. Thus, Taiwan Science and Technology Office for Net-zero Emission (T-stone) outlines two layout visions for strategic resource circulation: (1) achieving at least a 20% domestic autonomous circulation and reuse rate for key resources by 2030, while capping single-country import dependency at 65%; and (2) ensuring

at least a 16% comprehensive carbon reduction across total manufacturing processes. This aims to build a low-carbon, fully circular supply chain, accelerating Taiwan's Net-Zero transition and strengthening supply chain resilience.

Promotion Strategy Framework

Addressing the complex issue of "Strategic Resource Circulation," the T-STONE has formulated six major strategies to realize core values across three dimensions: "Innovative Technology R&D," "Circular Industry Linkage," and "Sustainable Market Mechanisms". Through systematic deployment across the four facets of society, scientific research, industry, and governance, the objective is to reverse the current outflow of critical materials and form a low-carbon, full-circulation industry chain for strategic resources.

Vision

To establish a low-carbon circular industrial chain for strategic resources that balances economic value and national security, and to enhance national resilience in critical resources.

(achieving at least 20% self-sufficiency through the recycling and reuse of key strategic resources)

1. Develop high-efficiency refining technologies for rare and precious metals, and promote the development of substitute materials for critical strategic resources.
2. Accelerate industrial linkages through demonstration and validation of strategic resource circularity, and establish strategic resource circular industry clusters.
3. Establish market incentive mechanisms and supporting regulatory frameworks to facilitate the sustainable development of the strategic resource circular industry chain.

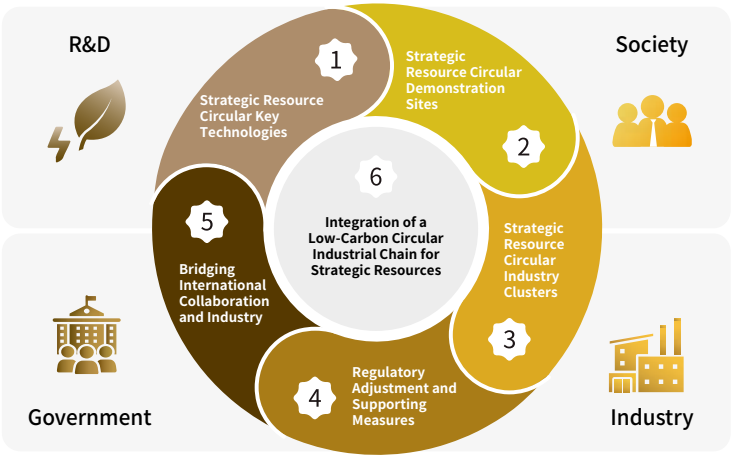

Figure 1 Layout of Promotion Strategy for Strategic Resource Circulation

Source: Taiwan Science and Technology Office for Net-zero Emission (T-STONE) (2025)

Strategy 1: Critical Technologies for Strategic Resource Circulation

Globally, over 22 countries have formally identified specific "strategic resource categories" that impact national and economic security, with metal mineral resources (e.g., rare earths, copper, nickel) being major components. As a primary hub for the global high-tech and electronics industries, Taiwan must ensure its resource management practices align with these international frameworks to maintain its competitive edge in the global supply chain. Centered on the full-circulation lifecycle of the electronics industry, this strategy focuses on the R&D and application of high-efficiency, low-carbon technologies across four key processes: (1) Manufacturing and Use phase: introducing green design concepts such as easy-to-disassemble modules; (2) Recycling and Pre-treatment phase: applying AI-driven smart identification and precision sorting technologies; (3) Refining phase: developing composite low-carbon refining technologies to reduce energy consumption; (4) Reuse phase: enhancing high-efficiency recycled material screening and quality validation capabilities.By advancing technological improvements across both upstream and downstream stages, this strategy establishes the critical infrastructure to support technology deployment.

Strategy 2: Establishment of Strategic Resource Circulation Demonstration Bases

Focusing on industrial demonstrations for strategic critical resources, two primary demonstration axes are planned for critical materials (e.g., low-volume rare/precious metals such as lithium, cobalt, tantalum, and rare earth metals) and strategic materials (e.g., high-volume base metals such as copper and aluminum). Based on refining scale and technological maturity, it establishes the "Low-Carbon Circulation Demonstration Site for Rare/Precious and Rare Earth Metals" and the "Stockpile Demonstration Site for High-Volume General Metals". By pursuing parallel tracks of technology deployment and feedstock stability, this strategy strengthens Taiwan's industry value chain integration in the electronic product resource circulation sector, constructing a demonstration system with strong potential for international alignment.

Strategy 3: Strategic Resource Circulation Industrial Clusters

This strategy focuses on integrating the two aforementioned demonstration sites with the industry-government-academia-research platforms of technology R&D centers to shape the "Three Major Centers" of the strategic resource industrial cluster. By promoting collaborative development across upstream and downstream industries, this approach bridges gaps in the industrial value chain, ensures a stable supply of recycled feedstock, and enhances the self-sufficiency rate. The construction of this cluster will provide long-term directional guidance for Taiwan's rare/precious metals and high-volume base metal industries.

Strategy 4: Regulatory Adjustment and Supporting Measures

Comprehensive regulations and incentive mechanisms are critical for industrial implementation. This strategy aligns with international norms and draws on the implementation processes of advanced nations. Core measures include: developing a prioritized strategic resource list and domestic retention strategies tailored to national circumstances; setting transparency and disclosure standards for imported electronic products; establishing economic incentive mechanisms integrated with Extended Producer Responsibility (EPR) (such as processing fee subsidies and stockpile rewards); and constructing a green finance and insurance system for metallic strategic resources.

Strategy 5: Bridging International Capacity

Capitalizing on Taiwan's technological advantages, this strategy promotes the global export of circular technologies from leading industries, such as advanced semiconductors and electronic appliances. It establishes international industry-academia cooperation platforms with neighboring import-dependent countries and policy-driven nations. In response to the global competition for critical minerals, the strategy supports enterprises in acquiring access to overseas natural mining sources or "urban mines" (e.g., reverse recycling of waste electronic products) through technology investment, technology transfer, and overseas technical services. Concurrently, it leverages the experiences of international demonstration sites to accelerate the development of domestic validation and implementation systems.

Strategy 6: Integrating the Low-Carbon Industrial Chain for Strategic Resource Circulation

Focusing on the integration of full-lifecycle carbon reduction benefits, this strategy aligns with international carbon reduction certification standards to establish carbon emission models and parameter data that fit Taiwan's context. By establishing open digital knowledge platforms and cross-disciplinary promotion platforms, it periodically assesses market supply risks and dynamically adjusts strategies. Simultaneously, it optimizes digital management systems and fosters cross-disciplinary talent to bolster the resilience and sustainability of the entire resource cycle.

Implementation Benefits

According to the International Energy Agency (IEA), metal recycling and reuse can reduce greenhouse gas emissions by an average of 80% compared to virgin material extraction. By achieving a 20% self-sufficiency rate in critical resource circularity by 2030, Taiwan is projected to realize substantial carbon savings exceeding 2 million metric tons of CO_2e annually. This strategic shift will drive a 16% reduction margin in the carbon footprint of the raw material phase within Taiwan's electronics sector.

With Taiwan's annual critical mineral imports valued at NT$670 billion, substituting imports through autonomous circularity is expected to generate NT$130 billion in direct economic value. Beyond financial gains, enhancing

resource autonomy mitigates the risks of global supply chain disruptions. Furthermore, cultivating over a thousand global-minded green-collar professionals will fortify the nation's industrial resilience, economic security, and long-term sustainable transition.

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