經濟部
Ministry of Economic Affairs

Circular Tech, New Energy, and Carbon Reduction:
Building a Sustainable Net-Zero Supply Chain

Key Industries in Taiwan
Circular Economy 2024

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“Industry Policy Guidelines”

Transitioning to a Sustainable Circular Economy

The concept of a circular economy has spread across the world. Countries are redesigning products and implementing measures for raw materials, manufacturing, sales, recycling, decomposition, preservation, regeneration, and services to ensure a new economic model for continued resource recycling.

To transform from a linear economy of “Take, Make, Use, and Dispose” to a sustainable circular economy, Taiwan introduced the 5+2 Industrial Innovation Plan in 2016. The plan encompasses intelligent machinery, Asia Silicon Valley, green energy, biomedicine, national defense and aerospace, new agriculture, and the circular economy – with the goal of employing green recycling technologies to drive sustainable development. In March 2022, Taiwan announced the Pathway to Net-Zero Emissions in 2050, followed by the 12 Key Strategies, which included specific action plans for “Resource Recycling and Zero Waste” and “Carbon Capture, Utilization and Storage (CCUS).”

The Resource Circulation Agency (RECA) under the Ministry of Environment (MOENV) is adopting three major circulation strategies: 1) green designs for waste reduction at source; 2) resource recycling and reuse; and 3) managing waste treatment capacity. At the same time, the RECA is developing innovative technologies to support resource circulation.

In response to international efforts to end plastic pollution, the RECA also promotes plastic recycling through elimination and substitution, source reduction, enhanced recycling, and circular regeneration to reduce the use of virgin materials. Products with eco-friendly designs enjoy a preferential recycling fee, known as the “green rate,” encouraging greater innovation in materials or product designs.

To foster development of circular technologies, the RECA also solicits innovative R&D projects for resource recycling from public and private universities, research institutions, product manufacturers, mandated recycling enterprises, recycling and processing industries, and related factories, companies, or legal entities. The maximum subsidy is NT$5 million, with a total budget of NT$100 million.

Industry Overview

Taiwan's strength in developing a circular economy lies in its comprehensive and diversified industrial chain. It is also home to many R&D units, engineering consultancy firms, and factories in clustered industrial parks. This set up has contributed to numerous examples of successful waste utilization, providing a solid foundation for promoting a circular economy.

Leveraging the circular economy to obtain resources and upgrade industries is especially crucial for the steel and petrochemical industries, which support the development of key high-tech industries. According to the *2024 Republic of China National Greenhouse Gas Inventory Report*, CO_2 emissions data for 2022 from the manufacturing and construction industries (see Table 1) indicate that the steel industry accounted for the highest proportion, representing 29.9% (9,658 thousand metric tons). Although emissions from petroleum refining only accounted for 4.8% of the energy industry, it still accounted for 8,796 thousand metric tons.

While CO_2 is not emitted in the semiconductor industry, other greenhouse gases (GHGs) such as N_2O, HFCs, PFCs, NF_3, and SF_6 are present and must be addressed due to their environmental impact. The GHG emissions from semiconductors, converted to CO_2 equivalent, amount to approximately 2,835 thousand metric tons. Given the importance of Taiwan's semiconductor industry, its development is closely tied to that of Taiwan's economy. As such, addressing carbon emissions from this sector must be a priority.

Table 1. CO_2 Emissions Data by Sector for 2022

(Unit: thousand metric tons of CO_2)

Sectors & Industries	Total Emissions
1. Energy Sector	257,958
1.A.1. Energy Industry	181,621
1.A.2. Manufacturing and Construction Industry	32,261
1.A.3. Transportation	34,696
1.A.4. Other Sectors (incl. Service; Residential; and Agriculture, Forestry, Fishery, and Husbandry Industries)	9,380
2. Industrial Process and Product Use Sector	14,770
2.A Mining Industry (Non-metal Process)	6,464
2.B Chemical Industry	1,270
2.C Metal Process	7,020
2.D Non-Energy Products from Fuels and Solvent Use	0.00006
2.E Others	15
3. Agriculture Sector	22
4. Waste Sector	933
Total GHG Emission (excl. LULUCF)	273,683

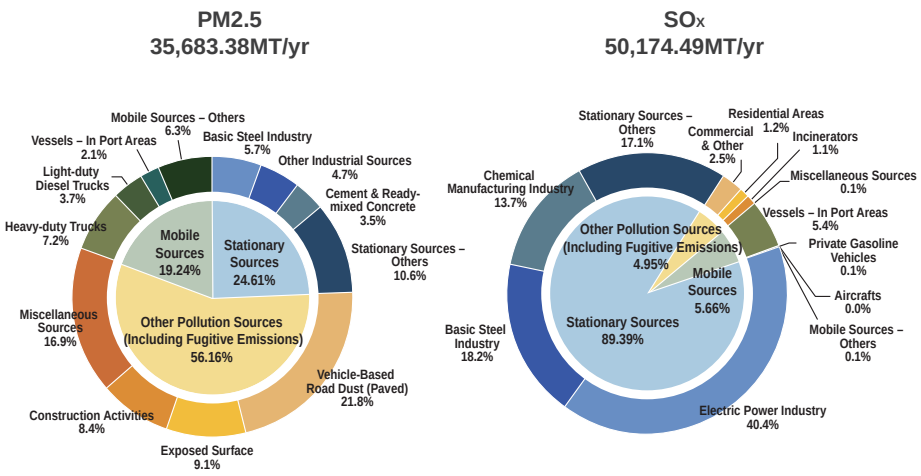
Source：*2024 Republic of China National Greenhouse Gas Inventory Report*

1 Steel Industry's Move Towards a Circular Economy

Steel is corrosion- and heat-resistant, making it a functional and versatile material widely used in many fields such as the automotive, ICT, electronics, and medical equipment industries. As such, the steel industry is often referred to as the "mother of industries."

Major Pollution in the Steel Industry Necessitates Transformation

The steel industry generates significant air pollution during production. According to the Ministry of Environment (MOENV), the steel industry accounts for 5.7% of the total PM2.5 emissions and 18.2% of the total SOx emissions in Taiwan, meeting the threshold of a high-pollution industry.



Source: Taiwan Emission Data System (TEDS)

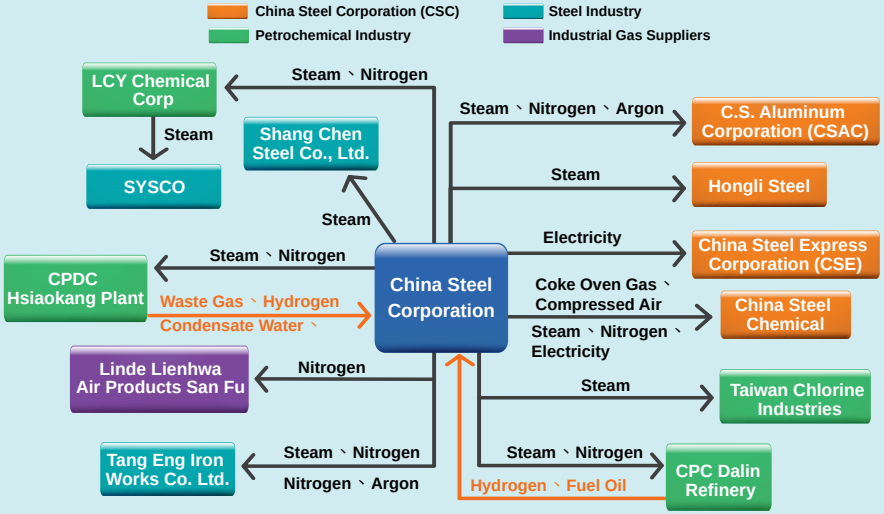
Figure 1. Overview of Air Pollution Sources in Taiwan, 2023

Efficient Waste Recycling: The Evolution of Steel Circular Economy

Steel stands out as a sustainable material as it is nearly 100% recyclable, highly durable, and has a long lifespan. Recycling steel significantly reduces the extraction of raw materials and conserves energy. The steelmaking process also generates numerous by-products such as slag, light oil, iron powder, and oxygen, which can be reused directly or after processing. Additionally, the high temperatures required in steel production may be utilized for processing waste. Recyclable components within waste, such as iron, carbon, or thermal energy, can be effectively recovered during the smelting process. These components serve as alternative raw materials or fuels, reducing the need for incineration and solidification, which is a major advantage for the steel industry in transitioning to a circular economy.

The Ministry of Economic Affairs (MOEA) has set up a dedicated committee to promote net-zero emissions policies and collaborate with relevant ministries to initiate transition strategies. The MOEA has also partnered with China Steel Corporation (CSC), establishing the Task Force on Energy Saving & Carbon Reduction and Carbon Neutrality, which focuses on enhancing energy efficiency, introducing carbon capture technologies, and adopting low-carbon energy sources.

China Steel Corporation (CSC) has long invested in research on recycling and reusing steelmaking by-products into raw materials for other industries. For instance, steelmaking produces approximately 1.6 million tons of basic-oxygen-furnace (BOF) slag annually in Taiwan. By collaborating with government agencies and other industries, CSC has successfully expanded BOF slag applications for road paving, cement raw materials, and land reclamation. Continuous research on high-value applications of BOF slag has transformed it into a premium engineering material that promotes the circular economy and carbon reduction benefits.



Source: Development of Taiwan's Circular Economy, 2020

Figure 2. Energy Integration at the Kaohsiung Linhai Industrial Park

Additionally, Taiwanese steel companies are venturing into the chemical industry for CCUS collaborations. CSC has invested NT$200 million in Taiwan's first Steel and Chemicals Co-Production Pilot Plant for the validation of carbon recycling technologies. The plan is to form an alliance with the chemical industry to develop a demo plant to verify commercial models. Upon validation, an industrial park dedicated to carbon recycling will be established, with an estimated annual carbon reduction of 2.9 million tons, creating new green industry opportunities.

Development Gaps in SMEs and Collaborative Solutions

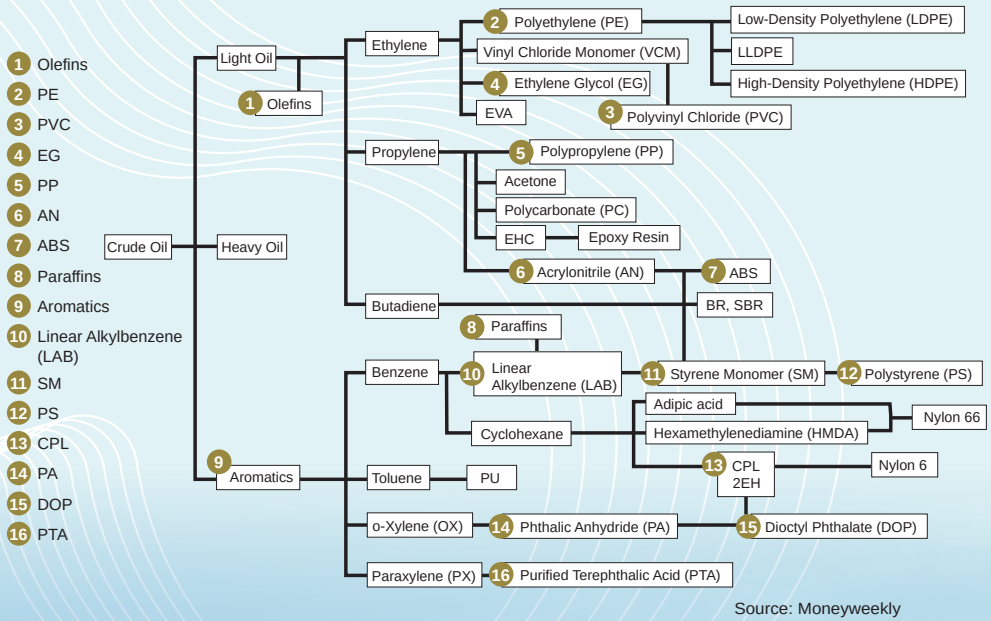
Taiwan's steel industry encompasses smelting, casting, and forging, with a majority of small to medium-sized enterprises (SMEs) despite the presence of large steel mills. For sustainable long-term development, the industry must focus on value-added services, energy-efficient production processes, and industry resource recycling - challenges to the circular economy within the steel sector.

While the inherent properties of steel provide an advantage for implementing circular economy practices, external constraints still pose significant challenges, including supply chain integration and innovation. Taiwan's steel industry has numerous examples of successful recycling and process improvements. Future opportunities may arise from sharing resources and services, and exploring partnerships with international companies for further breakthroughs.

2 Petrochemical Industry's Move Towards a Circular Economy

The petrochemical industry is closely linked to everyday consumer products, with net-zero carbon emissions and sustainable development becoming critical international trends. Leading global brands are setting goals to incorporate recycled plastics, prompting petrochemical manufacturers to accelerate the development of recycled materials.

Taiwan's petrochemical industry is a vast ecosystem, with nearly 10,000 downstream processing companies. Currently, there are 43 mid-to-upstream petrochemical companies, divided into two main systems: the CPC system and the Formosa Plastics Group (FPG) system, both of which dominate Taiwan's upstream raw materials through their naphtha crackers.



Source: Moneyweekly

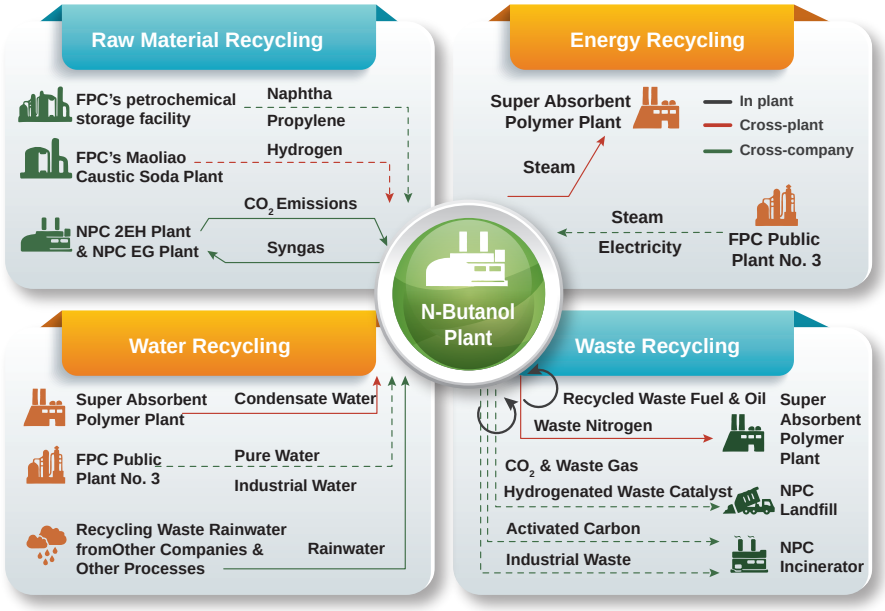
Figure 3. The Petrochemical Industry Supply Chain

Environmental costs have become a significant expense for the petrochemical industry, which is adopting corresponding circular economy strategies (e.g., thermal cracking technologies) to mitigate these costs. Another important collaboration model involves petrochemical plants working with recyclers to manage waste plastics effectively.

In response to the global trend of sustainability and environmental protection, as well as the negative spillover effects from the mass production of petrochemical and plastic products by other countries, Taiwan's petrochemical industry, represented by Formosa Plastics Group (FPG), has recently formulated crucial transformation strategies, such as deepening industry-academia-research collaborations, learning from the strategies of major global petrochemical companies, and establishing transition and development taskforces.

Taiwan's Petrochemical Industry's Competitive Advantage: Efficient Use of Water

The petrochemical industry is highly water-intensive. During periods of water scarcity, it is particularly crucial for the petrochemical industry to adopt wastewater treatment technologies to reduce water intake and costs. Wastewater comes from various sources, making it unlikely that a single treatment technology would be suitable for all types of wastewater.



Source: FPG Official Website

Figure 4. Example of Cross-plant and Cross-company Collaboration for Circular Economy, FPG's N-butanol Plant

For example: The Chang Chun Group has developed technology to recycle and reuse developer waste, helping manufacturers treat developer waste liquid and reducing treatment costs by over 80%; LCY Chemical Corp has successfully developed innovative technology to help downstream customers recycle and reuse isopropanol waste liquid; and FPG, within the Sixth Naphtha Cracker Project, has achieved a water recycling rate of 91.5% across the entire complex, saving up to 112.6 million tons of water annually.

Major Petrochemical Companies in Taiwan are Investing in Resource Recycling

Resource recycling is considered a crucial concept of the circular economy, and the major players in Taiwan's petrochemical industry have made significant strides beyond just recycling water. For instance, Nan Ya Plastics recycles billions of PET bottles annually, converting them into functional yarns supplied to major sports brands. Under its eco-friendly brand "SAYA," Nan Ya has developed innovative products such as BPA-Clear recycled yarn, CHROMUCH dope-dyed yarn that combines low carbon and water-saving properties with high vibrancy and colorfastness, and closed-loop recycling-friendly polyester products under the OneHub concept.

Formosa Plastics has also made groundbreaking advancements, such as developing the world's first "Formosa New Functional PP Fiber," which is used to create the world's first fully recyclable, single-material PP cold-resistant clothing, along with fashionable sports hoodies, seizing opportunities in the high-performance functional apparel market.

3 Semiconductor Industry's Move Towards a Circular Economy

The global semiconductor industry is a vital pillar of modern technology and economy. It encompasses a comprehensive ecosystem from chip design to manufacturing, testing, packaging, and final applications. This industry drives advancements in sectors including manufacturing, automotive, medical devices, industrial automation, and the Internet of Things (IoT).

Taiwan's Semiconductor Industry Shows Excellence in Waste Management

Taiwan's Semiconductor Industry Continues to Enhance Waste Recycling Technologies

Taiwan's semiconductor industry had the second highest global output value in 2020. However, the manufacturing process involves the use of various chemical raw materials, leading to the generation of chemical gases that pollute the air. Fortunately, comprehensive systems are in place to manage waste resources, including electricity reuse, wastewater recycling, solvent recovery, and waste heat recovery.

TSMC Leads by Example, Gradually Increasing Recycled Resources

TSMC (Taiwan Semiconductor Manufacturing Company) is the global leader in semiconductor foundries. Continuous expansion in recent years has resulted in an upward trend in the total amount of generated waste. In 2022, the total outsourced industrial waste from its Taiwan facilities reached 704,918 tons, nearly double the 377,767 tons in 2018. However, the waste recycling rate also remained high at 96% in 2022. The total amount of recycled resources within plants also showed a significant increase, reaching 268,935 tons in 2022, nearly three times that of 2018.

Table 2. Semiconductor Waste Types and Recycling Products

Types of Semiconductor Waste	Treatment	Recycled Products
Wastewater from Cleaning	Chemical Neutralization, Filtration	Recycled for Domestic Use After pH Adjustment (Non-Potable)
Concentrated Sulfuric Acid Waste	Collected for Recovery	Used in Metal Manufacturing
Copper Sulfate Waste	Electrolytic Reduction in Closed Tubular System, Copper Metal Ions Collect at Cathode	Semiconductor-Grade Recycled Copper Tubes (Reused in TSMC)
Hydrofluoric Acid Wastewater	Calcium Chloride Sludge (pH Adjusted with Sodium Hydroxide, Reacts with Calcium Chloride, Producing Precipitated Calcium Carbonate, Dehydrated and Filtered)	1. Synthetic Fluorite (Used as Flux in Steelmaking) 2. Secondary Raw Material for Cement Production
Isopropanol Waste	Distillation and Purification	Converted to General Industrial Isopropyl Alcohol
Process Control Chips	Chemical Etching, Mechanical Grinding, and Cleaning	Recycled Wafers (Reused Process Control Chips)

Source: SEMI/Circular Taiwan Network/Business Today/Compiled by Metal Industries Research & Development Centre MII-IT IS Research Team

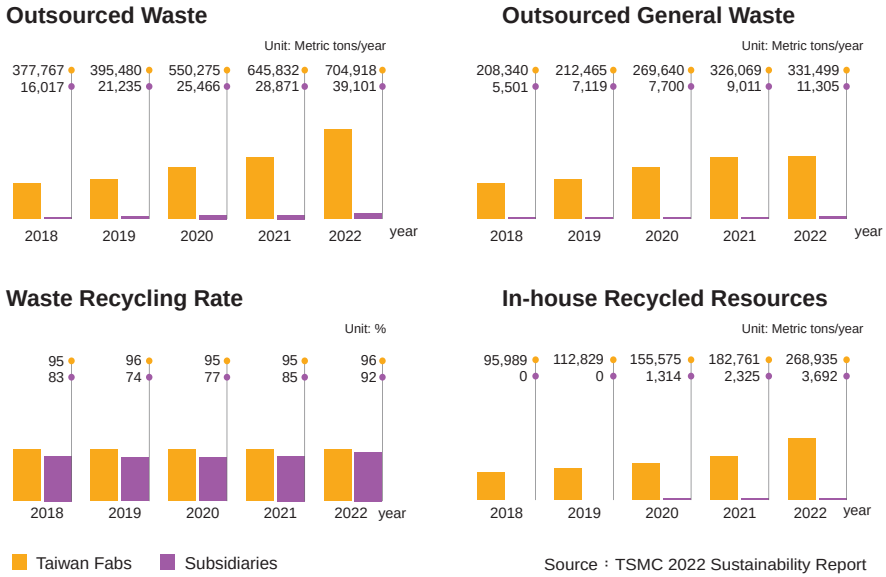


Figure 5. Waste & Resource Recycling at TSMC (2018-2022)

Gaps in the Circular Economy of Taiwan's Semiconductor Industry

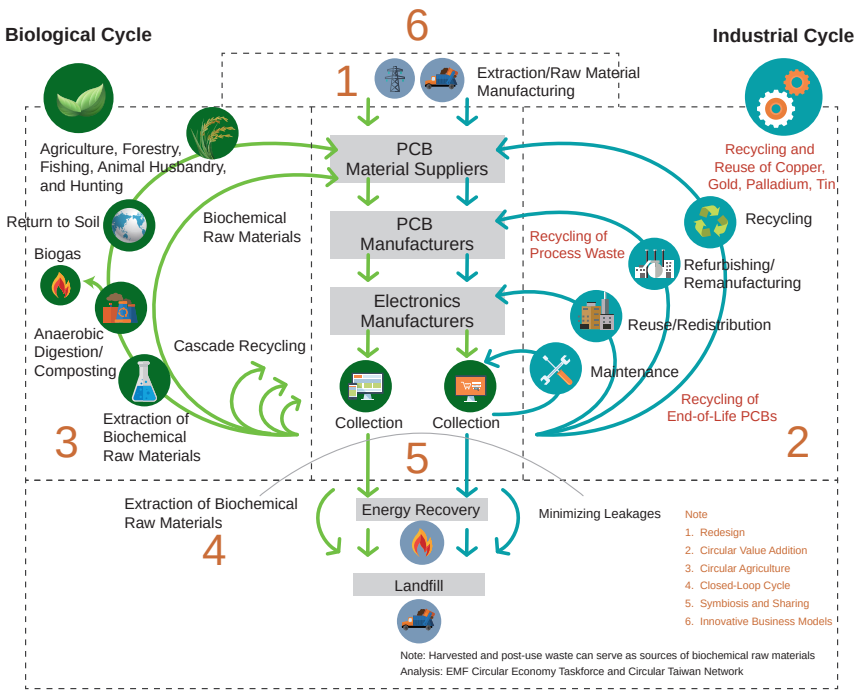
Although Taiwan plays a crucial role in the global semiconductor industry, there are still many areas that need improvement for the circular economy. The recent rise of ESG issues has compelled Taiwan's semiconductor and ICT industries to carefully consider how to enhance environmental protection throughout manufacturing processes and product recycling.

A Key Focus: Incorporating Circular Economy into Printed Circuit Boards (PCBs)

The PCB industry has two circular economy models. The first loop involves the internal recycling of manufacturing waste (i.e., defective boards and waste chemical solutions), from which reusable resources like copper and gold can be recovered through recycling plants and technologies. These reusable resources are then returned to PCB material suppliers, forming a circular economy model.

The second loop occurs after the materials are successfully manufactured into PCBs and used in end products. Once these products are discarded by consumers, the circuit boards with components are processed using recycling technologies to recover reusable resources like copper and gold, which are then returned to PCB material suppliers, forming another circular economy loop.

Recycling technologies for PCBs include incineration, physical, and chemical methods. Each possesses pros and cons, such as secondary pollution, inefficiency, high investment costs, and the inability to recover certain valuable materials. As such, there is still room for improvement. Limitations in copper smelting equipment and regulatory constraints hamper the development of a circular economy for PCBs in Taiwan.



Source: Circular Taiwan Network official website; Taiwan Printed Circuit Association (TPCA); ITRI IEK

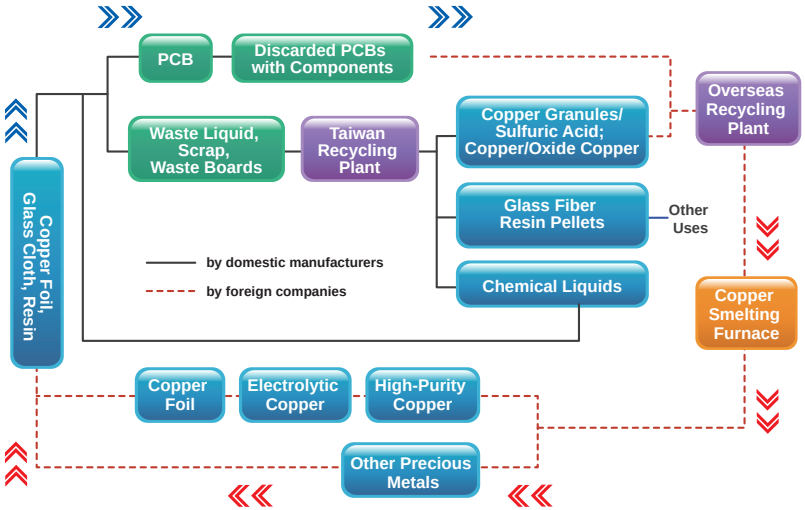
Figure 6. Taiwan PCB Circular Economy Process

Reusing Waste from PCBs is a Key Priority

Addressing waste management issues requires more than just economic incentives. There is significant room for improvement in recycling operators, projects, and regulations. This results in issues such as an underdeveloped corresponding ecosystem and a lack of harmonization in the verification and regulation of recycled resources.

For instance, most wastewater from PCB manufacturers in Taiwan is treated in-house, but typically only to the extent that it meets discharge standards before being released. Treating wastewater to a reusable level involves additional equipment, which is often expensive, and each additional treatment cycle increases the associated costs. Taiwan's low water prices and minimal subsidies do not provide sufficient incentives for manufacturers to increase wastewater recycling and reuse rates.

Copper recycling faces similar challenges. Copper from PCB waste, whether solid waste or waste liquids, is typically low-purity crude copper. This crude copper needs refining in copper smelting furnaces to become high-purity copper. However, Taiwan lacks copper smelting furnaces, so most crude copper is sold to foreign companies for refining and then used to make copper materials, completing the PCB circular economy.



Source: TPCA; ITRI IEK (2018/02)

Figure 7. Taiwan PCB Circular Economy Process

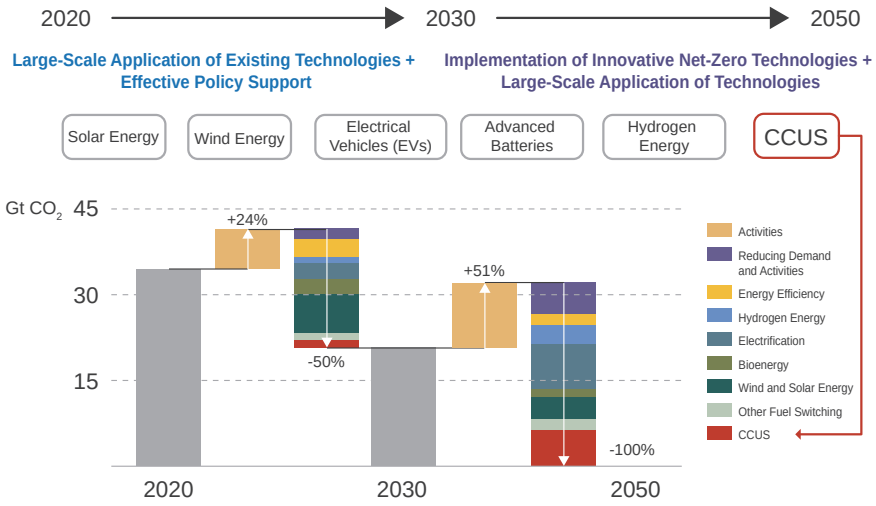
“Opportunities for Foreign Investment”

According to projections by the International Energy Agency (IEA) in the sustainable development scenario, "process technology improvements" and "renewable energy" are the key technologies contributing to carbon reduction in the early phase (2020 to 2040). From 2040 to 2050, "Carbon Capture, Utilization, and Storage" (CCUS) and hydrogen applications become the critical technologies for carbon reduction. The IEA estimates that industries with high CO_2 emissions, such as thermal power generation, chemical production, cement, and steel, will increasingly adopt CCUS technologies from 2040 onwards to significantly reduce carbon emissions. The key pillars of global energy decarbonization are energy efficiency, changing human activities, electrification, renewable energy, hydrogen, bioenergy, and CCUS.

Taiwanese industries and research institutions have made some progress in CCUS, but are currently limited to the demo plant stage. The Taiwanese government has formulated the “Carbon Capture, Utilization and Storage, CCUS Action Plan” under the Pathway to Net-Zero by 2050, allocating a total of NT$2.8919 billion in funding for 2023 to 2024.

Currently, there are two major forward-looking strategies under planning: 1) development of forward-looking CCUS technology, and 2) field demonstrations. The first strategy focuses on developing and demonstrating CO_2 and CO-based carbon cycling technologies for at least four sites within the petrochemical and steel industries. It involves over nine companies investing more than NT$2 billion in research and development. The goal is to establish the technology needed for large-scale carbon cycling systems and to create a chemical industry chain based on CO_2 in Taiwan.

The second strategy aims to construct and complete a ton-scale carbon capture demo site by 2025, targeting a carbon reduction of at least 300 tons per year. This will provide a foundation for industries to establish million-ton-scale carbon capture systems. The strategy plans to attract over NT$400 million in investments from businesses from 2023 to 2024, promoting the expansion of these technologies to other factories and enhancing economic benefits and commercial applications. Overall, the CCUS strategy is expected to drive private investment of NT$20.4 billion and generate over NT$36 billion in output value by 2030.



Source: IEA (2021), Net Zero by 2050-A Roadmap for the Global Energy Sector

Figure 8. Key Pillars of Global Energy System Decarbonization

Common wastes in the steel industry include iron slag, steel slag, and Electric Arc Furnace (EAF) dust. Taiwanese companies handle these wastes by recycling EAF dust, zinc-containing waste, and waste iron. Producing one ton of steel billet generates about 2% EAF dust, which mainly contains zinc, lead, and cadmium. Currently, Taiwan employs four recycling technologies for EAF dust: High-Temperature Rotary Kiln, Multi-Layer Furnace + Electric Furnace, High-Temperature Molten Reduction Furnace, and Submerged Arc Furnace (SAF). Companies are actively investing in these technologies.

Establishing a zinc smelting industry could integrate the flow of zinc-containing materials and cross-industry capital, creating a closed-loop zinc resource network. This network would provide over 5.5 tons of zinc oxide annually, ensuring the full utilization of zinc-containing dust. Such integration would extend the resource recycling industry chain and increase overall value. Moreover, innovative zinc resource technologies would not only take root domestically but also aid in optimizing and upgrading industrial technologies. This would help expand sales channels, promoting mutual benefits for the industry.

Although the Taiwanese government has no specific CCUS plans or policies for the electronics and semiconductor industries, TSMC, the world's leading semiconductor foundry, is proactive in encouraging suppliers to develop carbon capture equipment for distillation towers and design CO_2 residual liquid recovery systems for return tankers. These initiatives aim to reintegrate residual gases from the industrial-grade liquid CO_2 distillation process into the production process, purify them, and convert them into electronic-grade liquid CO_2 that meets TSMC's quality standards, enhancing resilience in the green supply chain.

The main sources of waste in Taiwan's semiconductor industry are crystal growing plants and wafer fabs, which account for 70%. Packaging and testing plants account for 20%, and others for the remaining 10%. Potential resource recycling examples include: recycling waste from chip cutting at crystal growing plants into cutting powders, silicon ingots, and cutting fluids; and recycling fluorine-calcium sludge from wafer fabs into artificial fluorite.

As mentioned earlier, Taiwan's steel industry has made significant efforts in waste recycling and reuse. Moreover, the steel industry provides materials for various downstream industries. Integrating platform resources and connecting with international markets could accelerate the development of Taiwan's steel industry in the circular economy. For instance, Infrastructure as a Service (IaaS) providers like Microsoft and Software as a Service (SaaS) providers like PTC are collaborating with local metal fastener companies wishing to market their products internationally. The domestic metal processing industry has already invested considerably in the circular economy as well. Collaborating with international SaaS providers from a circular economy perspective would deepen connections for local companies.

In conclusion, Taiwan has invested substantial resources in the circular economy across the petrochemical, steel, and semiconductor industries, significantly enhancing environmental protection and strengthening relationships with international supply chains. As the 2050 net-zero policy has become a common goal for government ministries, additional policies have been introduced to promote domestic economic growth. Government budget for the 2050 net-zero transition exceeds NT$2.8919 billion, creating a carbon capture industry valued at over NT$36 billion. In the semiconductor sector, TSMC leads the ecosystem in actively promoting the development of the circular economy. TSMC and other renowned semiconductor companies have also planned expansions domestically in recent years, benefiting carbon capture and ESG investments.

Investment Incentives

To attract corporate investment, the government offers various incentives and subsidy programs, including:

Corporate Level – Tax exemptions for industrial parks to attract introduction of advanced foreign technologies to Taiwan

Incentive	Details
Global Innovation Partnership Initiatives Program	The program encourages multinational companies that complement Taiwanese industries to engage in R&D of forward-looking technologies, critical technologies required by the industry, or integrated technologies with Taiwanese companies to build Taiwan's industrial ecosystem. Collaboration can extend to startups and production activities for deeper value creation, achieving mutually beneficial outcomes. MOEA-approved companies can receive subsidies up to 50% of the total R&D expenses.
R&D Incentives in Science and Industrial Parks	The designated management bureau for science or industrial parks provides subsidies for innovative industry-academia collaboration R&D projects. To be eligible, applicants must obtain the "scientific industry" qualification within the park and utilize an industry-academia collaboration model. Each approved R&D project is eligible for subsidies of up to NT$10 million, but this amount shall not exceed 50% of the total project cost. Machinery and equipment used for R&D purposes are also exempt from import duties.
Tax Incentives for Businesses in Parks, Bonded Areas, and Free-Trade Zones	• Importing Raw Materials: Exemptions from import duties, excise tax, business tax, and trade promotion service fees apply within industrial parks and science parks. • Importing Fuel, Materials, and Semi-Finished Products: Exemptions from import duties, excise tax, business tax, and trade promotion service fees (including samples, experimental animals and plants, and goods for trade, storage, and transportation) are available within industrial parks, science parks, bonded warehouses, and logistics centers.
Investing Undistributed Earnings	Companies or limited partnerships can reinvest their undistributed earnings within three years following the year they were generated. Provided that it meets a certain threshold, investments used for constructing or purchasing buildings, hardware, software, or technology for business operations, may be deducted from the current year's undistributed earnings, exempting them from the additional 5% profit-seeking enterprise income tax.

Talent Level – Attracting foreign talents to obtain permanent residency

Incentive	Details
Foreign Specialist Professional	Article 20 of the Act for the Recruitment and Employment of Foreign Professionals stipulates that for foreign specialist professionals approved to work in Taiwan for the first time “and have a salary income of more than NT$3 million, half of the part of their salary income above NT$3 million in each such tax year will be excluded from the assessment of individual income tax” for the first five years.
Permanent Residency	The requirements for foreign professional talents applying for permanent residency have been relaxed as follows: (1) Foreign Professional：The requirement of five years of continuous residence in Taiwan is maintained. However, this period is reduced by one year for those who obtain a master's degree in Taiwan and by two years for those who obtain a doctorate in Taiwan. (2) Foreign Specialist Professional：The required continuous residence period is reduced from five years to three years. Additionally, those who obtain a doctorate in Taiwan can deduct one more year from this requirement.
Employee Stock Compensation	Employees who receive stock compensation can choose to defer taxation on the awarded stock until it is sold. If the employee holds the stock and continues to work for the company for more than two years, the taxable amount at the time of sale can be calculated based on the lower value between the acquisition price and the sale price.

Steel Industry

China Steel Corporation (CSC)

China Steel Corporation (CSC), founded in December 1971 and located in Kaohsiung, Taiwan, is the largest steel company in Taiwan with an annual crude steel production capacity of approximately 10 million metric tons. The company's main products include steel plates, bars, hot-rolled coils, cold-rolled coils, electrogalvanized coils, electrical steel coils, and hot-dip galvanized steel coils. About 52.4% of its products are sold domestically, and 47.6% exported mostly to Southeast Asia, Europe and Japan.

Since 2021, CSC has been proactive in carbon reduction efforts and digital transformation. In February 2021, CSC established the Task Force on Energy Saving & Carbon Reduction and Carbon Neutrality under its Corporate Governance and Sustainability Committee, aiming to achieve carbon neutrality by 2050 through developing energy-saving and carbon reduction technologies.

Petrochemical Industry

Chang Chun Group

Founded in 1949 as Chang Chun Plastics Factory, Chang Chun Group is a leading Taiwanese petrochemical company. In 1964, Chang Chun Petrochemical Co., Ltd. was established, becoming the second core company of Chang Chun Group. It specialized in the production of methyl alcohol using natural gas processed in its Miaoli Factory, making it a pioneer in the petrochemical industry in Taiwan.

Chang Chun Group has invested heavily in developing processes to recycle and regenerate various product waste liquids, assisting customers in managing and recycling their process waste. This effort not only reduces pollution at the customer's end but also promotes the recycling and reuse of resources. In recent years, Chang Chun has developed a new process using carbon dioxide as a raw material to produce acetic acid, contributing to the reduction of greenhouse gas emissions. In 2024, Chang Chun plans to collaborate with the Kaohsiung City Government to enhance carbon capture and reuse technology exchanges.

Semiconductor Industry

TSMC

TSMC created the semiconductor Dedicated IC Foundry business model when it was founded in 1987. In 2023, TSMC served 528 customers and manufactured 11,895 products for various applications covering a variety of end markets including high performance computing, smartphones, the Internet of Things (IoT), automotive, and digital consumer electronics. Annual capacity of the manufacturing facilities managed by TSMC and its subsidiaries exceeded 16 million 12-inch equivalent wafers in 2023.

TSMC has made significant investments in the circular economy, including partnering with suppliers to regenerate waste cyclopentanone into electronic-grade cyclopentanone, jointly obtaining UL 2799 Platinum level certification, and optimizing air pollution control equipment to reduce NOx emissions by 65%.

Steel Industry

Mitsui Kinzoku Trading (Japan) – Key Supplier of High-purity “Bright” Copper in Taichung Port Technology Industrial Park

Mitsui Kinzoku Trading Co., Ltd. Taiwan Branch received approval in September 2017 to establish operations in the Taichung Port Technology Industrial Park. The company primarily engages in the trading of “bright” copper – with a purity of 99.95% or higher – obtained through electroplating processes which result in a reddish, lustrous finish. At the same time, Mitsui Kinzoku is involved in recycling common metals.

Taiwan is renowned globally as a leading producer of electrolytic copper foil, with an annual demand for bright copper exceeding 150,000 tons. As new consumer electronic products continue to develop worldwide, the market demand for copper foil is also steadily increasing. Looking ahead, the copper foil industry trend shows substantial growth in the demand for high-end PCB applications and electric vehicle batteries. The need for thin copper foils, such as 1/3-ounce foils, and high-quality copper foils is expected to rise rapidly, driving growth and niche opportunities for domestic copper foil manufacturers. As such, synergy in the circular economy is generated when combined with Mitsui's common metals recycling operations.

Petrochemical Industry

Tokuyama Corporation (Japan) – Establishing an Electronic-Grade Isopropanol (EIPA) Plant to Expand Taiwan's Semiconductor Chemical Material Landscape

In 2020, Formosa Plastics Corporation, through its subsidiary Formosa Tokuyama, acquired a 50% stake in Taiwan Tokuyama Corporation, an electronic-grade isopropanol (EIPA) chemical manufacturer under Japan's Tokuyama Corporation. The joint venture has constructed a plant in the Linyuan District of Kaohsiung, with an annual EIPA production capacity of 30,000 tons. EIPA, with a typical purity of 99.99%, is primarily used for cleaning wafers and other high-end electronic products. Currently, there are only two global suppliers of EIPA: Japan's Tokuyama Group and Taiwan's LCY Chemical Corp.

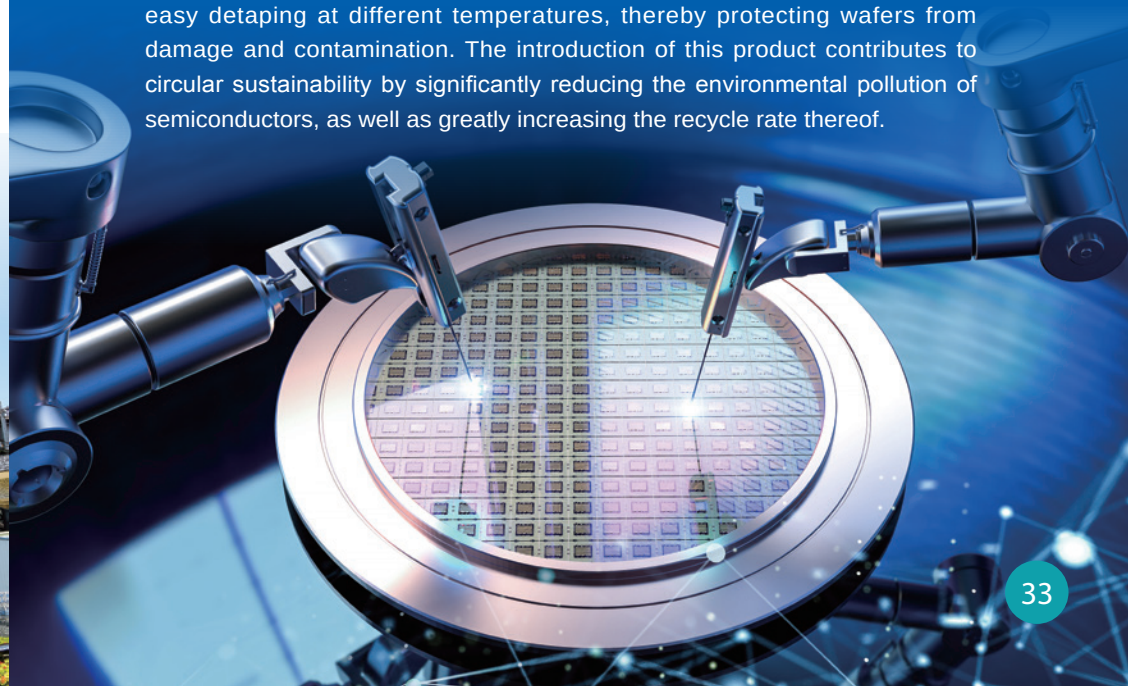
Formosa Plastics Group's presence in the semiconductor industry includes DRAM manufacturer Nanya Technology, packaging and testing company Formosa Advanced Technologies Co., Ltd., and substrate manufacturer Nan Ya Printed Circuit Board Corporation, holding significant positions in the industry. This acquisition marks Formosa Plastics Group's foray into advanced semiconductor process chemicals, significantly contributing to the development of Taiwan's semiconductor industry. EIPA can be recycled after use, becoming industrial isopropanol for use in other industries, achieving reuse under the circular economy model.

Semiconductor Industry

Mitsui ICT Functional Sheet, Inc (Japan) - Protecting Semiconductor Wafers with Special ICROS Tape

Known as "Taiwan Tohcello Functional Sheet" before April, 2024, Mitsui ICT Functional Sheet, Inc., a subsidiary of Japan's Mitsui Group, was approved to enter the Kaohsiung Science Park in the Southern Taiwan Science Park in November 2017, with an investment of NT$550 million. This project marks Mitsui Group's first overseas production site dedicated to ICROS tape, which is used in semiconductor processing.

The company's core technology lies in producing patented tapes with specific resin and density compositions. By adjusting the type and ratio of resins, the structure of the tape achieves high flexibility and encapsulation properties necessary for absorbing protruding electrodes. Combined with precise coating technology and patented formulations, this tape minimizes the potential for wafer surface contamination. Furthermore, the tape's adhesion properties can change with UV curing, providing excellent adhesion and easy detaping at different temperatures, thereby protecting wafers from damage and contamination. The introduction of this product contributes to circular sustainability by significantly reducing the environmental pollution of semiconductors, as well as greatly increasing the recycle rate thereof.



Appendix

1. MOENV Resource Circulation Agency (RECA)
   https://smmdb.moenv.gov.tw/circulation/views/06b30262-3925-48d1-917f-e3ef0eafda43
2. TEDS (Taiwan Emission Data System, TEDS) (https://www.moenv.gov.tw/page/32C2088A810CF7EF)
3. Ministry of Economic Affairs (MOEA) https://go-moea.tw/
4. https://money.udn.com/money/story/5612/7964746
5. “The Industrial Heritage in Taiwan” https://iht.nstm.gov.tw/form/index-1.asp?m=2&m1=3&m2=76&gp=21&id=7
6. Moneyweekly https://www.moneydj.com/funddj/yb/yp052001.djhtm?a=39C8F789-6726-4EC2-83B4-850799C594F9
7. Industry Chain Information Platform https://ic.tpex.org.tw/introduce.php?ic=N000
8. MOEA Industrial Development Administration's High-Value Petrochemical Industry Promotion Project https://www.pipo.org.tw/News/PNews_More?id=2613
9. KPMG https://kpmg.com/tw/zh/home/insights/2019/07/tw-circular-economy-petrification-industry-opportunity.html
10. FPG's Sixth Naphtha Cracker Project and Economic Development 2024 six naphtha_ch.pdf (fpg.com.tw)
11. Trends: Realizing the Circular Economy in the PCB Industry [趨勢專欄 : 電路板產業 實現循環經濟關] https://www.pcbshop.org/tw/mobile/articlesDetail.asp?serno=67
12. The Key Issue of Circular Economy in Taiwan PCB Industry https://ieknet.iek.org.tw/iekrpt/rpt_more.aspx?rpt_idno=365113473
13. Low-carbon Transformation Strategy for the Taiwanese PCB Industry, 2023 Taiwan Printed Circuit Association (TPCA)
14. Taiwan's Pathway to Net-Zero by 2050 “Carbon Capture, Utilization and Storage, CCUS Action Plan” https://www.ey.gov.tw/File/EF63415FAC210FF2?A=C
15. Development of Taiwan's Circular Economy [台灣循環經濟發展論] (2020)
16. Act for the Recruitment and Employment of Foreign Professionals – “Foreign Specialist Professional” https://foreigntalentact.ndc.gov.tw/Content_List.aspx?n=23CD782FBC63F065
17. Act for the Recruitment and Employment of Foreign Professionals – “Permanent Residency” https://foreigntalentact.ndc.gov.tw/cp.aspx?n=A7C836C13205092B&s=85176E194E7C848A
18. China Steel Corporation (CSC) Official Site https://www.csc.com.tw/csc/ch/ifo/ifo.html
19. Chang Chun Group https://www.cdns.com.tw/articles/957273
20. Environmental Protection Bureau, Kaohsiung City Government https://ksepb.kcg.gov.tw/ActivitiesDetailC001100.aspx?Cond=5104c0eb-048b-42d7-bd1a-f1a5cce7069b
21. About TSMC https://www.tsmc.com/chinese/aboutTSMC/company_profile
22. TSMC ESG https://esg.tsmc.com/ch/focus/APractitionerofGreenPower.html

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