Research Report on The Promotion Strategy of Resource Circulation in Chinese Taipei

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Environmental Protection Administration,

Executive Yuan, Chinese Taipei

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1. Promotion strategy framework

Chinese Taipei lacks natural resources. Therefore, the Environmental Protection Administration (EPA) formulates the Resource Recycling Act to save natural resources, reduce waste, facilitate material recycling and reuse, reduce the environmental load, and establish a society of sustainable resources. In addition, to effectively accelerate resource circulation, the EPA established the Office of Resource Circulation in July 2021, responsible for overall resource circulation policy planning and management. Different from the previous waste management perspective, the resource circulation policy is formulated from the perspective of four primary materials, namely biomass, organic chemical substances, metals and chemicals, and inorganic recycled aggregates. The promotion strategy framework for resource circulation is shown in Figure 1.

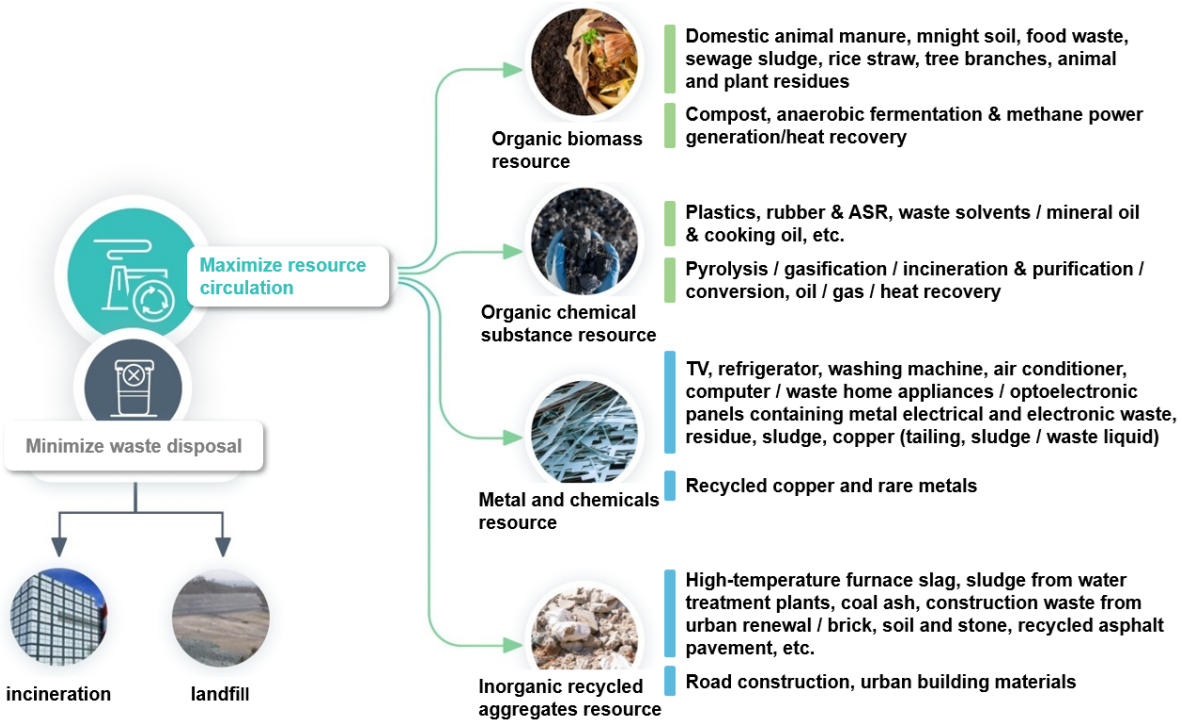


Figure 1 Resource circulation promotion strategy framework

2. Background

2.1 Resource recycling system in Chinese Taipei

Since 1997, the EPA has been promoting the Four-In-One Resources Recycling Program. The program contains numerous policies. Based on extended producer responsibility, regulations should be formulated to require the responsible manufacturers and imports of articles or containers to register. The responsible manufacturers and imports should report their recycling and clearance fees according to the announced rates. The income is used to establish a resource recycling management fund to promote resource recycling policies and plans. The program integrates the resources of central and local governments and facilitates the cooperation between government, industry, academia, and researchers. The sense of public participation is gradually enhanced, encouraging the public to sort and recycle materials at the source. A comprehensive recycling system should be established to encourage technological innovation, improve the reuse of recycled materials, and smooth the operation of the recycling system. From 1997 to 2021, the announced and listed materials have covered containers, motor vehicles, tires, lead-acid batteries, electronic appliances, information technology products, dry batteries, and lighting waste, totaling 13 categories, 33 classes, and 67 types. The current resource recycling system framework is shown in Figure 2.

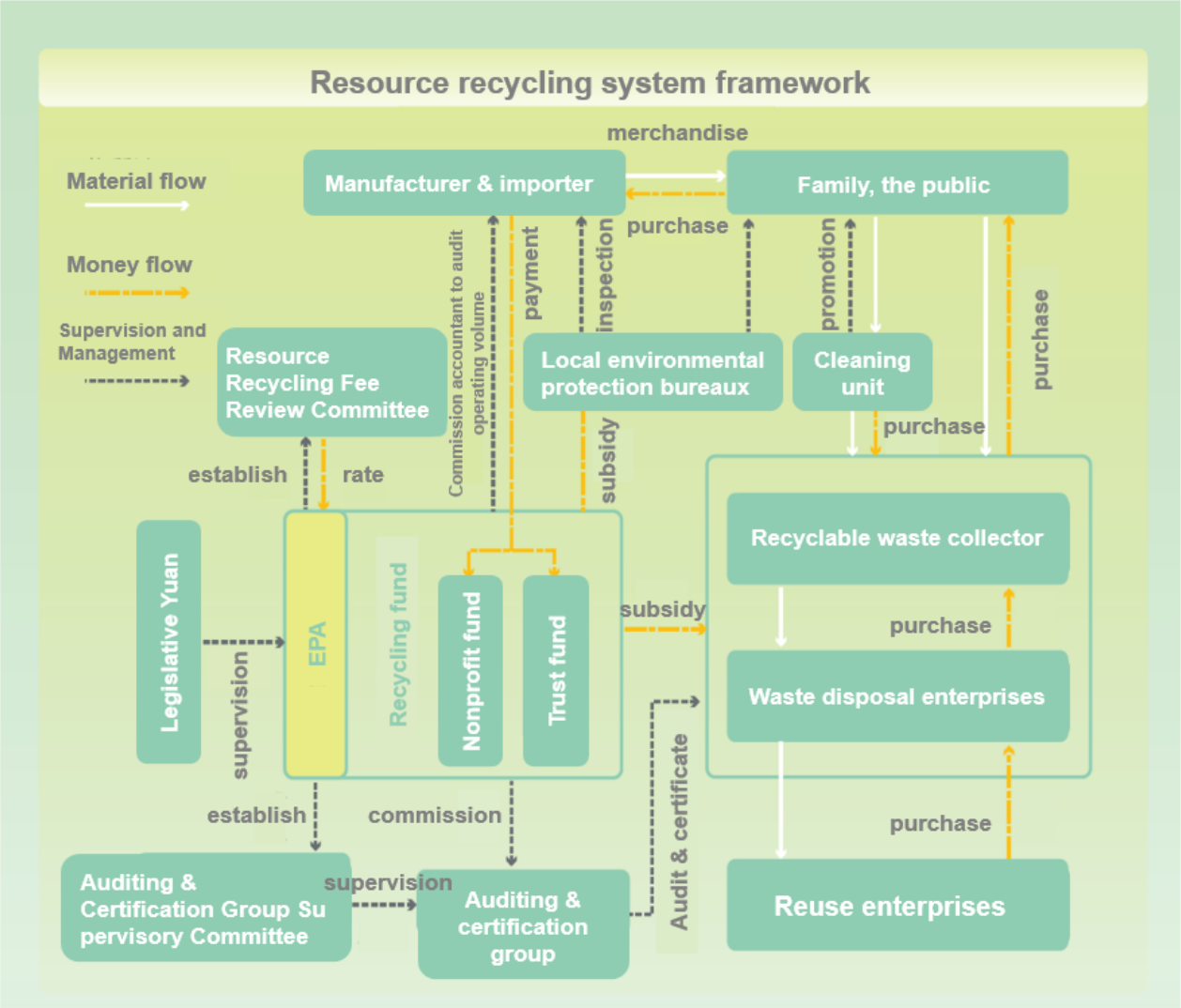


Figure 2 Resource recycling system framework

2.2 Resource circulation promotion

To pursue sustainable development, Chinese Taipei is committed to promoting the Zero Waste and Resource Recycling policy. Through the concept of sustainable materials management, the EPA improves the overall resource recycling based on the existing waste management measures. These measures enhance domestic resource productivity and recycling rate, as well as reduce the direct material input (DMI). Regarding the four primary materials, namely biomass, organic chemical substances, metals and chemicals, and inorganic recycled aggregates, their background of resource circulation is introduced as follows.

2.2.1 Biomass resource circulation

Numerous types of waste biomass can be generated from agricultural production to food processing, from people's daily consumption to excretion. Biomass from sectors (e.g. agriculture, industry and commerce, people's livelihood) are governed by designated departments. Therefore, the regulations on waste biomass management are formulated by specific departments. Currently, the promotion strategy focuses on materials, feed, fertilizers, and biomass energy.

Regarding the promotion of integrating biomass resource circulation, the sources of waste biomass are governed by multiple competent authorities. As the waste biomass is subsequently reused as a resource, competent authorities may have different management policies. Red tape and restriction conditions may hamper the biomass treatment flow. Moreover, the high cost of biomass collection and pre-treatment, as well as the doubts about the product quality, affect biomass processing operators' willingness to invest. To facilitate the diversification of waste biomass circulation, the EPA expects that ministries will cooperate to jointly promote biomass circulation. Currently, the EPA has taken a preliminary inventory of the waste biomass flow from agriculture, food manufacturing, and people's livelihood to illustrate the output quantity and treatment methods, as

shown in Figure 3.

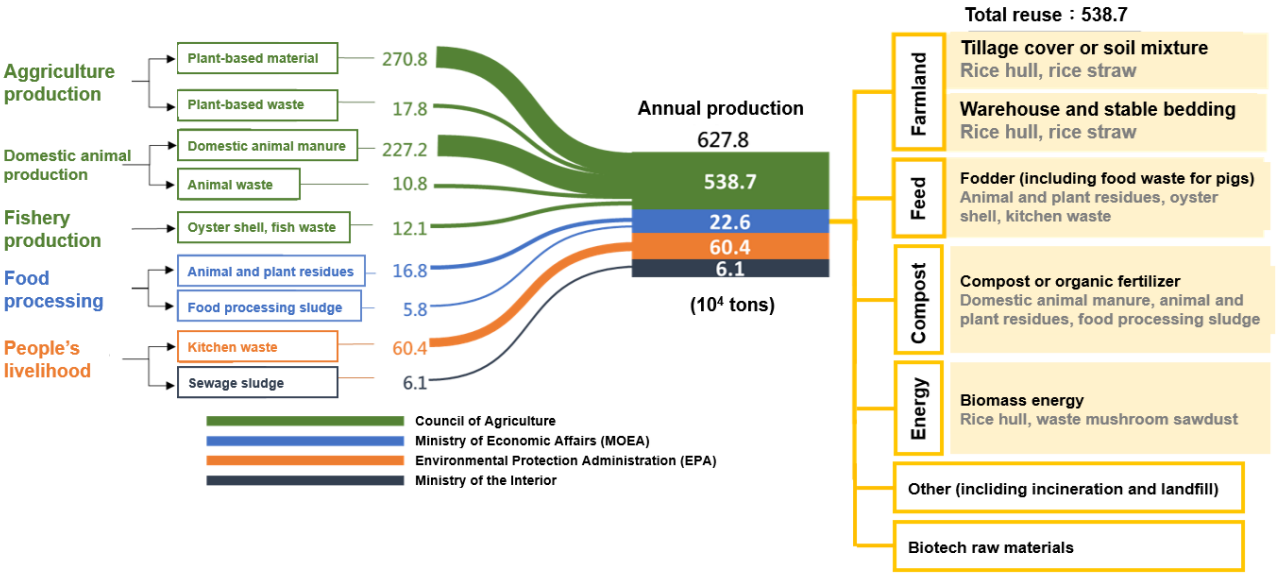
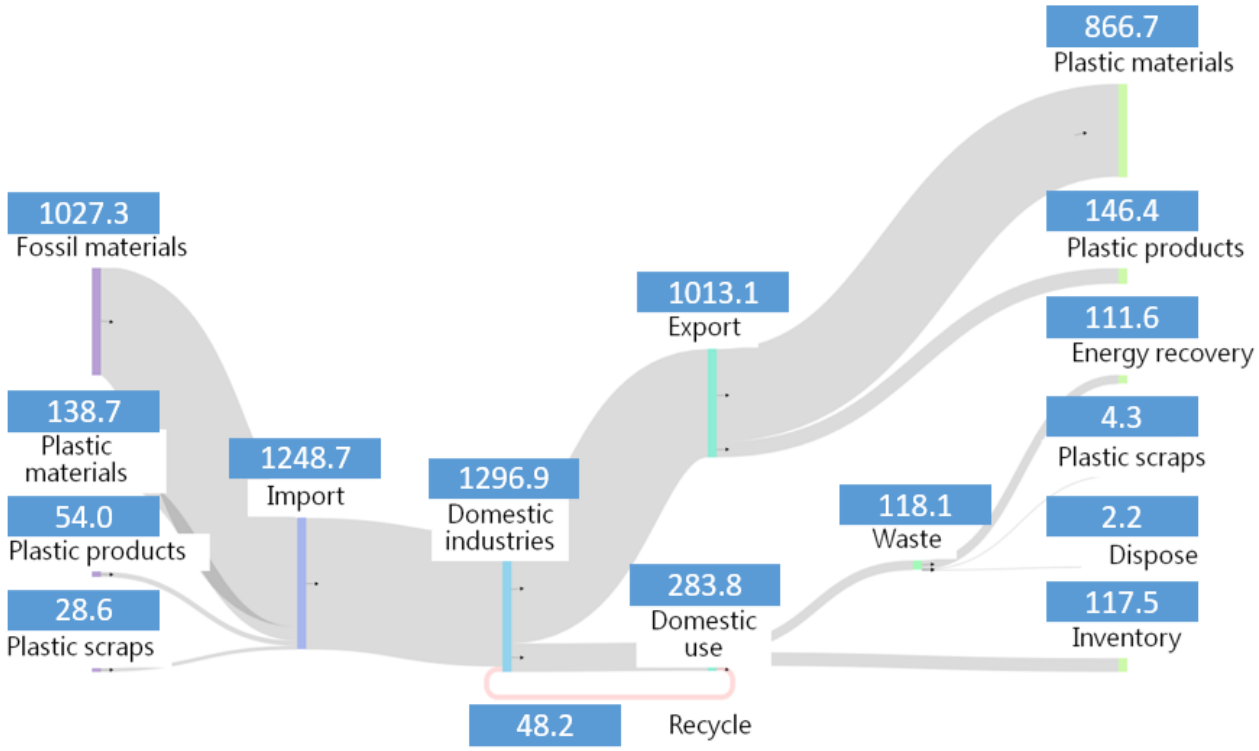


Figure 3 Biomass production and reuse in 2020

2.2.2 Organic Chemical Substance Resource Circulation

Products of the Chinese Taipeiese plastic industry are primarily for exportation. On average, the Chinese Taipeiese consume 103 kg of plastic products every year. Used plastic products are mainly treated with material recycling, reuse, and energy recovery. Approximately 482,000 tons of materials are recycled and reused. The remaining waste plastics are approximately 1.181 million tons, and those for energy recovery are about 1.116 million tons (accounting for 95% of the waste). After an inventory survey, the distribution and material flow of plastic resources in Chinese Taipei, including source input, production, disposal, recycling, and reuse, are shown with other life cycle stages in Figure 4.



Unit: 10,000 tons/year
Source: 2021 Resource Recycling Strategy Improvement and Material Distribution Management System Maintenance Project

Figure 4 Material flow chart of plastics in 2020

Regarding the management policy of used plastics, the EPA has redirected the policy from promoting source reduction to enhancing resource recycling and reuse. The promotion methods include formulating laws and regulations to reduce single-use plastic products (e.g. plastic bags, disposable tableware, beverage cups, straws), promoting the reduction of product packaging and online shopping packaging, and announcing details on recyclable plastic containers. In the past three years, the statistics show that the annual processing volume of plastic containers that should be recycled is approximately 190,000 tons (Table 1), and the recycled materials include PET (about 100,000 tons per year) and PP/PE materials. Numerous domestic recycling manufacturers can turn the recyclable waste into recycled materials, which can be further made into high-value recycled products, such as electronic products, automobile parts, furniture, eco-friendly yarns, and packaging materials. According to the data on import, export, waste production, resource recycling, and reuse, the

overall plastic recycling rate in Chinese Taipei is estimated to be 60%.

Table 1 Announced recycling volume of plastic containers to be audited and certified from 2018 to 2020

Recycling Object (t) / Year	PET	PP/PE	PVC	EPS	PS (unexpansible)	Plastic container-bioplastic
2018	107,061	83,967	278	776	4,495	470
2019	110,445	79,382	708	706	4,105	458
2020	93,483	81,600	359	553	3,600	348

Source：Recycling Fund Management Board (data last updated on 2021-08-19)

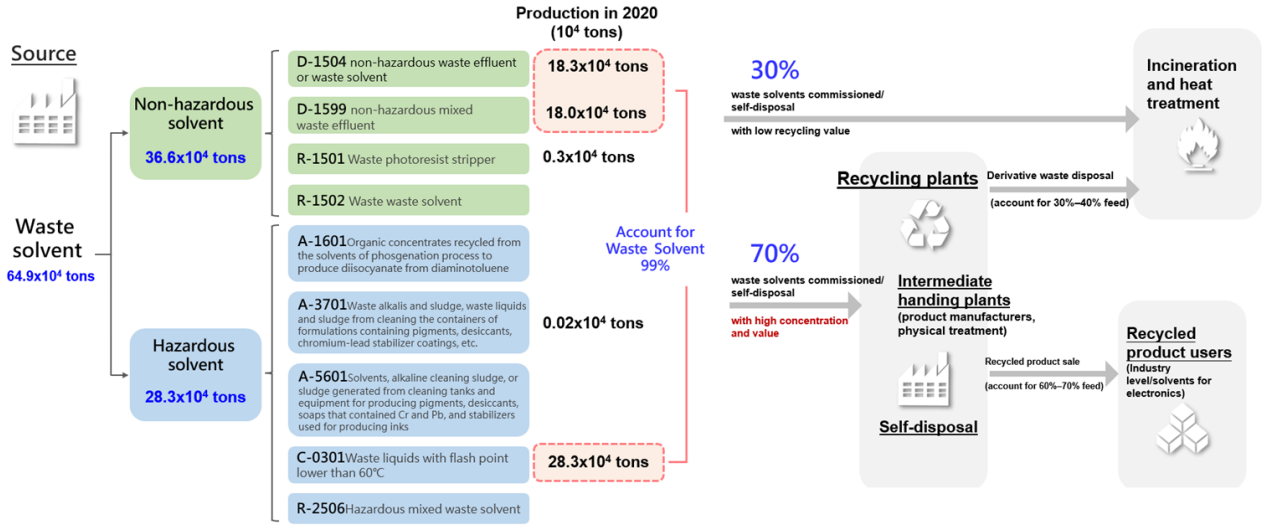
Regarding specific waste, approximately 2,300 tons of discarded fishing nets are produced in Chinese Taipei each year, and about 7,500 tons of agriculture films are produced annually. For the aforementioned items that are not announced to be recycled but are feasible for recycling, the EPA promotes centralized storage areas, designs the promotional materials, and matches treatment enterprises. For materials that are difficult to reuse or with a low recycling value, the EPA recommends using solid renewable fuel (SRF) technology for energy recovery.

2.2.3 Metal and chemicals resource circulation

Chinese Taipei is a large manufacturing and exporting country, but its natural resources are relatively scarce. According to the EPA resource circulation analysis system, approximately 70% of materials are imported, and the proportion of imported metal ores is even higher than 99%. In addition to solid metal resources, metals in waste solvents generated by industrial processes are also valuable, as it is difficult to separate metals from waste solvents. Therefore, this report discusses metals and chemicals together in this section. Compared with existing high-value solid metal resources, the treatment and circulation of chemicals and waste solvents have a high promotion priority due to the development of Chinese Taipei's high-tech industry and the expanding chemicals market. Therefore, the EPA analyzes and promotes the resources circulation of chemicals as the main object.

Most chemicals in Chinese Taipei are manufactured by domestic and foreign suppliers. After industrial use, chemicals are recycled or discarded. The recycled chemical products return to the original industry or are used in other industries, and the electronics industry is the primary user. Chemicals are essential materials in the electronics industry. They are used for drying, cleaning, etching, and so on. With the vigorous development of high technology, the structure of electronic components become more and more sophisticated. The use and requirements on the impurity rate of chemicals are also increasing. To effectively use chemicals, related competent authorities actively promote this topic to achieve resource circulation.

Part of high-value chemicals, however, are restricted by regulations and cannot be effectively purified for reuse. This is not conducive to the promotion of resource circulation. Regarding this predicament, the EPA has analyzed and compiled related recycling information. Based on industrial waste generation and processes, waste is classified into seven resource circulation modes. In 2019, the Reference Guidelines for the Review of Industrial Waste Disposal Plan were included to review industrial waste disposal plans, unifying review standards through administrative measures. In addition, for the three science and technology parks, the EPA promotes a pilot program to verify the feasibility of the resource circulation of chemicals in the electronics industry. Third-party organizations and industrial associations assist in identifying the value of chemicals and the feasibility of recycling technology, so that valuable chemicals can be constantly used in the same industry to further facilitate and improve the efficacy of chemical circulation.



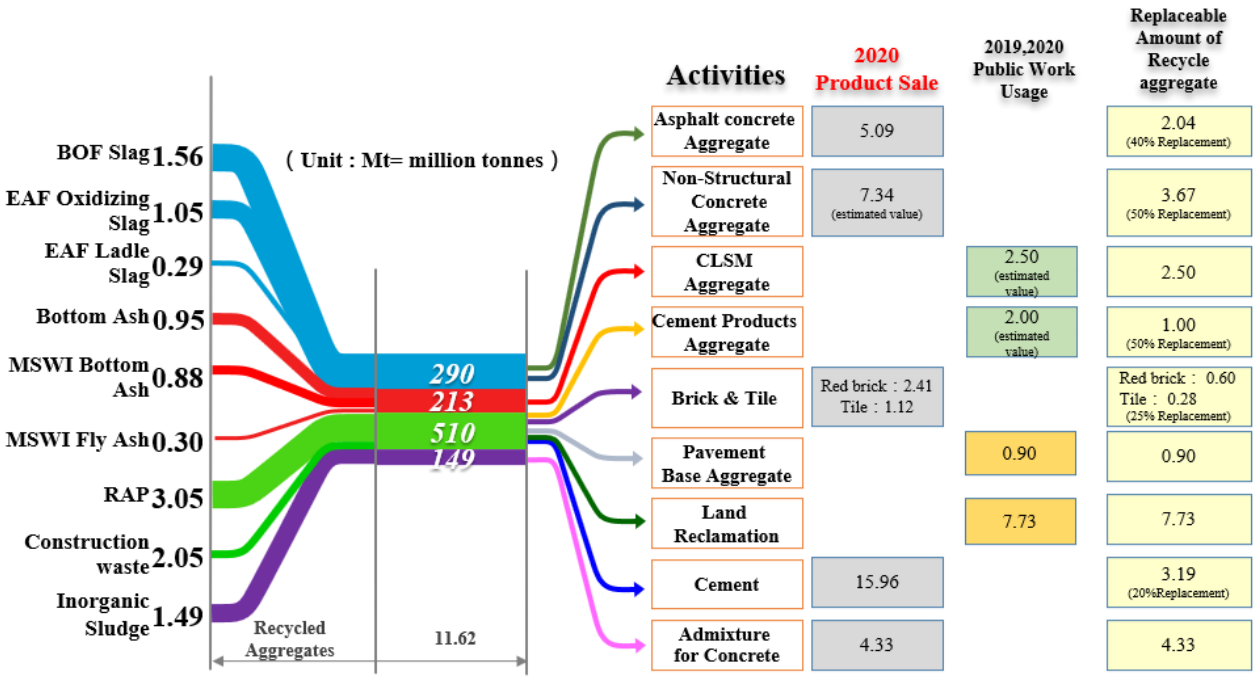
Data：Industrial Waste Report and Management System

Figure 5 Flow chart of chemicals in waste solvents

2.2.4 Inorganic recycled aggregates resource circulation

Among the promotion strategies of resource circulation, inorganic recycled aggregate circulation plays an essential role in the recycled material market section. Numerous topics, including the resource circulation specifications of recycled products, financial support for facilitating industrial technology research and development (R&D) and innovation, and enhancing communication and education, should be optimized.

Various types of inorganic residual resources or waste resources, including basic-oxygen-furnace (BOF) slag, oxidizing slag, ladle slag, incinerated recycled aggregate, and construction waste, can be made into inorganic recycled aggregates. These recycled aggregates are mostly used in public work and mainly used for asphalt concrete, non-structural ready-mixed concrete, controlled low strength materials (CLSM), cement products, cement raw meal, non-agriculture backfill materials, and so on. (Figure 6). Most properties of inorganic aggregates meet the requirement of public work. Through recycling processes, recycled inorganic aggregates can be used as raw materials or materials for suitable uses and projects, facilitating resource circulation and circular economy.



*EAF : Electric Arc Furnace , MSWI : Municipal Solid Waste Incinerator, RAP : Reclaimed Asphalt Pavement

Figure 6 Application planning of inorganic recycled aggregates in public work

2.2.5 Green living and promotion of green consumption

Given the booming e-commerce platforms, people are increasingly accustomed to online shopping, thereby generating additional packaging waste. Moreover, changes in eating habits also increase the demand for dining out, leading to an increase in the waste of disposable products. Therefore, the EPA continues to promote the tableware rental service to provide the public with rental recyclable tableware. The EPA matches delivery platforms and reusable tableware rental companies to promote eco-friendly delivery. The EPA also cooperates with online shopping platforms to promote recycling bags (boxes) to realize eco-friendly packaging for online shopping. In 2020, the EPA and Tainan City launched the first pilot program to establish an eco-friendly delivery platform to serve meals in recyclable containers. This program also stimulated a feasible eco-friendly delivery process including stores taking orders, delivering, consumers' tableware, returning the tableware to recycling stations or partner stores, unified tableware washing stations, and

returning the tableware to stores. To facilitate the return of tableware, 29 recycling stations have been established in designated areas.

Regarding the enhancement of circular economy for enterprises, as consumers tend to pay more attention to user experiences, consumers no longer demand long-term product ownership. The key to corporate profit has changed to providing professional and flexible services to meet the diverse needs of the market. The Product-as-a-Service (PaaS) business model uses products as service carriers, enabling enterprises to provide more professional and flexible services. Meanwhile, considering the extension of life span or reuse of products in their original form, integrating various systems and supporting measures are necessary (e.g. IoT and data analysis) to improve the efficacy of resource circulation.

Enhancing producer and consumer participation is essential for promoting green living and changing consumption patterns. The promotion can be implemented by changing the business model and product design of the production end to motivate the production end through the consumers' demand. In addition, improving the promotion and environmental education for consumers and producers can facilitate circular procurement. Circular procurement contains several concepts, such as rent-to-own/buy-back, using circular-friendly or recycled materials, adopting durable products or modular designs, and providing maintenance and warranty services to extend the lifecycle. The short-term goal of this working group is to prioritize the promotion of rent-to-own, and in the future, to gradually incorporate circular designs (e.g. modular production with increased durability) and extended product warranties and maintenance services to extend product lifecycles.

3. Promotion Strategy

To maximize material circulation, increasing material utilization efficiency and reducing the demand for raw materials would facilitate resource productivity. Feasible strategies include promoting product designs that are easy to recycle, extending product life, improving the energy efficiency of production processes, or facilitating energy recovery to reduce fossil fuel use. To minimize environmental impact, waste disposal by incineration or landfill should be avoided to enhance the recycling system. The quality of recycled and reused products should be ensured to increase product use.

To integrate the action plan into the circular economy, the EPA adopts a material life cycle perspective to specify the highlights of promotion strategies at each stage. The strategies can be divided into four perspectives, namely production, consumption, waste management, and market for secondary raw material. The proposed 12 strategies are shown in Figure 7.

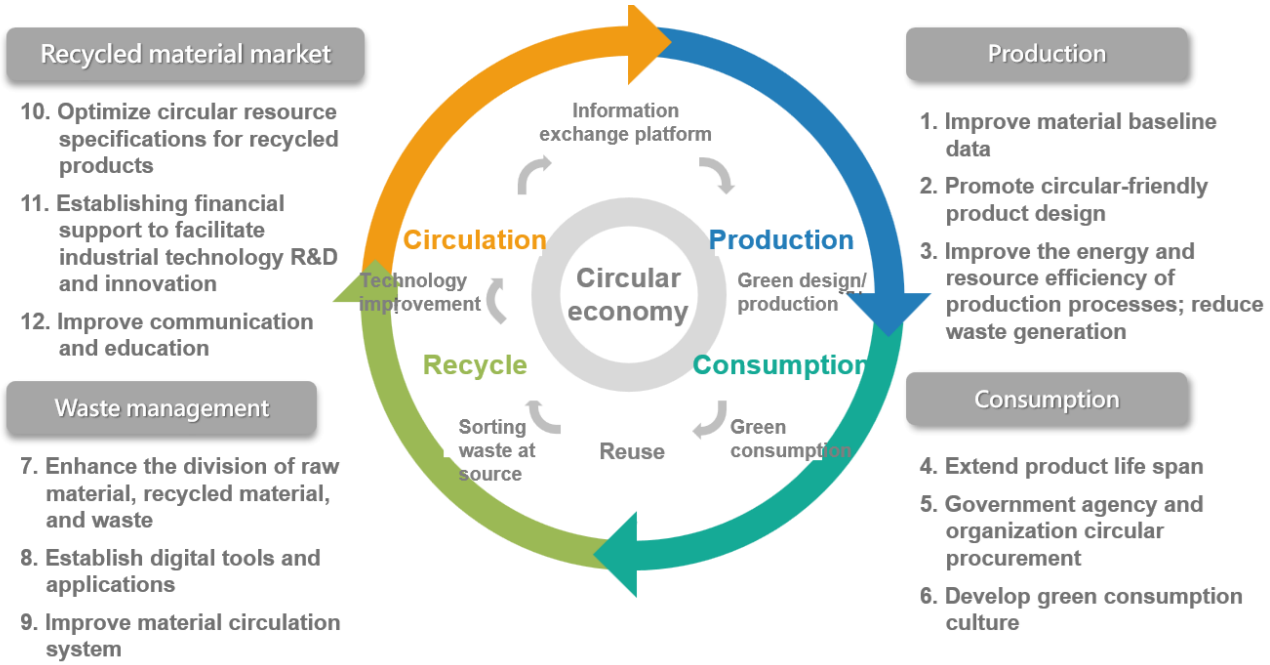


Figure 7 Promotion strategies of resource circulation

Table 2 Perspectives and Strategies of Resource Circulation in Chinese Taipei

Perspective	Strategy	Policy
Production	Improve material baseline data	(1) Acquire knowledge of nationwide baseline data (including raw materials and waste). (2) Improve the national sustainable material management database. (3) Ensure sustainable sources of key materials.
	Promote circular-friendly product design	(1) Improve product design in the aspects of durability, upgradability, and repairability. (2) Design products for remanufacturing and recyclability; ensure end-of-life products can return to the industrial circulation. (3) Promote the use of non-toxic, bio-based, compostable, localized, or secondary materials that are circular-friendly.
	Improve the energy and resource efficiency of production processes; reduce waste generation	(1) Establish the connection between waste generation and resource collection among industries to promote industrial symbiosis. (2) Reduce waste generation and maintain the basic requirements of minimizing the final sink. (3) Improve the guidance and promotion of industrial pollution prevention and waste reduction.
Consumption	Extend product life span	(1) Producer ownership brings extended producer responsibility. (2) Promote product maintenance and exchange of second-hand items. (3) Improve and facilitate the maintenance capacity of the retail industry; develop the maintenance and second-hand industries.
	Government agency and organization circular procurement	(1) Enhance the promotion of using recycled aggregates in public constructions. (2) Promote innovative business models of circular procurement and ownership transfer to shift from an ownership economy to an access economy, e.g. leasing models or sharing models. (3) Prioritize procurement of circular products, renewable resources, and reused products with national standards, remanufactured products, and sustainable products or services.
	Develop green consumption culture	(1) Promoting source reduction of disposable products. (2) Promote the use of durable and circular products or services that fully disclose information.
Waste Management	Enhance the division of raw material, recycled material, and waste	(1) Improve the effectiveness of material sorting and recycling collection, and encourage up-cycle recycling. (2) Enhance the connection between the processing industry and producers, and improve the efficiency and quality of resource circulation.

Perspective	Strategy	Policy
	Establish digital tools and applications	(1) Establish a market research system for circular resources, and promote the application of AI, blockchain, and IoT technology to identify, trace, and manage circular resources. (2) Develop material passports and material banks, and establish material types and grades.
	Improve material circulation system	(1) Establish a system for tracking, ensuring, checking, or verifying the use of recycled materials and reused/recycled products. (2) Encourage the establishment of internal circulation in the process or industry, and establish a material matching system for different processes or industries.
Market for Secondary Raw Material	Optimize circular resource specifications for recycled products	(1) Determine the item or proportion of recycled content in the product. (2) Establish a material source resume system to trace the source of product ingredients.
	Establishing financial support to facilitate industrial technology R&D and innovation	(1) Enhance the incentive system for product circulation design to facilitate circular-friendly product design. (2) Use economic measures or means, such as financing, loan concessions, subsidies, incentives, subsidies, tax relief, and pollution taxes, to encourage industries to promote material circulation and a circular economy. (3) Provide subsidies or preferential measures to encourage the public to purchase resource circulation products or services.
	Improve communication and education	Adopt various channels to enhance the knowledge of people (industry/the public) about circular economy concepts and policy perspectives.

4. Implementation results

To achieve the goal of “maximizing resource recycling and minimizing waste disposal” to fully implement a circular economy, waste reduction and resource recycling, as well as to reduce the environmental loading from primary resource consumption, the EPA, relevant ministries, and stakeholders through the concept of networking cooperation have jointly established the circulation model and formulated relevant rules for certain materials including organic biological resources, organic chemical resources and non-metallic residue resources. This section presents the resource recycling implementation results achieved by our joint efforts from cross-ministerial and cross-field cooperation in 2020, based on the loop of material life cycle from material management and green design, circular business models and extending product life, resource management and recycling technology, and strengthening the recycled materials market.

4.1 Material management and green design

Investigation of material flow to help collect material baseline data as the basis for green design and sustainable management, and for waste reduction at the source. In 2020, the results of baseline data collection and waste reduction at the source, as well as the implementation of green design conducted by relevant ministries are listed below.

4.1.1 Collection of baseline data

To effectively grasp the waste treatment capacity and the flow distribution of manufactured products, the EPA has checked and reviewed 13 reporting methods for sludge waste and other products, and reclassified the index code data for products reported by industries to improve the efficiency and correctness of data reporting by industries. Based on the experience in 2018, regarding the waste (resources) statistical reports generated by manual statistics on a quarterly basis, the EPA developed an automated system for some statistical reports in 2020, and reviewed the statistics, charts and overall policy plannings for 11 industrial wastes of concern

over the years. Due to the instructions provided for current waste disposal plan reporting, some operators may choose to fill in the product category as “other”, which leads to difficulties in following up on some product flows. In 2020, product codes were reviewed and some index codes were reclassified according to the product code data provided by operators to improve the efficiency and correctness of data reported by industries.

The Ministry of Science and Technology conducted a census on the implementation of 150 enterprises in the park (including 30 representative enterprises) and analyzed their raw materials input, source reduction, resource recycling measures and circular economy effects. The overall source reduction was 56,000 tons, equivalent to an economic benefit exceeding NT$271 million (about US$9.2 million). The recycling of resources reached 73,000 tons, equivalent to an economic benefit exceeding NT$316 million (about US$10.7 million).

To improve the recycling of sewage sludge, the Ministry of the Interior has carried out an investigation and analysis of dried sludge in several sewage treatment plants for the possibility of turning dried sludge into fuels, materials or fertilizers. In 2020, the Yilan Demonstration and Verification Plant completed the carbonized material quality test for sewage sludge recycled products and will continue the progress on demonstration and verification to receive a permit for the recycling operation. The Ministry of the Interior also cooperated with the Public Construction Commission to investigate the number of recycled aggregates that can be used for public constructions within the jurisdiction of each county and city government for various applications.

4.1.2 Strengthen waste reduction at the source

The EPA has expanded the restrictions on the use of disposable tableware and authorized local governments to announce their implementation schedules. In 2020, 18 county and city governments have reported implementation of the rule to prohibit disposal tableware at department

stores, shopping centers and hypermarkets within their jurisdiction for eat-in dining, which could reduce the consumption of 130 million disposable tableware annually.

The EPA has continued the promotion of Xiaoliuqiu Plastic-Free Island Action for cup sharing in 2020. Currently, there are 25 locations on the island to borrow and return beverage cups at convenient stores and supermarkets, as well as 31 locations at homestays. The highest record showed 2,787 cups borrowed in one day during the moon festival holidays in 2020. In addition, in conjunction with the "Tea Serving Action", water dispensers are set at several locations to serve drinking water on the island, and a location map for tea serving is provided through APP, so tourists can always use the water dispensers on the island to fill-up their bottles for drinking. The action also planned to set up 3 places for borrowing and returning cups (so there is no need to buy drinks).

Figure 8 Xiaoliuqiu Plastic Free Island water dispenser service

In July 2020, through the cooperation between the EPA, Environmental Protection Bureaus and night market business districts, the environmental protection renovation for 22 night markets or business districts across the nation was launched with six major environmental protection improvements promoted, including the reduction of single-use products, resource recovery, low-carbon, and energy-saving, cooking fume

emission control, catering wastewater treatment, high-quality public toilets and clean environment, to create environmental-friendly night markets with “plastic reduction, low-carbon, and freshness.” In July 2020, an environmental protection night market counseling group was established with policy management experienced leaders and practical work experienced seed lecturers to provide on-site counseling, to actually understand the current situation of the 22 night markets and business districts across the nation, to give suggestions for environmental protection improvements. Counseling suggestions were evaluated by each market for improvements followed by an on-site assessment of the improvements from November 23 to December 4, 2020. The results came out with a total of 826 vendors to receive the Environmental Protection Vendor Trademark, which could mean the reduction of 137,000 disposable tableware every day. The seven indicators set for environmental-friendly night markets are the reduction of single-use products, resource recycling, low-carbon energy-saving, cooking fume emission control, catering wastewater treatment, high-quality public toilets, and clean environment, plus other special features for environmental protection retrofit. A total of 16 night market business districts across the nation complied with more than 5 out of the 7 indicators to receive the special honor.

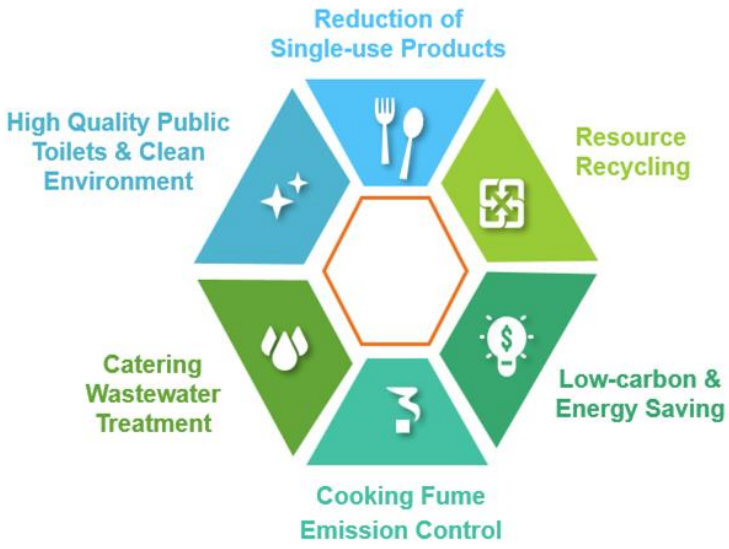


Figure 9 Indicators for environmental-friendly night markets

To facilitate the prevention and control of industrial pollution as well as the reduction of waste at source, the Ministry of Economic Affairs (MOEA) has continued to guide the improvement of environmental protection quality for industries in 2020. A total of 166 enterprises have been assisted to improve their environmental protection capacities, from MOEA assisting factories to reduce environmental protection risks and promote investment for environmental protection improvement. The action has contributed to a total economic benefit of NT$280 million (about US$9.5 million). In addition, 170 (of 83 factories) industrial boilers have been completed for improvement consultation, and 313 industrial boilers have been subsidized, which has prompted the industry to accelerate the conversion of industrial boilers to clean fuels to reduce the emission of air pollutants, including the reduction of total particulate matter (TSP) 194.7 tons/year, sulfur oxides (SOx) 1,504 tons/year, nitrogen oxides (NOx) 953.5 tons/year. Besides, the MOEA also facilitates the linkage of industrial waste resources and industrial symbiosis. In 2020, a total of 8 energy and resource-related projects were linked together (about 100,000 tons for the volume of linkage).

Figure 10 The MOEA industrial boiler improvement consultation

The Ministry of Science and Technology selected the D-0299 waste plastic mixture as the target to assist industrial units in the park to review and establish source reduction targets and measures. A total of 6 manufacturers have been consulted to reduce waste and improve resource recycling. In addition, the Ministry of Science and Technology also holds the Outstanding Enterprise Award for Waste Reduction and Circular Economy, and invites experts and scholars to evaluate and select enterprises with excellent performance for awarding in public, so as to set good models for learning and fulfilling corporate social responsibilities.

For domestic and foreign medical care institutions, the Ministry of Health

and Welfare has implemented a strategy to reduce the amount of single-use products when there is no concern for infection, including the use of containers (needle collection boxes) made from recycled plastic material, procurement of products with Green Mark, and to order and use medicines according to patients' needs, to set environmental management standards, to encourage employee creativity competition, to give reduction and reuse awards, to set recyclable waste sorting and collection buckets with labels, and to encourage patients to participate in the sorting operations.

In 2020, a total of 30 medical care institutions carried out work related to waste management and reduction with reference to the aforementioned methods and practices conducted at other hospitals. Appropriate waste reduction methods from these practical experiences are incorporated into the Guidance Handbook for Medical Waste Reduction and Resource Recovery. The Handbook gives an introduction to practical cases at hospitals that won the Corporate Environmental Protection Awards, including the six hospitals, namely Wanfang Hospital, Changhua Christian Hospital, Chiayi Christian Hospital, Buli Taoyuan Hospital, Chi Mei Hospital, and Puli Christian Hospital. The waste reduction models learned from these hospitals are also referenced for the establishment of environmental management systems or specifications, such as for the requirements for permitting infectious waste recycling, and for recycling of medical waste plastics, electronic medical records, or medical imaging, as well as for environmental education, and incentive measures for waste reduction and recycling.

The Ministry of Health and Welfare, according to the improved measures for source management of waste from restaurant business developed in 2018, has set priority to conduct on-site counseling visits in 2020 for restaurants with a large amount of waste, and a total of 18 restaurants were counseled to encourage source reduction and effective use of ingredients

to reduce food waste, while at the same time assist business operators to comply with the Act Governing Food Safety and Sanitation.

Figure 11 Consultation for advanced source management at restaurants

4.1.3 Implementation of green design

To promote the implementation of green product design for industries, the EPA promotes the Chinese Taipei Cradle to Cradle Alliance (hereinafter referred to as the C2C Strategic Alliance) for dedication to C2C design and local industrial innovation solutions by connecting industries, government agencies, education, and research institutions, as well as NGOs together. By the end of 2020, the number of C2C members has increased to 124. In addition, recycled aggregate was selected for the theme in 2020 to reward enterprises with outstanding performance for Circular Economy – Promote Circulation of Recycled Materials to select outstanding enterprises for awards in order to encourage enterprises that actively promote resource recycling. Among the recycling group, six enterprises were awarded the two-stars award, and three enterprises won the one-star award. For the renovation group, three enterprises were awarded the two-stars awards, and six won the one-star awards.

Figure 12 The 2020 Outstanding Enterprise Awards Ceremony

The Ministry of Economic Affairs assists industries in responding to international environmental protection and ESG trends by gradually driving industries into green upgrade and transformation, as the major goal for the Industrial Development Bureau, by guiding industrial operators into sound management for the aspects of environment, society, and governance, with the introduction of high efficiency and best available treatment technology. In 2020, a total of 26 applications for Green Factory and clean production were reviewed with the issue of eight Green Factory marks and seven Clean Production certificates. The performance of clean production program implemented by certified factories in 2020 has reduced approximately168,000 tons of CO_2e/year of greenhouse gas emissions, 3,572 tons/year of industrial waste, and 3.3 million tons/year of water consumption. In 2020, a total of two Green Factory workshops and two benchmarking enterprise observation activities were held to promote the Green Factory mark certification system and to promote the exchange of green technologies among industries.

The Ministry of the Interior continues in promoting green building materials. Recycled Green Building Materials refers to building materials made from recycled materials, through remanufacturing procedures, and manufactured in compliance with the 3R principles of waste reduction, reuse, and material recovery. The Recycled Green Building Materials are for green designs that include the considerations for function, health, and ecology, as well as the increase in the ratio of using recyclable materials. In2020, the Ministry of the Interior issued a total of 29 Recycled Green Building Materials labels, and the number of labeled products has increased to 219 over the years, with a total of 1,940 recycled green building material products.

4.2 Circular business models and extending product life

Based on the core spirit of usership instead of ownership, the circular business model promotes innovation in business and service such as leasing instead of

purchasing and Product as a Service (PaaS) to improve the efficiency of resource use while decreasing resource idling and waste generation at the same time. Green consumption and green procurement are also the directions for implementation. Green consumption refers to a simple and economical lifestyle, purchasing environmental-friendly products or services when necessary. Extending product life can be achieved by promoting repairs of products or exchange of second-hand items to improve resource efficiency.

4.2.1 Demonstration of innovative business models

The EPA promotes innovation in business and service such as encouraging environmental-friendly delivery service by using reusable containers and reducing packaging for online shopping delivery. The implementation results are described below.

(1)Promote environmental-friendly delivery

To reduce the amount of disposable tableware and to establish a circulation model for the use of tableware in delivery service, the EPA has cooperated with delivery service operators foodpanda, circulation container supplier Haobox and the Environmental Protection Bureau of Tainan City to conduct a pilot project for environmental protection delivery at small-scale or designated areas to promote tableware rental service by providing tableware that can be cleaned and reused. The delivery service platform cooperates with its partner stores to add non-single-use containers for serving meals as an option for customers to choose. After use, the containers are collected at returning point for recovery and sent to an entrusted professional cleaning company for cleaning. Customers may choose non-single-use containers for meals on the ordering page with no extra charge, and they can get a NT$30 discount code for returning the container. The discount can be used next time when they spend over NT$100 as an economic incentive to encourage the reduction of using disposal tableware. The first trial operation has established a feasible environmental protection delivery

operation model with accumulated practical experience. The trial has shown the results under the operation with no extra charge for a deposit, the container return rate reached 98.7%. The operation model is shown in Figure 14.

Figure 13 The 2020 Love the Earth Delivery and Zero Waste Life Press Conference

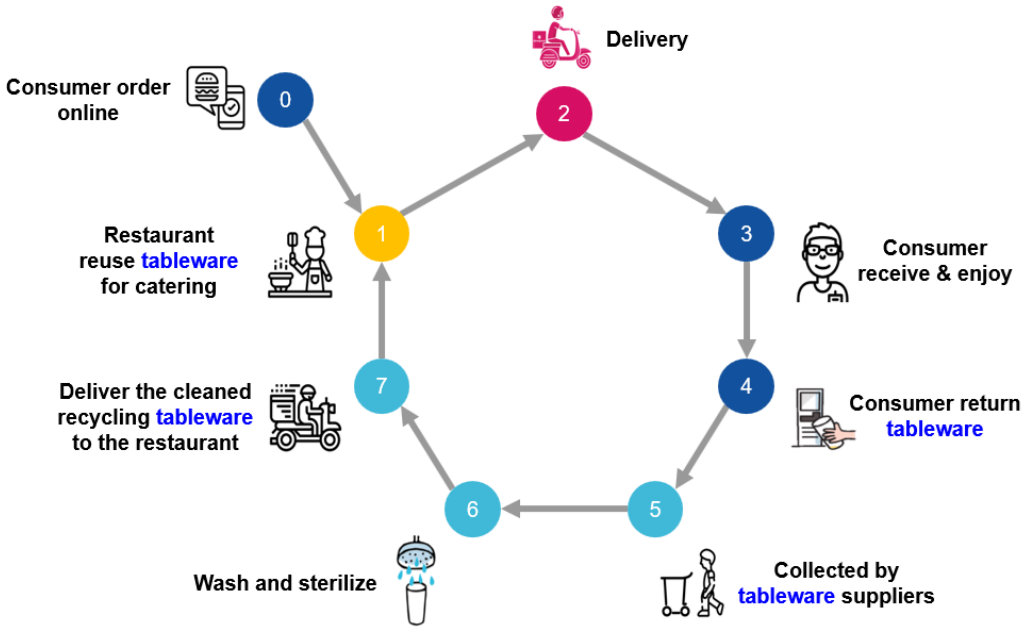


Figure 14 Environmental-friendly delivery service model

(2)Online shopping packaging reduction

To reduce packaging waste generated from online shopping, a Circulation bag (box) pilot program was promoted together with four

online shopping platforms including the PChome 24-hours shopping, Momo shopping network, Formosa shopping network, and Buy direct from farmers, to launch the option for online shoppers to choose from environmental-friendly circulation bags (boxes) for packaging. The program invited Chunghwa Post to cooperate with PackAge+ in collecting back the circulation bags and boxes. Since October 2020, consumers who choose circulation bags (boxes) at cooperating online shopping platforms for delivery and return them afterward may participate in a lottery draw. The program has opened a new innovative business model for packing reduction.

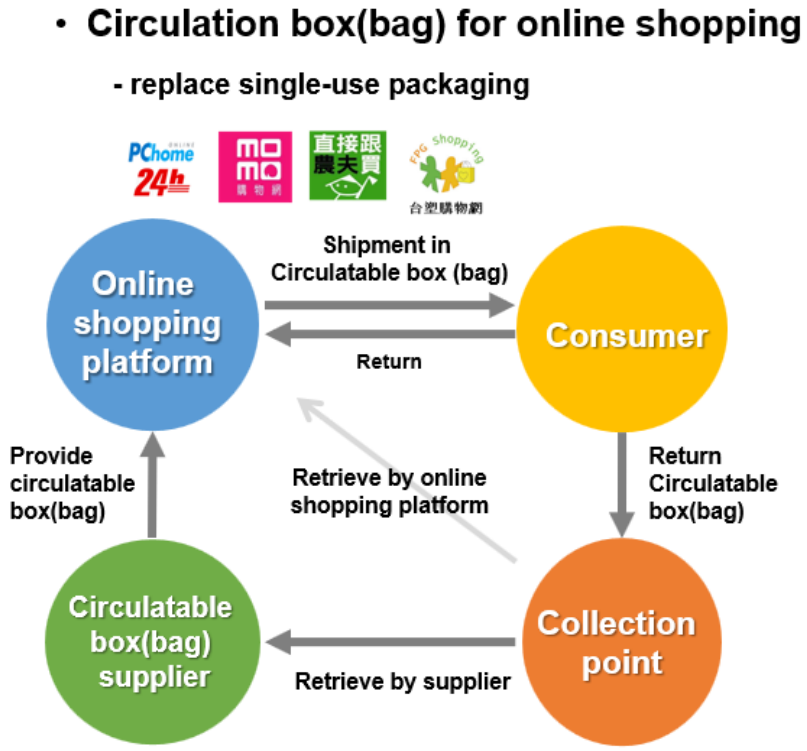


Figure 15 Online shopping box (bag) circulation model

4.2.2 Promotion of green consumption concept

The Council of Agriculture published an announcement on the Agriculture and Food Agency website (https://www.afa.gov.tw) to recommend a list of domestic organic fertilizer brands, including 90 companies and 391 brands, and updated the information 175 times, providing the public with

correct and most updated agricultural waste recycled products online information services; and organized 27 education and publicity sessions to guide farmers how to correctly use domestic organic fertilizers, and how to use fermented and decomposed livestock manure compost and to avoid using raw chicken manure, a total of 2,160 farmers have participated in the activities.

In 2020, the Ministry of Education organized six workshops to propagate the prohibition on single-use consumer products and to promote using environmental-friendly products, in response to the EPA's policy on reducing plastics and restricting single-use products. In addition, two sessions on green procurement education and training seminars, as well as online learning courses for green procurement were organized.

4.2.3 Promote green procurement

The EPA promotes governmental green procurement with emphasis on recycled aggregates and works in conjunction with the Ministry of Economic Affairs, Ministry of Transportation and Communications, and Ministry of the Interior to promote the use of recycled aggregates or other renewable resources for public constructions. The Ministry of Science and Technology, Council of Agriculture, Ministry of Education, and Ministry of National Defense, in accordance with their respective functions, promote priority procurement of environmental-friendly products. The EPA promotes incinerator slag recycled aggregates as a reference for the base layer of road pavement in harbor areas. According to statistics published by the EPA, from January to December 2020, the use of incinerator slag recycled aggregates was about 852,000 tons, while 636,700 tons were used for public constructions, accounting for 74.73% of the total use, reaching the promotional target (of 70%) set for 2020.

The rate of green procurement implemented by the Ministry of Transportation and Communications reached 99.17% in 2020, which has achieved its annual target (of 90%). In 2020, the Directorate General of

Highways used 171,817 m^3 of recycled asphalt concrete, and carried out recovery of removed asphalt concrete materials, recovering 243,000 tons. Chinese Taipei International Ports Corporation used a total of 1,228 tons of incinerator slag recycled aggregates in 2020, mainly for pipeline backfilling controlled low-strength backfill material (CLSM). Chinese Taipei International Ports Corporation used basic-oxygen-furnace (BOF) slag asphalt concrete for Taichung Port pavement repairs and refurbishment works, and a total of approximately 3,100 tons of BOF slag were used in 2020. In the meantime, Chinese Taipei Railway projects used blast furnace slag powder and fly ash with cement to reduce the consumption of cement.

In 2020, the Ministry of the Interior applied new construction methods and new technologies to promote trial operation on cold-mix recycled asphalt concrete to solve the problem of stockpiling and reuse of scraped materials for construction waste reuse and sustainable development. The Ministry of the Interior also planned the recycling of sewage sludge for controlled low-strength backfill material to promote public works or state-owned enterprises to try out sewage sludge recycled products.

4.2.4 Extending product life

The EPA has handled the recycling and reuse of huge waste for many years and urged local executive agencies to handle the recycling and reuse of huge waste by repairing the still valuable furniture for reuse, while decomposing, crushing, and sorting those without value to recover wood materials, wood chips and metals for recycling. In 2020, 39,270 waste furniture and bicycles were repaired nationwide, with 34,896 recycled furniture and bicycles sold for a total amount of NT$23.83 million (about US$0.8 million).

The current extended producer responsibility system levies fees from importers and manufacturers. In 2020, the EPA also reviewed the responsibilities of operators from the perspective of the product life cycle

and reviewed the objects for fee levy according to the types or usages of different products, such as the evaluation of feasibility to levy fees on solar photovoltaic panels from the operators of the installations, so the operator shall be responsible for the actual and economic responsibility through the product life cycle.

The EPA and the Energy Bureau of the Ministry of Economic Affairs are working together to gradually establish the recycling system for waste solar panels. As shown in Figure 16, discharged waste solar panels must be registered in the Waste Solar Panel Recycling Service Management Information System, and the project office will arrange for removal and disposal. Currently, there are already two institutions that can handle the treatment.

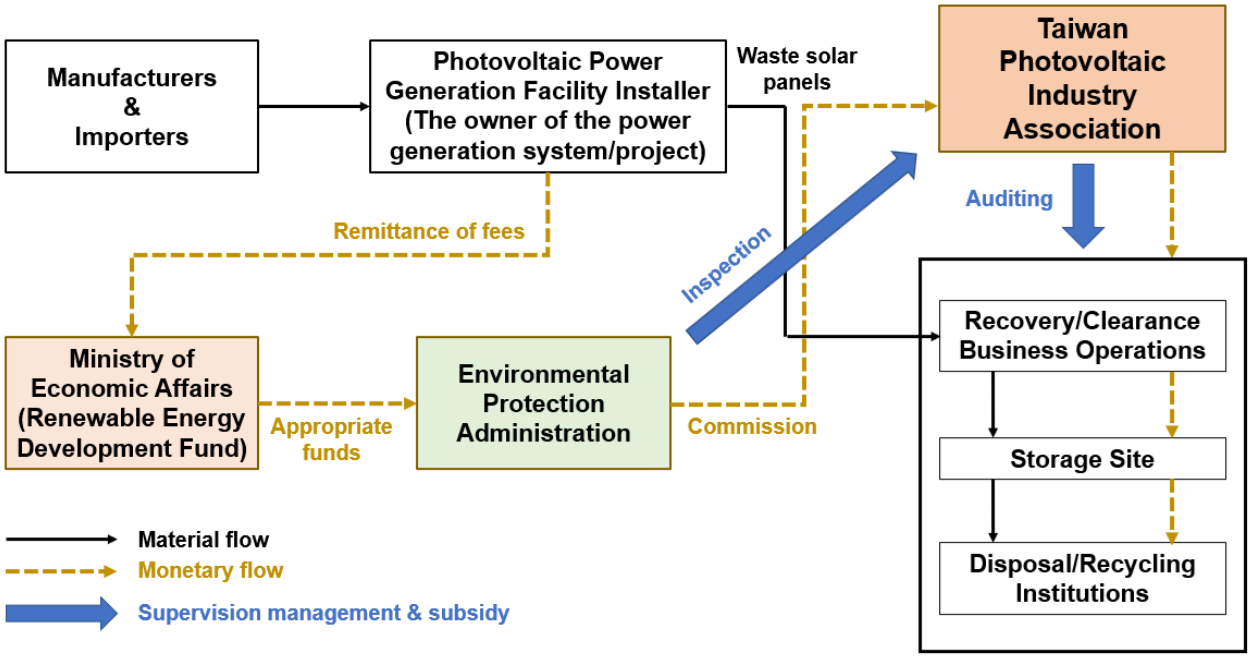


Figure 16 Schematic diagram of waste solar panels recycling system

The Ministry of Transportation and Communications promotes the replacement of the still usable parts of scrapped equipment (such as computers, printers, electronic scales, etc.) for the same type of equipment (such as 210 sets and 73 items for Chunghwa Post, 36 sets and 386 items for the Directorate General of Highways, one set for Freeway Bureau, one

item for the Institute of Transportation), donations of scrapped machinery and tools (such as 2,035 units from the Directorate General of Highways, 27 units from the Chinese Taipei Railway, 24 units from Maritime Port Bureau, 364 units from Freeway Bureau, five units from Chinese Taipei International Ports Corporation, 1,076 units from Chinese Taipei Railway, etc.) and second-hand auctions (569 pieces from the Civil Aeronautics Administration, 161 pieces from Tourism Bureau, 3,379 pieces from the Directorate General of Highways, 107 pieces from Freeway Bureau, 169 pieces from Maritime Port Bureau, and four pieces from Chinese Taipei Railway.

4.2.5 Circulation system development and management

(1)Plastic resource recycling

From 2018 to 2020, the EPA has taken plastic packaging materials as an example to gradually build up a recycling system for the plastic resource economy and industry. Based on the baseline data from past inventories and achievements from matching recyclers with industries, the performance indicators and targets for the plastic circular economy were established in 2020 for the recycling rate of recyclable plastic packaging and the ratio of recycled content in plastic packaging. It is expected in 2025 that the proportion of recycled content in plastic packaging to reach at least 25%. In 2020, the Ministry of Health and Welfare has promoted 385 public and private hospitals to participate in the recycling of various types of waste plastics. Among them, 385 hospitals followed the policy for the waste plastics recycling, with 24 hospitals implementing general medical waste plastics recycling, and 155 hospitals implementing infectious waste plastics recycling. Other hospitals that did not include medical waste plastics and infectious waste plastics in the recycling program because these hospitals do not generate infectious waste plastics (such as psychiatry hospitals) or they are located in remote areas/offshore islands (with no recycling

institutions to accept the waste). The Ministry of National Defense has instructed military hospitals to recycle and reuse some medical waste plastics (with no contamination from body fluids).

(2)Metal resource recycling

The EPA focuses on evaluating the environmental feasibility of establishing copper smelting facilities, at the same time continues the development of refinement technologies and cooperation with foreign circulation systems as well to enhance recycling efficiency. In addition, in line with the practical needs of industries, the model for recycling metal indium is evaluated and promoted. The results showed metal indium has been successfully recycled among related industries, therefore continuous development to meet growing market demand will be the direction for future efforts.

(3)Other resources recycling

In 2020, the EPA selected composite materials such as aluminum-containing plastic bags and LCD panel glass for secondary material evaluation. Currently, we have the chemical treatment technology for aluminum-containing plastic bags, however since the recycled materials are used only for wastewater treatment agents that the added value is rather low, and the recycling process generates a large amount of waste plastic mixture, which needs to be further processed, and the processing cost is high, that there is no economic benefit for recycling. For LCD panel glass, we already have the physical and chemical recycling technologies for LCD panel glass. The processing steps mainly consist of crushing the panel glass into fragments, followed by the separation of liquid crystal and indium from the glass for extraction, purification, washing, concentration, and modification. The separated and purified liquid crystal is returned to the original process for use. Since the liquid crystal is a high-priced material, recycling liquid crystal is highly profitable. At present, there is one domestic manufacturer with

a practical case, which can be helpful in increasing the value of recycling LCD panel glass.

To encourage the conversion of high calorific value industrial waste into solid recovered fuel (SRF), the EPA investigated and tested the physical and chemical properties of high calorific value industrial waste for the three items, namely calorific value, heavy metal content, and TCLP, in 2020. The test results showed five samples of the waste plastic mixture having calorific values up to 5,000 Kcal, and more than 85% of flammable contents; three samples of waste wood mixtures, waste paper mixtures, and waste fiber cloth having a net calorific value of 3,000~5,000 kcal/kg. All samples tested are in compliance with TCLP standards that they can be used as raw materials for SRF according to the preliminary assessment, subsequently, the SRF can be used as fuel for cement kilns and industrial boilers.

To promote the sustainable operation of the oyster raising industry and to reduce marine pollution from oyster raising, the Council of Agriculture is committed to guiding the western coastal areas where oyster raising is popular, such as Tainan City and Chiayi County, to implement recycling of discarded oyster sheds. In 2020, Tainan City recovered about 1,547 tons of oyster sheds (racks), with a recovery rate of 100%, and recovered about 18 tons of styrofoam floats; Chiayi County recovered a total of 332 tons of discarded racks. In addition, the Council of Agriculture also instructed other local governments to follow the model of Tainan City and continue to promote the use of environmental-friendly floats by fishermen.

The Ministry of Transportation and Communications promotes the recycling and reuse of waste oil and water from ships. In 2020, the total amount of waste oil and water from ships commissioned by the Chinese Taipei International Ports Corporation for recovery and clearance was 5,934 tons. The Maritime Port Bureau of MOTC carried out individual

recycling and reuse of waste oil and water from ships in accordance with the Management Regulations for Recycling of Transportation Industrial Waste, and the total amount recycled was 1,414 tons, which will be reused as a reducing agent for molten iron production at China Steel Corporation blast furnace process and as fuel for sintering plants. MOTC affiliated agencies are also encouraged to compost the fallen leaves within their jurisdiction areas and use them as organic fertilizers for planting. In addition, some measures are also promoted to assist in promoting environmental-friendly lunch box rental, and reuse of waste wood, old lamps, and construction concrete.

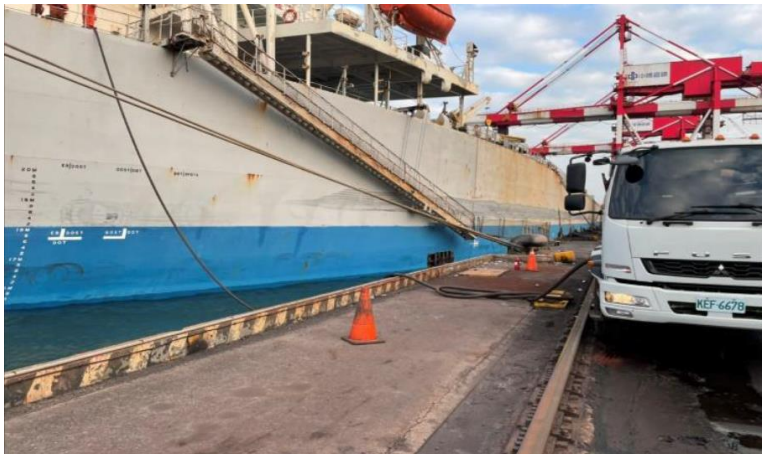


Figure 17 Recycling and reuse of waste oil and water from ships

(4)Promote energy recovery

The EPA plans to prioritize the processing of regional food waste by building at least 3 food waste biomass energy plants and improving the efficiency of environmental protection facilities. The Taichung City Waipu Green Energy Ecological Park is the first biomass energy plant in Chinese Taipei that officially started operation on July 9, 2019. The construction for the second phase of that facility has started in 2020, expecting to be completed in 2023. When it is completed, the food waste treatment capacity can reach 54,000 tons per year, saving about NT$5,400 (about US$184) of incineration treatment costs. Its power generation capacity can reach 8.87 million kWh/year, which means

under full load about NT$72,000 (about US$2,450) of the electric bill can be earned every day. The construction progress for Taoyuan Biomass Energy Center BOT was about 79.27% at the end of 2020, and it is scheduled to complete and start operation in July 2021. Other similar operation plannings are also underway in Taipei City, New Taipei City, and Kaohsiung City, respectively.

To keep abreast of the latest industrial development situation and biomass energy supply, the Ministry of Economic Affairs conducted a joint visit to reveal the supply and demand for biomass energy or waste. In 2020, the Ministry of Economic Affairs promoted manufacturers to use biomass fuels up to 30,800 tons, reducing greenhouse gas emissions by 64,300 tons CO_2e /Year, with the investment from manufacturers in biomass energy production amounted to NT$2.869 billion (about US$97 million).

4.3 Strengthening the recycled materials market

By strengthening the implementation of quality specifications and supervision systems for recycled materials, such as the specifications for acceptance and the verification systems for recycled materials or recycled products, manufacturers can follow a credible and professional specification and supervision system to carry out technical R&D and innovation. In addition, the government can apply appropriate financial measures or methods or promotions to provide incentives for implementation, to further strengthen the market for recycled materials.

4.3.1 Strengthen the quality standards and supervision system for recycled materials

In 2020, the EPA reviewed the current recycling inspection items and established a complete list for inspection based on the corresponding relationship between “wastes, products, and normative standards” with continued rolling review and control of the listed items together with local

competent authorities. By the year 2020, 171 out of 244 types of recycled products have been established with corresponding quality standards, representing that 70% of the recycled products already have their specified quality standards, which means the goal to reach over 50% has been successfully achieved. The EPA has completed the compilation of the technical manual - Graded Aggregate Material For Bases or Subbases for Highways for engineering application to promote the use of incinerator slag recycled aggregates as a reference for road pavement engineering base or subbase in harbor areas.

The Council of Agriculture strengthens the flow and control operations for dead livestock and poultry at livestock farms, and actively inspects and controls the flow of dead livestock and poultry. It is inevitable that livestock and poultry may die or be eliminated due to health conditions affected by the occurrence of epidemic diseases during the breeding process. The occurrence rate is also closely related to the breeding technology, management technology, and breeding environment. Livestock and poultry that died or have been eliminated cannot be used as food for humans and have become a kind of industrial waste that must be treated or disposed of. At present, chemical recycling is the most environmental-friendly and economical way to dispose of dead livestock and poultry. In 2020, a total of 2,077 inspections were conducted at chemical treatment plants, and 238 roadside inspections were conducted for chemical treatment plants related to transportation vehicles. In addition, 264 commercially available fertilizers were sampled and 69 brands of fertilizer manufacturing plants (fields) were inspected according to the Domestic Organic Fertilizer Subsidy Principles and the Domestic Organic Fertilizer Brands Recommendation Specifications.

4.3.2 Recycling technology research development and innovation

Important achievements related to research and development of recycling

technologies by the EPA include the validation of the process for manufacturing Autoclaved Lightweight Aerated Concrete (ALC) partition materials with domestic recycled glass, recycling of waste refrigerator PUR with improved compatibility for making furniture, development of a continuous process for mass production of conveyor belts from recycled waste tire rubber, factory application and test of regenerated positive precursor materials for waste lithium batteries.

Figure 18 Recycling technology and R&D achievements of the EPA

The Ministry of Transportation and Communications conducted a feasibility study on the application of earthworms for the treatment of organic sludge that came from passengers at airports. The use of earthworms to treat organic sludge can reduce the amount of waste generated from the treatment process while reducing the cost and risk associated with the waste treatment and disposal as well. The manure from earthworms can be used as a natural fertilizer that can reduce the cost of purchasing fertilizers and lower the damage to the soil from chemical fertilizers.

The Ministry of the Interior has issued a permit to Yilan Water Resource Recycling Center for a pilot plan to verify and demonstrate sewage sludge recycled fuels. The Ministry of the Interior also applied new construction methodologies and techniques to promote the trial operation on cold-mix recycled asphalt concrete to solve the problem of stockpiling and reuse of scraped materials for construction waste reuse and sustainable development.

4.3.3 Market development and promotion

The EPA drives market incentives through the implementation of a management system to develop the channels for recycling, for example on October 13, 2020, by connecting manufacturers, users, and recyclers together in promoting the voluntary use of recycled plastics. The event invited well-known domestic cleaning product manufacturers such as Unilever, Nice Enterprise, Kao Corporation, and Greenvines, as well as container manufacturers such as Youmei Corp., Yongyu Plastics, and recycler Horng En Co., to jointly respond to and declare the target to achieve 25% recycled materials used for non-food-grade plastic containers by 2025, and to promote the use of recycled plastics by brand name products and plastic containers. In the future, we will promote the application of a verification system suitable for the domestic plastics industry to track and inspect the quality and source of plastics recycled materials, in cooperation with brand name manufacturers and container manufacturers to assure the quality and source of recycled plastics, and to encourage brand name manufacturers to disclose information on recycled content. The recycled materials inspection system is shown in Figure 19.

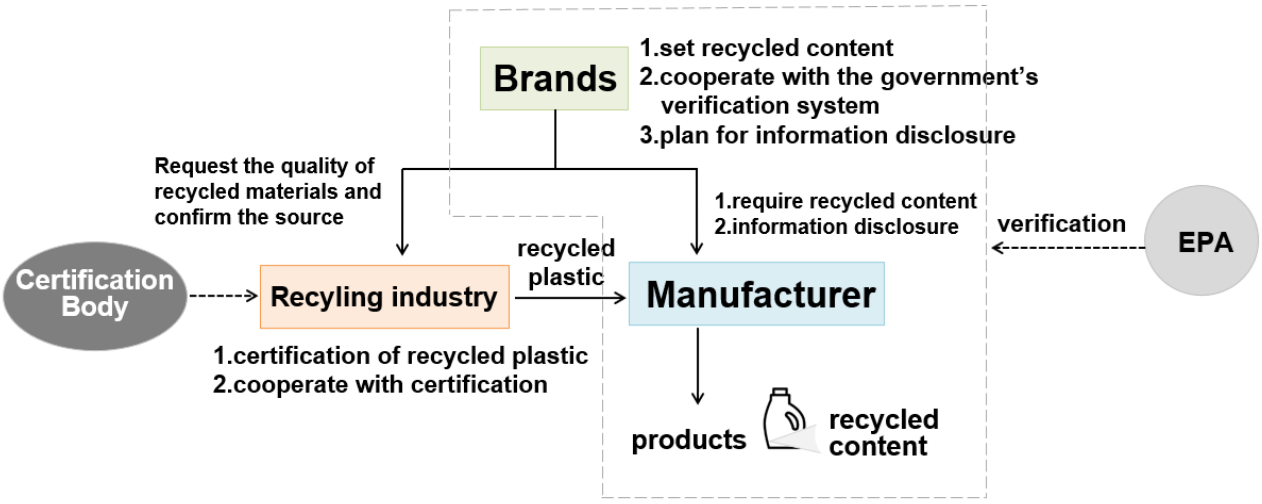


Figure 19 Recycled material inspection system

The EPA primarily subsidizes the research and development of two topics—(1) the technology for waste designated for mandatory sorting and recycling and (2) recycled materials utilization and high-value applications of recycled-material-made products—to enhance recycling efficiency, effectiveness, recycled ratio or recycled materials value, low-energy recycling technology or systems, and innovative management of recycling systems etc. The selected subjects for subsidies include Module analysis of recycling fees and subsidy fees, Innovation module for recycling collection vehicle application design research by evidence-based design method, Application and development of cellulose nanofiber functional composite materials derived from waste paper containers, Research and development of product category rules and verification systems for waste plastic containers recycled materials, Recycling of waste refrigerator PUR with improved compatibility for making new foam products, Plant trial of devulcanization and cyclic application of waste tire rubber using a twin-screw extruder, Factory application and test of regenerated positive precursor materials for waste lithium battery, etc. In 2020, a total of 17 applications were approved for recyclable waste treatment innovation research and development projects, with a total amount of subsidy at NT$30.97 million (about US$1.05 million).

The EPA by encouraging local governments to build bottom slag recycling plants on their own has subsidized four counties and cities including Kaohsiung City, Tainan City, Chiayi City, and Yilan County to build the plants. Presently, Tainan City and Yilan County have completed construction and will produce the incinerator slag recycled aggregates as well as control the quality of the recycled materials by themself. Subsidy to local governments for setting up food waste pre-processing facilities such as for crushing and dehydration has been completed with the installation of 50 units, plus the installation of 13 units of high-efficiency composting treatment facilities. In October 2020, the EPA continued to host the mobile phone recycling month lottery draw event for the sustainable development of earth resources. At the same time, the event promoted the value of mobile phone recycling to enhance the effective recovery of waste mobile phones. A total of 54 activities were conducted by Environmental Protection Bureaus in counties and cities, with 97 locations set for permanent waste mobile phone collection services, which is an increase of 20 locations compared to that in 2019. As a result, the number of waste mobile phones collected has increased by approximately 5.2% in 2020.

Figure 20 EPA "Mobile Phone Recycling Month" promotional icon

The Council of Agriculture implemented domestic organic fertilizers promotional plan through economic incentive measures. Under this, local

county and city governments guided farmers to use fermented and decomposed compost to improve farmland fertility with the application of 189,672 tons of domestic organic fertilizers to 31,612 hectares of farm fields. The incentive measures also include the provision of low-interest loans for purchasing pollution prevention and resource recycling facilities by livestock farms and livestock manure composting fields to promote pollution prevention and resource recycling. In 2020, a total of 6 loan applications were approved for a total amount of approximately NT$42.28 million (about US$1.43 million). A total of seven advertisements for Recycling and Reuse of Fishery Wastes were published in New Fisheries Magazine to promote various ways for recycling and reuse fishery wastes by fishermen.

The Ministry of Transportation and Communications organized seminars related to environmental education and resource recycling to promote the concept and knowledge of environmental resource recycling. In 2020, a total of 2,483 people participated in relevant workshops and activities organized by the Directorate General of Highways ; 122 people participated in similar workshops and activities held by the Civil Aeronautics Administration; 191 people participated in the training courses and activities provided by Tourism Bureau. In addition, various information network platforms will continue the service for publicity.

The Ministry of Education promotes the concept of resource recycling and a friendly environment through organizing competitions and training activities. In 2020, the competition and training organized included one green chemistry creativity competition for senior high schools, three green chemistry summer camps, and two green chemistry creativity competition teachers training camps; to promote green chemistry creativity competition activities, and for teachers and students to understand the concept of reducing toxification and pollution in green chemistry as well

as to learn the achievements obtained from green chemistry creativity competitions in the past. The competition and training activities have well introduced the importance of green chemistry and brought enthusiastic participation in the activities to explore and practice from learning.

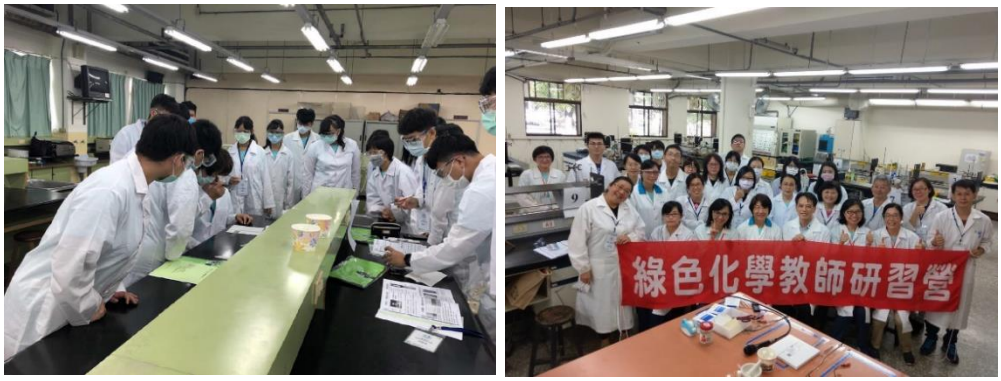


Figure 21 Green Chemistry Teachers Workshop