Executive Summary

Taiwan's Abundance of Waste Burning:

National Report on Waste-To-Fuel Import, Export, Produce and Use in Taiwan ROC

November 2024

Taiwan Watch Institute

IPEN
for a toxics-free future

Executive Summary

Taiwan industry burns very large volumes of waste in several forms including Refuse Derived Fuel and exports significant quantities of combustible wastes that may also be turned into RDF in other countries. Taiwan Watch Institute analyzed the waste to energy industry in Taiwan and mapped most of the key facilities that burn waste for energy or other purposes as well as imports and exports of plastic wastes. Our research indicates that much domestic plastic waste intended for recycling actually ends up as RDF burned in incinerators or cement kilns as RDF. We have developed interactive flow charts showing the fate of various wastes in relation to waste management and waste burning activities. On the basis of our research, we recommend:

- The burning of domestic waste and industrial waste be phased out due to hazardous emissions and waste of resources.
- The import and export of Refuse Derived Fuel and similar waste-based fuels should be regulated under the Basel Convention as mixed plastic waste requiring a hazardous waste import/export permit and prior informed consent from trading partners.
- A specific HS code should be assigned to RDF so that its global movement can be tracked properly and regulated.

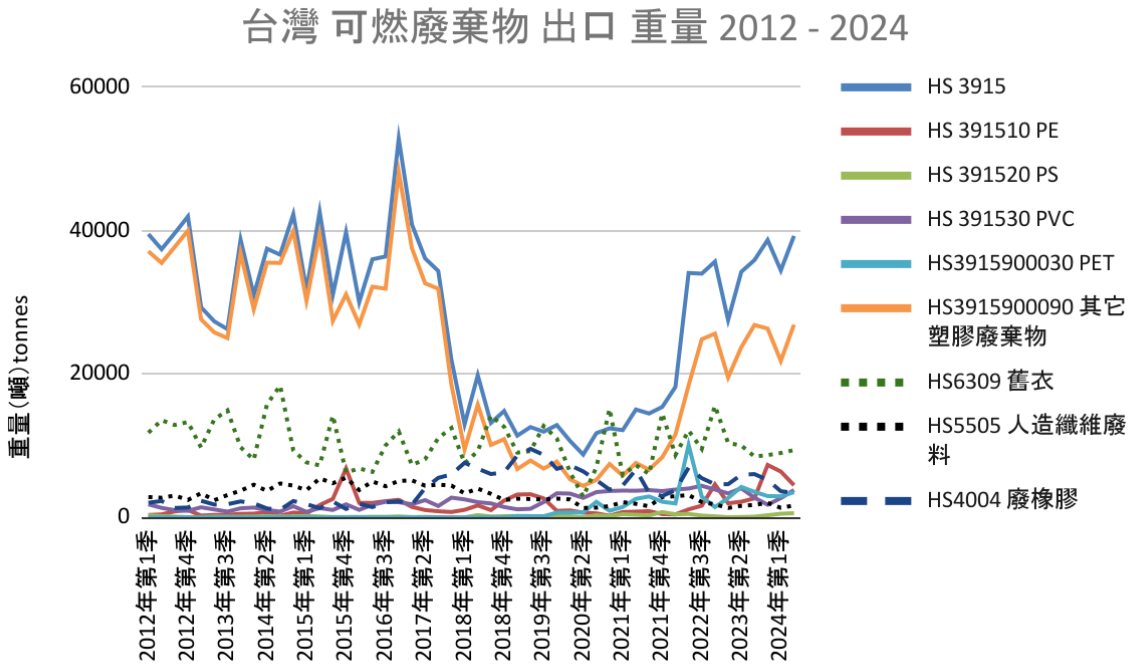
  And as a small island nation with a heavy waste burden, we strongly urge our government to explicitly ban the import and export of any kind of RDF, abolish the status of waste plastic as industrial raw materials that can be traded without import/export permit, abolish the status of waste-to-energy as renewable energy by amending the law, designate PVC waste and mixed plastic waste with high halogen content as hazardous waste that should not be used as fuel or incinerated, and implement policies that truly follow zero waste principles.

Combustible Waste Exportation

- Among the 3 HS codes which are related to plastic waste, **HS3915** accounts for the vast majority of total export volume. In the past decade (2014 - 2023), average export volume per year of **HS3606** is **18.8 mt**, of **HS3825 92.2 mt**, of **HS3915 104,973.8 mt**.

- There are 4 subheadings under HS3915:
  - HS391510 represents waste of polymers of ethylene - PE
  - HS391520 represents waste of polymers of styrene - PS
  - HS391530 represents waste of polymers of vinyl chloride - PVC
  - HS391590 represents waste of other plastics，further under these subheading are 4 categories:
    - HS3915900010 Waste, parings and scrap of celluloid, can be ignored due to little export volume.
    - HS3915900020 Waste optical disc, can be ignored due to little export volume.
    - HS3915900030 Waste, parings and scrap, of polyethylene terephthalate - PET
    - HS3915900090 Waste, parings and scrap, of other plastics

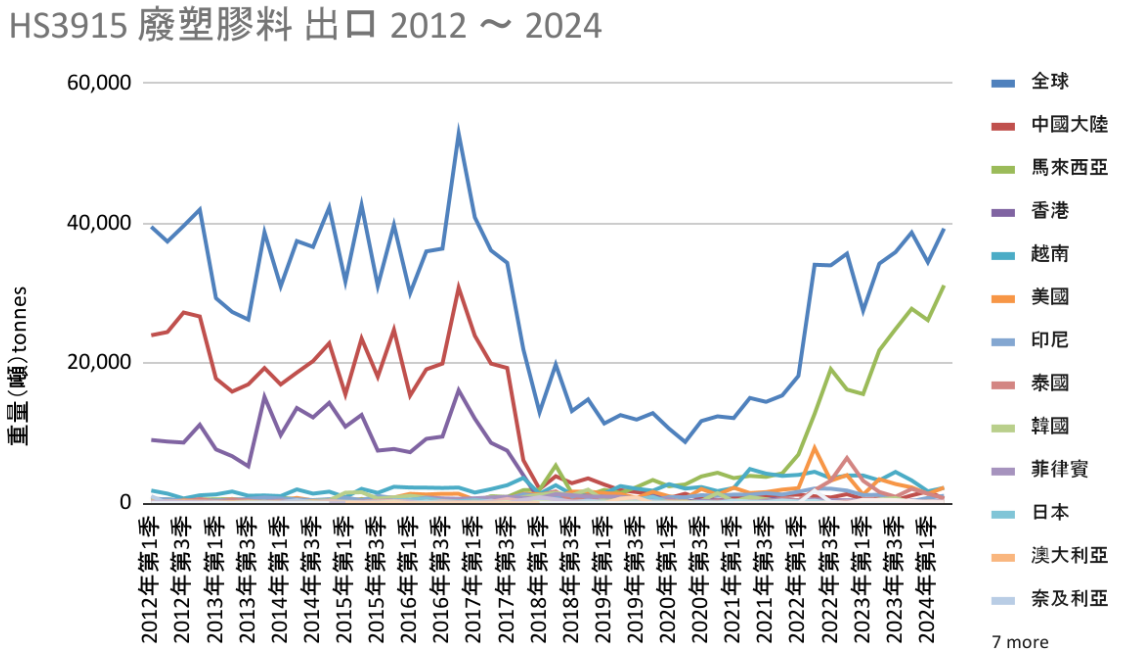
- HS3915900090 - **Waste, parings and scrap, of other plastics**, accounts for the majority (almost all before 2018) of the HS3915 exportation, see Annex A, Fig. A, orange line. This category contains plastic waste of various types, supposedly other common polymers but not yet classified in the HS system, like PP, PC, ABS, acrylic, scraps from textile products …etc.



○ Annex A. Fig. A：Combustible waste exportation from Taiwan

- **Before 2018**, the exportation of HS3915 almost all went to **China and Hong Kong**, see Annex A, Fig. B, red line China, purple line Hong Kong.

- From **2018** until the end of **2021**, HS3915 export volume decreased dramatically to about ⅓, mostly going to countries in southeast asia, see Annex A, Fig. B.



○ Annex A, Fig. B：HS3915 Plastic waste exportation from Taiwan

- Since the beginning in **2022**, **Malaysia** (Annex A, Fig. B, Green Line) has taken the role of major HS3915 export destination, few others went to the USA and other southeast Asian countries. Afterwards the export volume climbed back close to the level (about 40,000 tonnes per season) before 2018.

- In 2023, **Malaysia** alone imported **90139.4 tonnes** of plastic waste (HS3915) from Taiwan, **66%** of total export volume. The second place Vietnam only imported 14937.78 tonnes, 11% of total volume.

- **PVC waste** (HS391530, Annex A, Fig. A, purple line) has been the second largest portion of plastic waste exportation in the past decade, whilst since 2023, PE (HS391510, Annex A, Fig. A, red line) exportation has risen up to 2-3 times of its previous level. **Malaysia** imports most of the PVC wastes, next **Indonesia**, with the notoriety of PVC this should be a serious concern and brought into discussion of Basel Convention.

- There are other combustible wastes which are likely to be the source of RDF, and their export volumes, though not as much as HS3915, are to be reckoned with, such as worn clothes (HS6309, Annex A, Fig. A, green dot line)、Waste of man-made fibres (HS5505, Annex A, Fig. A, black dot line）and waste rubber（HS4004, Annex A, Fig. A, blue dash line）

- Starting from early 2018, the export volume of HS4004 Waste, parings and scrap of rubber (other than hard rubber) and powders and granules obtained therefrom, climbed rapidly as much as 3 times to its previous level. 2018 - 2023 The average export volume per year is about 23869.88 tonnes, and the additional amount is almost all exports to Japan (Annex A,

Fig. J, red line)

- The annual export volume of HS6309 (Worn clothing and other worn articles) is about 40000 tonnes. Before 2023, they mostly went to Bangladesh (Annex A, Fig. C, red line), who took about half of the export volume but seems only in specific seasons (3 or 4). For the rest of the year, they went evenly to some southeast Asian and African countries.

- Export volume of HS5505 (Waste of man-made fibres) kept 16210.9 tonnes per year before China (Annex A, Fig D, red line) shut its door in 2018. After that, it falls about half down to 8651.5 tonnes per year. Most of the exports went to Thailand, Vietnam, Malaysia and Indonesia.

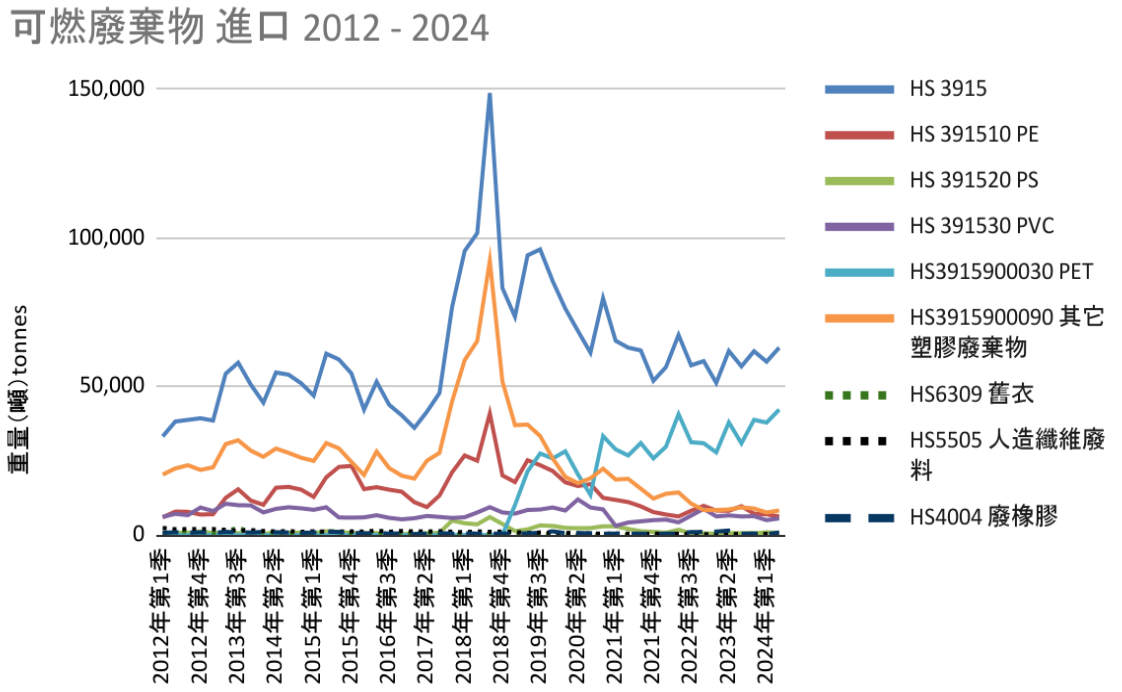
Combustible Waste Importation

- Among the 3 HS codes which are related to plastic waste, same as exportation, HS3915 accounts for the majority of importation. In the past decade (2014 - 2023), average import volume of **HS3606 is 76** tonnes per year, of **HS3825 129** tonnes, of **HS3915 258443** tonnes.

- **Before 2018** the import volume of **HS3915 (plastic waste)** was stable around **200,000 tonnes per year**(50,000 per season), see Annex A, Fig. K, **mostly HS3915900090 (other plastics, orange line)**, HS391510(PE, red line) the second.

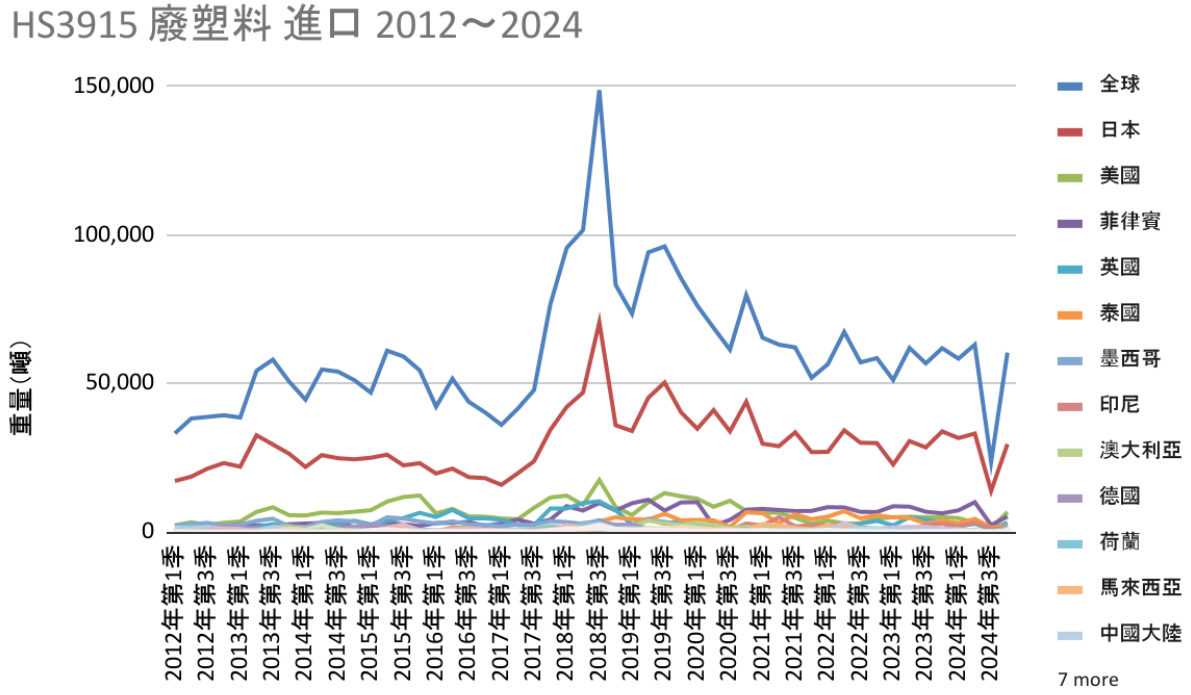
- Impacted by the 2018 event where China rejected lots of solid wastes, they were forced to be rerouted to southeast Asian countries including Taiwan, the import volume (Annex A, Fig K, blue line) **peaked up at 150,000 tonnes in 2018 season 3**. Although it fell immediately afterwards, it has been above previous levels, never falling below.

- Also after 2018, **HS3915900030 (PET, cyan line) became the largest part** of plastic waste importation, while importation of other plastic waste categories shrunk a lot. The reasons behind this shift could be: 1. Promotion of bottle-to-bottle policies by big corporations; 2. Technology of recycling PET to clothes has matured in Taiwan; 3. Other southeast Asian countries has greater plastic waste treatment capacity than Taiwan.



○ Annex A, Fig. K：combustible waste importation into Taiwan

- **Japan** has always been the **main country who exports HS3915 plastic waste** to Taiwan, obviously, see Annex A, Fig L, red line. **About 50%** of imported plastic waste **comes from Japan**. Suppose the reason could be that Japan is the nearest developed country, but ironically, Japan has poorer waste treatment capacity than Taiwan, or any other developing southeast Asian countries.



○ Annex A, Fig. L：HS3915 Plastic waste importation into Taiwan

- Table 1 lists the top 10 countries who exported the most plastic waste (HS3915) into Taiwan in 2023. One can see that **value is not proportional to the distance** from Taiwan to the source country, although it shows a little bit of an inversely proportional relation. Since the shipment from Europe costs a lot and is time-consuming, a rational speculation about why it's so cheap from UK and Netherland could be that the **waste has poor quality, mixed materials**, and needs to be treated abroad, which makes it very suspicious.

Table 1: Top 10 (by volume) countries exporting HS3915 plastic waste to Taiwan in 2023

Ranking	Source	Volume (tonnes)	Value (NTD/KG)
1	Japan	115,691	19.23
2	Philippines	30,384	25.76
3	USA	20,109	11.60
4	Thailand	16,408	27.04
5	UK	14,752	5.37
6	Indonesia	7,445	23.41
7	Vietnam	6,132	25.14
8	Netherland	2,489	8.63
9	Mexico	1,817	29.33
10	China	1,719	28.27

Waste to Energy or to Resource? Domestic Flow Diagrams for Waste streams allowed to be used as RDF and the Corresponding Waste Recycling/Disposal Organisation Maps

- Whether import or export of plastic waste takes up **a small portion** of the total amount of **production and recycling** stream in Taiwan. **Imported plastic waste** accounts for **less than 5% (1.83% in 2022)** source material for the industrial plastic life cycle, other sources include imported crude, plastic polymers, imported plastic products, and domestic plastic waste. **Exporting** plastic waste also accounts for **less than 5% (4.3% in 2022) of downstream treatments**, which include recycling, incineration and landfill …etc..

Table 2. Volume of plastic stream through its life cycle

Year	Raw Material/Foreign Product Input →					Plastics Industry	→ Product/Waste Output	
	Crude Import (Mt)	Plastic product Import (Mt)	Plastic polymers Import (Mt)	**Plastic Waste (as industrial raw material) import (Mt)**	Plastic waste recycling (Mt)	Plastic industry stream (Mt)	Plastic products/polymers Export (Mt)	Domestic plastic manufacture and consume (Mt)
2018	1056	47	127	**43**	45.9	1318.9	1056.92	261.98
2019	1041	48.3	131	**34.92**	49.9	1305.1	1033.8	271.3
2020	1027.3	54	138.7	**28.6**	48.2	1296.9	1013.1	283.8
2021	1081.5	63.6	146.1	**24.3**	92.7	1408.2	1084.8	323.4
2022	982.1	58	136.2	**23.9**	104	1304.3	950.9	353.4

Table 3. Volume of domestic plastic waste treatment

Year	Volume of domestic plastic waste treatment (Mt)				
	Recycling	Incineration	Landfill	**Export**	Total
2018	45.9	81.4	1.4	**6.08**	134.78
2019	49.9	86	1.4	**4.88**	142.18
2020	48.2	111.6	2.2	**4.3**	166.3
2021	92.7	118.4	6.5	**5.7**	223.3
2022	104	153.5	8.6	**12.2**	278.3

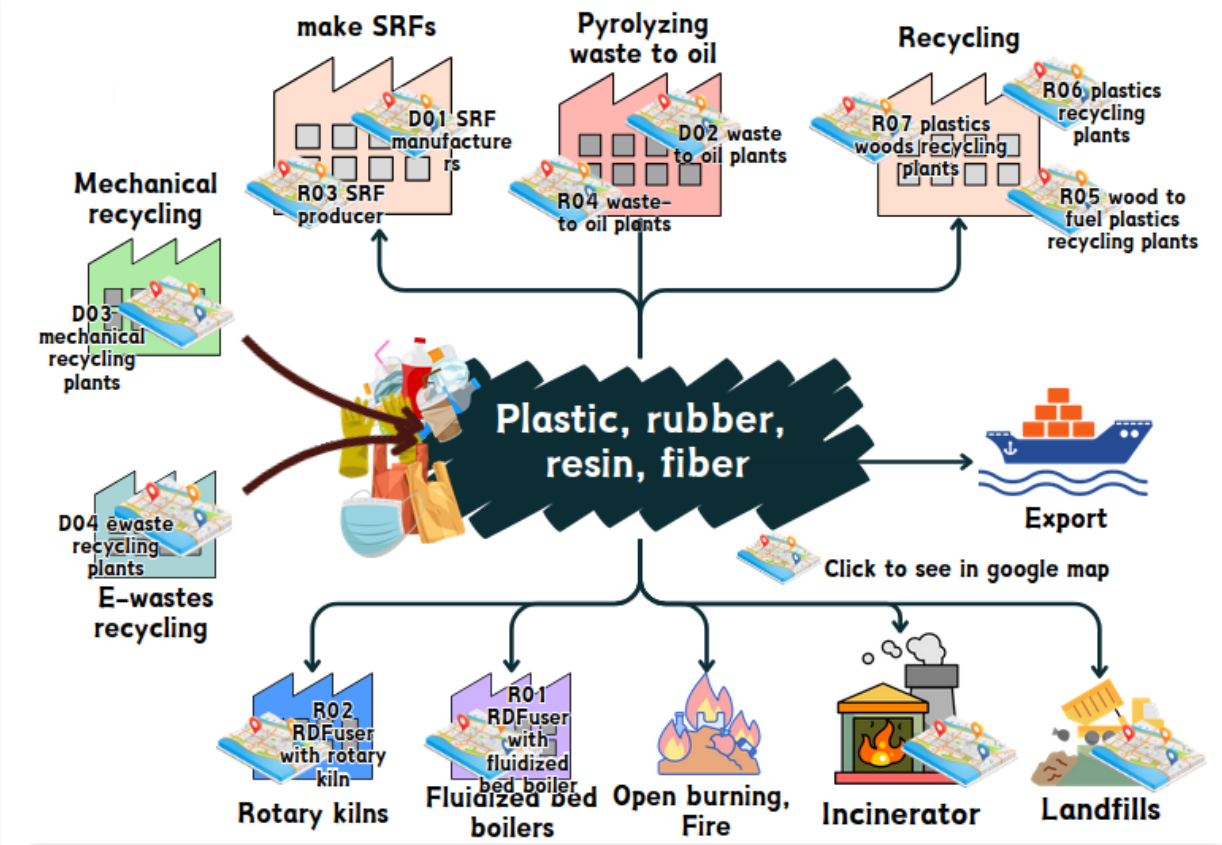
- In general, a large portion of domestic plastic waste goes into **incinerators**, the rest into **recycling**, **very few export** abroad. When it comes to waste treatment policy, either local or central authorities embrace **incineration**. In recent years, nevertheless, more and more of those supposed to be diverted into recycling, eventually turn out **to be converted and burned as RDF**.

- The reasons that we don't import much plastic waste include: 1. At the end of 2018 Taiwan EPA **restricted importation** of plastic waste furthermore; 2. **Low crude value** suppresses plastic recycling market, making it shrink; 3. Amount of **domestic plastic waste is enough** to supply the shrunken recycling market.

- Other than exporting, waste downstream treatments in Taiwan such as recycling into production; converting to oil; **converting to SRF**; **burned directly as RDF** in rotary kilns and fluidized bed boilers, or other industrial boilers; compost, anaerobic digestion, and of course incineration and landfills.

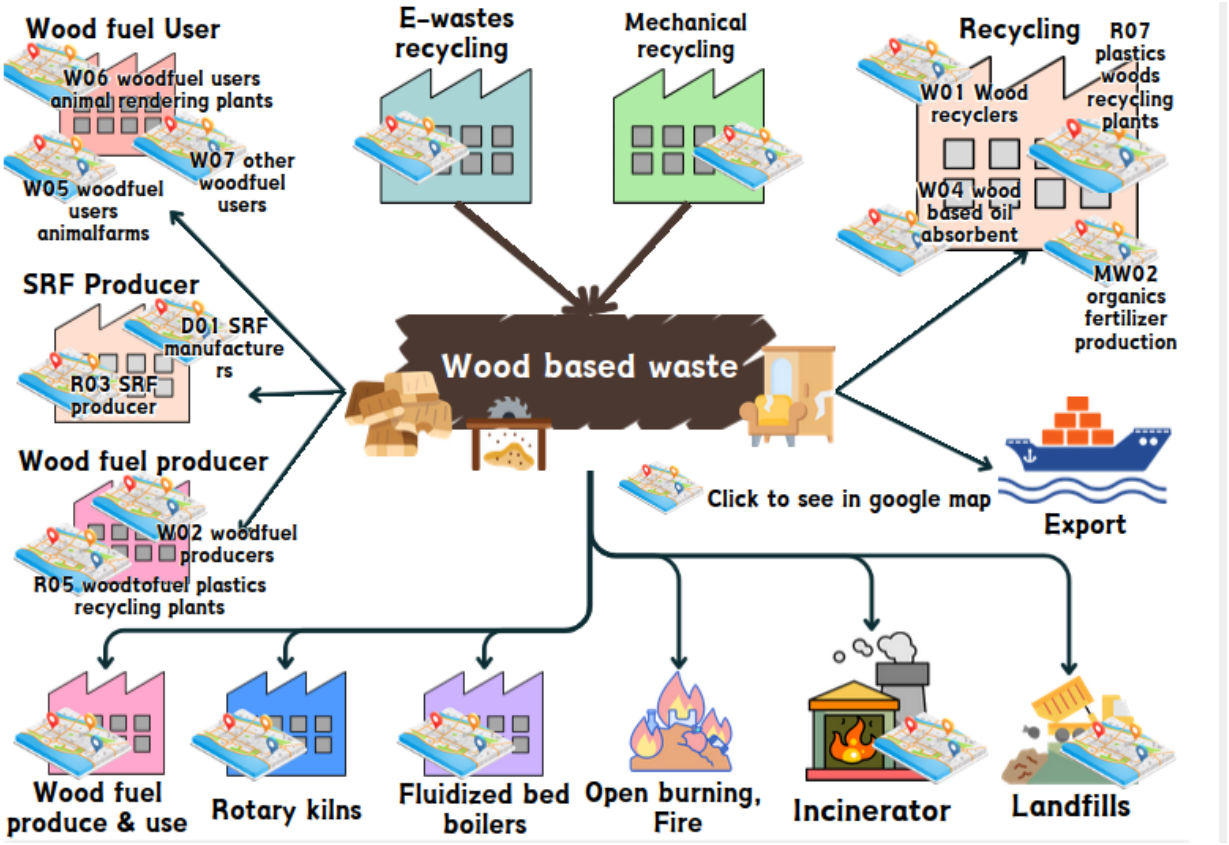
- Many types of waste are possible sources of SRF or RDF, like plant-based residue, wood waste pellets, industrial waste from paper mills, waste from man-made fibers, rubber or resin waste, …etc. Regards the amount used as sources of SRF/RDF in Taiwan, they can be categorized into 4 major groups:
    - Waste of plastic, rubber, resin and plastic fibers.
    - Waste of wood scraps, wood furniture or buildings.
    - Waste of paper, paper board or paper pulp residue.
    - Waste of mushroom substrates.

- Below are the downstream flow diagrams of these 4 groups of possible sources of SRF/RDF. Clicking on the image redirects to the webpage of the same diagram but with interactable google map links. Clicking the map icons on each treatment shows a map with organizations each of which has official permission to receive corresponding types of waste and operate certain treatments. For example, Annex C Map 01 shows SRF producers who receive combustible waste.

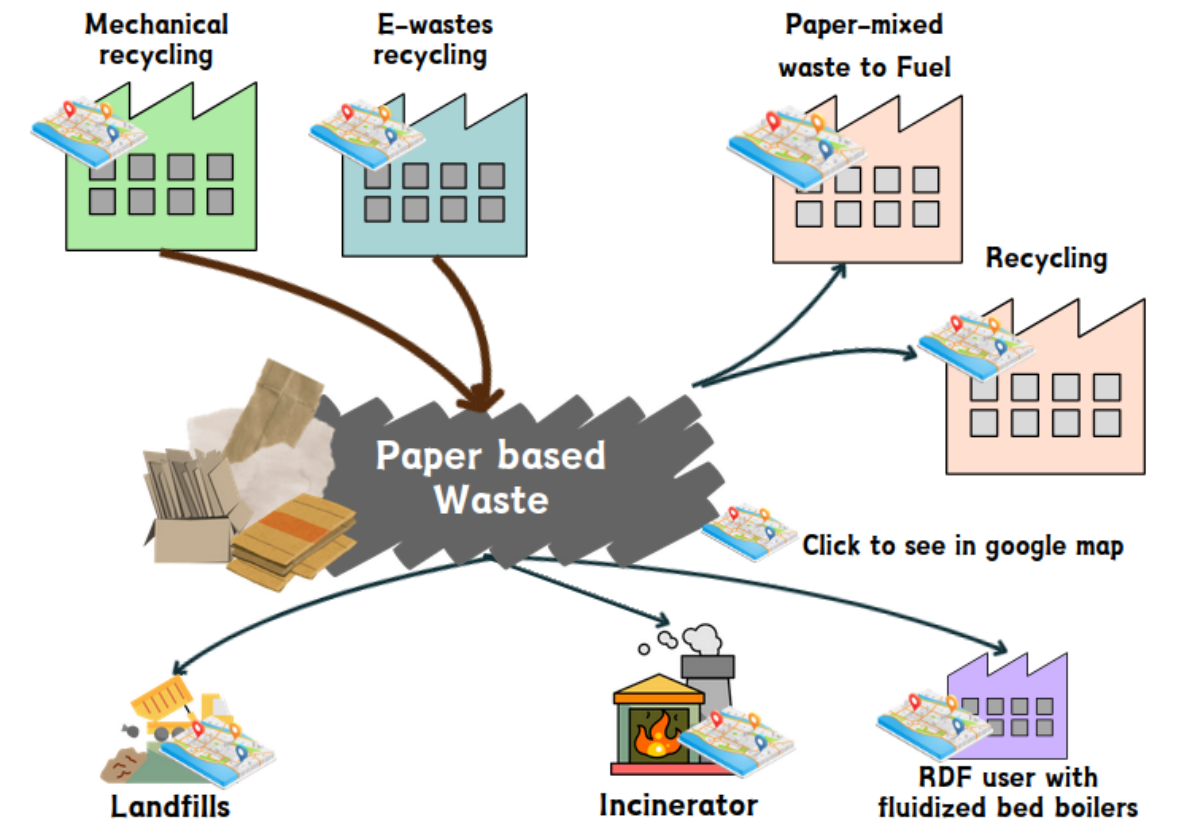


Annex B, Diagram A：Waste management downstream for plastic, rubber, resin, fiber，

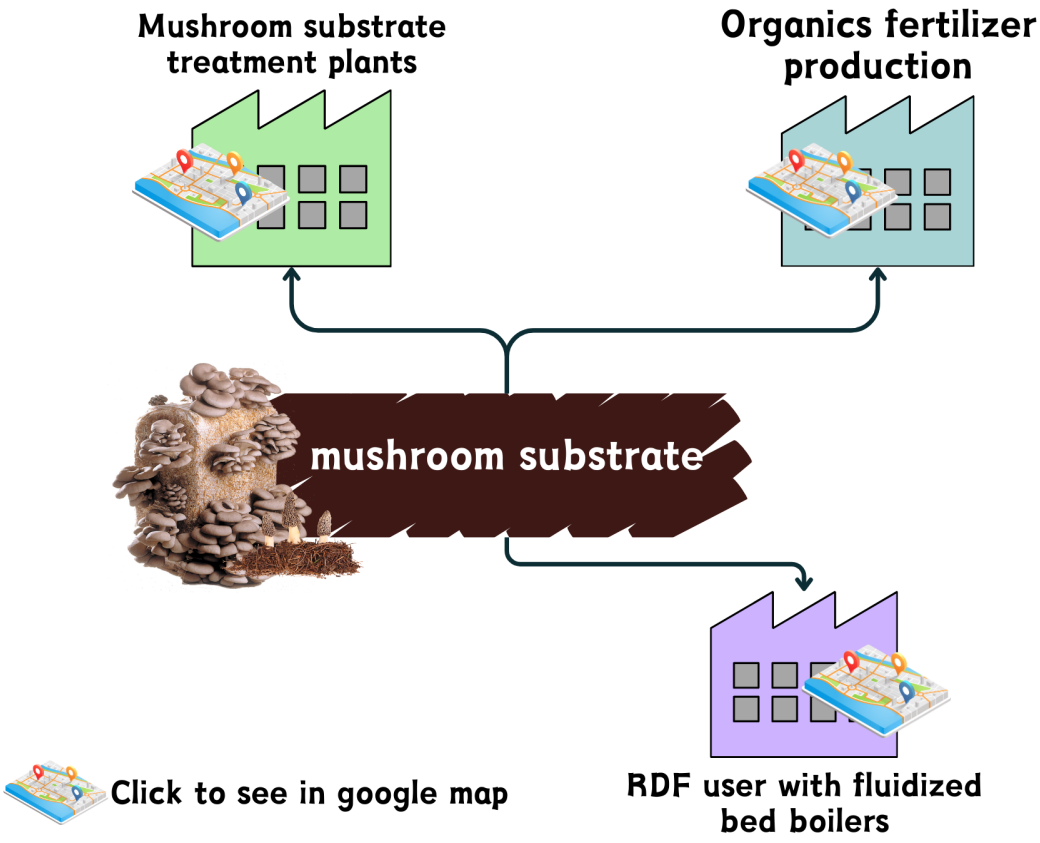
Interactable Webpage



Annex B, Diagram B：Wood-based waste management downstream，Interactable Webpage



Annex B, Diagram C：Paper-based waste management downstream，Interactable Webpage

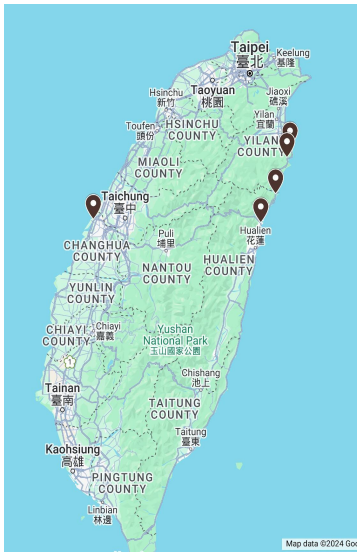


Annex B, Diagram D：Mushroom substrate waste management downstream，Interactable Webpage

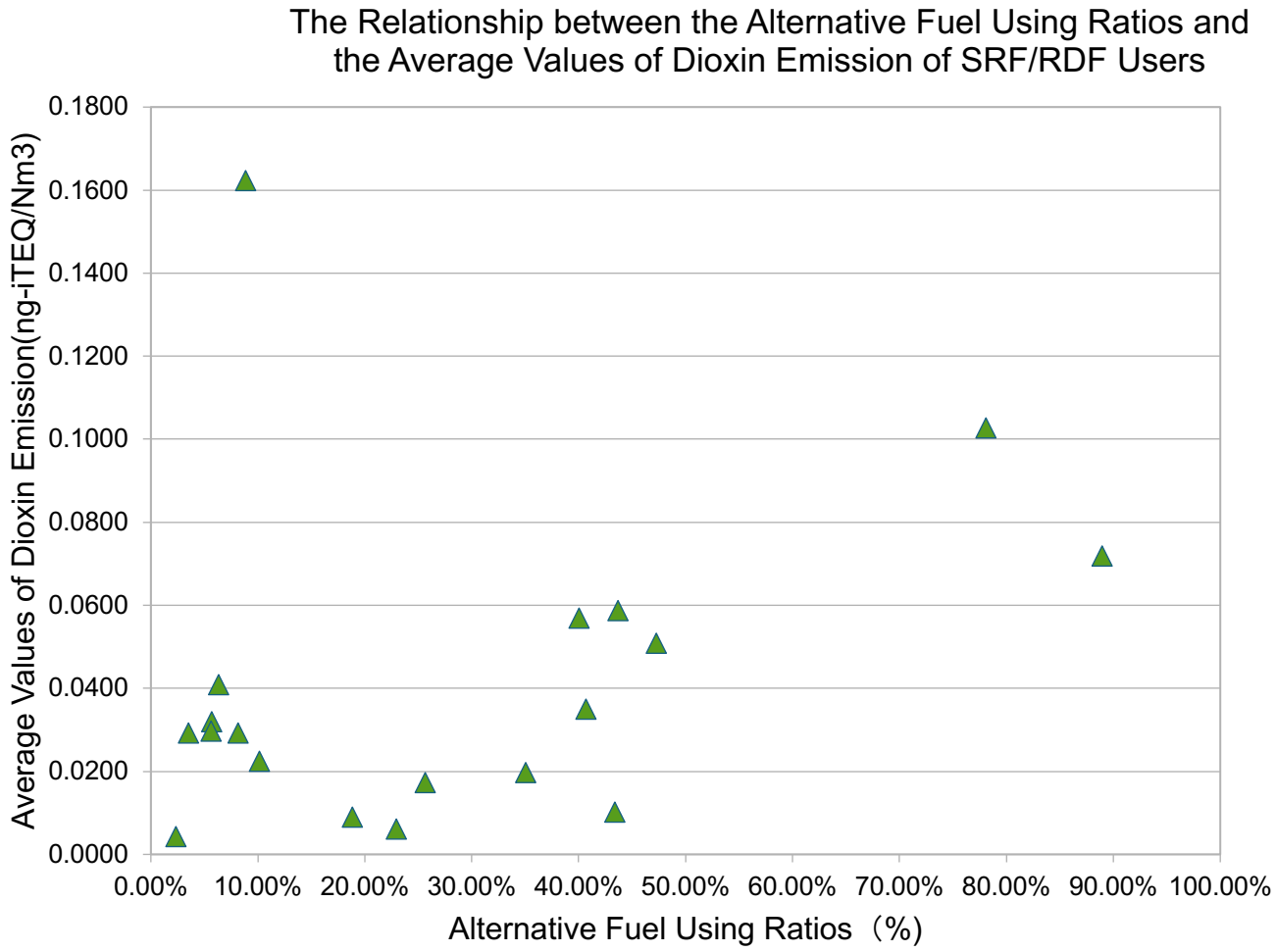
- The following map shows the numerous recycling **organizations** in Taiwan who are capable and have official permissions to **receive combustible waste**, including pre-mentioned plastic, rubber, resin, fiber, paper, wood, mushroom substrates, and **use various types of waste to produce SRFs**.

Annex C, Map 01 SRF producers who receive combustible waste, see on google map

- The following maps shows the numerous facilities in Taiwan which use RDF/SRF fuel or burn waste directly. The left one shows SRF/RDF users with fluidized bed boilers, the middle one shows SRF/RDF users with rotatory kilns, the right one shows MSW/industrial waste incinerators. Other maps please see Annex C.



- From the dioxin emission test results of the 19 industrial plants which use SRF/RDF as alternative fuel in 2023, we found that, as shown in the following diagram. the more SRF/RDF they use, the more dioxin emissions from their stacks.



Regulations for Waste Import/Export

- According to complicated geopolitics, Taiwan is not a party to the Basel Convention. Although it is written in our Waste Disposal Act that "**Hazardous industrial waste shall give priority to domestic treatment and recycling… …for transboundary movement of hazardous industrial waste in accordance with international convention**", but it is not specified which international convention applies.

- Basic rule 1: The import, export, transit and transshipment of industrial waste may commence only after receipt of permission granted by the special municipality, county or city competent authority; for **hazardous industrial waste**, additional approval from the central competent authority is necessary. **However, wastes that are officially categorized as industrial raw material** by the central competent authority after consultation with the industry competent authority are **not subject to this provision**.

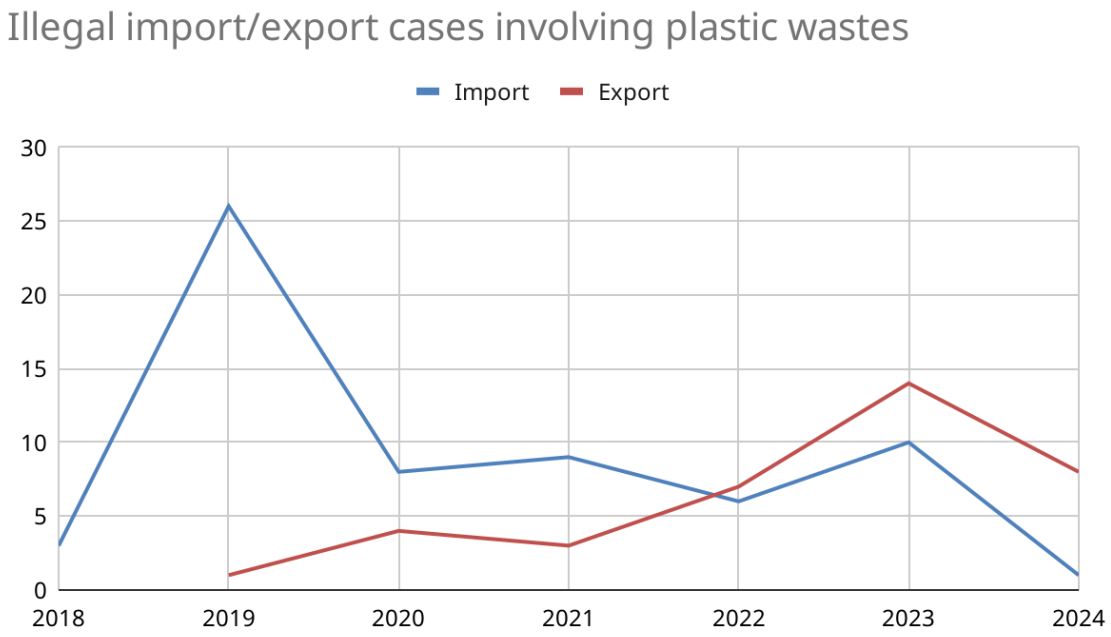
- Basic rule 2: Importation of waste types below are legitimately forbidden:
  - Hazardous industrial wastes **except which certified as industrial raw material**
  - Scraps of peeled leather or leather waste.
  - Municipal solid waste and its ash from incineration

- Waste Animal Oil and Vegetable Oil

- The so-called “certified as industrial raw material” indicates those wastes which through the government's announcements are **useful as material for recycling into industry production**, thus are allowed to import, even without official permission. It has become a **weak point** undermining our guard **against hazardous waste imports**. These types of waste include wastepaper, thermoplastic waste plastic, waste rubber (particle size > 4mm), waste steel and mono-material waste metals.

- In 2018, as the consequence of China closing the door of waste importation and hence huge amounts of wastes were rerouted to Taiwan, Taiwan EPA had to tighten the scope of “waste as industrial material” which are allowed to import without permission. For example, the stricter requirements for thermoplastic wastes are:
  - Scraps or defects from thermoplastic plastic production, or waste of plastic products, should be mono-material or mono-form. This implies that the import plastic waste should be sorted according to its polymer type (PE, PP, PS, …etc.) or its product type (bottles, clothes, containers, etc.).
  - Only officially registered plastic manufacturers can import (brokers out).
  - Medical and dirty (contaminated) waste forbidden.

- Below shows the trending of illegal import/export cases involving plastic wastes. A sudden **increase of illegal import cases happened in 2019**, mostly due to 2018 China shutting down waste importation. In other years the number of illegal import cases remains almost the same. On the other hand, **illegal export cases increase these years**, could be that manufacturing industries moved from China back to Taiwan, making more industrial wastes which are troublesome and difficult to handle.



Regulations for Waste to Energy

- The main law which paves the way for waste to energy and drives the market to some extent is the "Renewable Energy Development Act" . In article 3 it defines renewable energy: "Refers to solar energy, biomass energy, geothermal energy, ocean energy, wind energy, non-pumped storage hydroelectric power, **energy generated by direct use or treatment of domestic general waste and general industrial waste**, or other energy approved for sustainable use by the central competent authority."

- For a long time environmental groups in Taiwan have been trying to **get this "energy generated by waste" definition removed** from the Renewable Energy Development Act, even our EPA tends to do that. But the funny problem is that it is the Ministry of Economic Affairs who is the central competent authority for the act and holds the authority of amendment. In a manner of speaking, they think it's convenient to leave that definition there.

- Good thing is that the word "domestic" is there to at least **prevent importation of waste** from exploiting the subsidies established by the Renewable Energy Development Act.

- Another regulation which is trying to deal with the possible pollution caused by burning waste, is the Technical directive and quality specifications for SRF manufacturing. It sets regulations as:
  - What types of combustible waste can be the source of SRF. Again, exclude imported wastes.
  - Quality standards of SRF products, see Table 4.
  - SRF producers should install certain equipment, such as homogenize and pollution control equipment.
  - SRF users can burn SRF only with certain equipment, such as rotary kilns and fluidized bed boilers.

  This directive is not final yet, still in revision for sake of uncertainty of domestic SRF usage.

Table 4: Taiwan quality standards of SRF

Quality item.	Unit		Standard method	Limit
NCV (net calorific value)	MJ/kg (as received)	Mean	NIEA M216.00C ISO 21654	≥ 10
	kcal/kg (as received)			≥ 2,392
Cl	% (dry based)	Mean	NIEA M217.00C EN 15408	≤ 3
Hg	mg/MJ (as received)	Mean	NIEA M360.01C EN 15411	≤ 0.15
	mg/Mcal (as received)			≤ 0.6279
Pb	mg/kg (dry based)	Mean	NIEA M360.01C EN 15411	≤ 150
Cd	mg/kg (dry based)	Mean	NIEA M360.01C EN 15411	≤ 5
※ The wet basis weight ratio of unavoidable and naturally mixed non-combustible waste				

contained in SRF shall not exceed 1% based on manual sorting.

Annex A: Statistic Charts of Combustible Wastes Import/Export

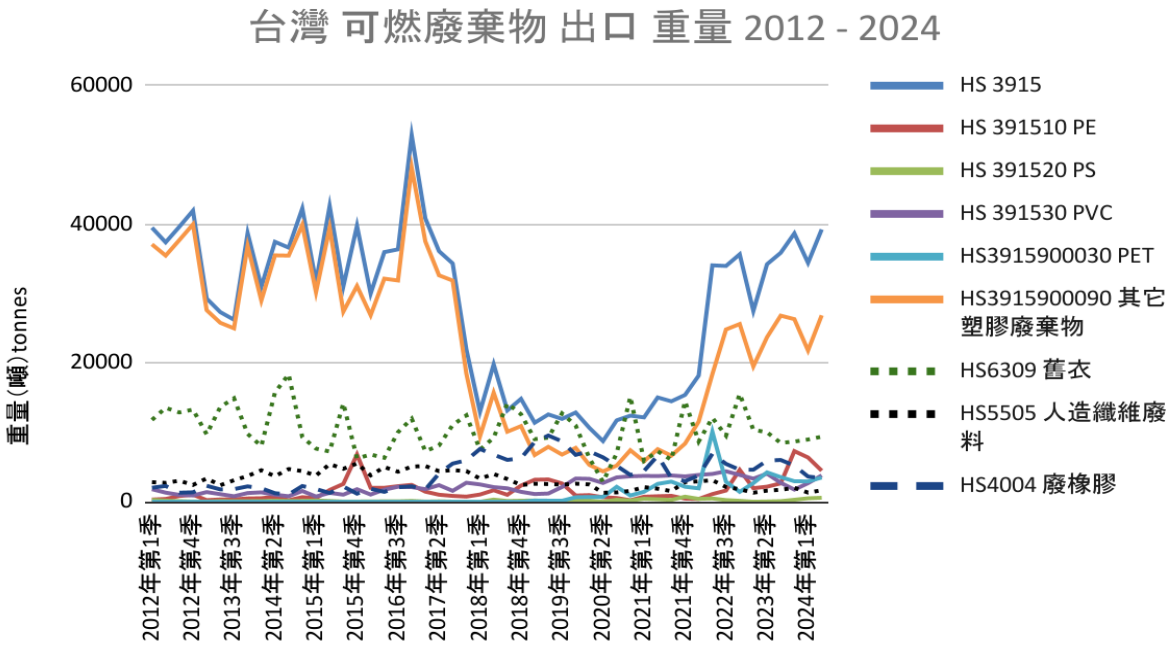


Fig. A：Combustible waste exportation from Taiwan

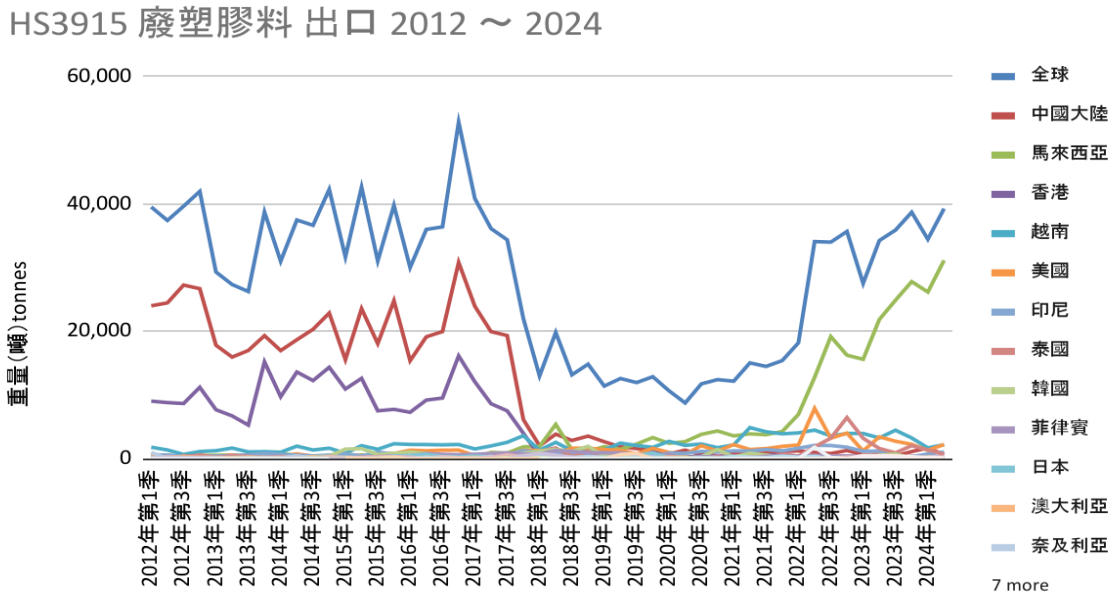


Fig. B：HS3915 Plastic waste exportation from Taiwan

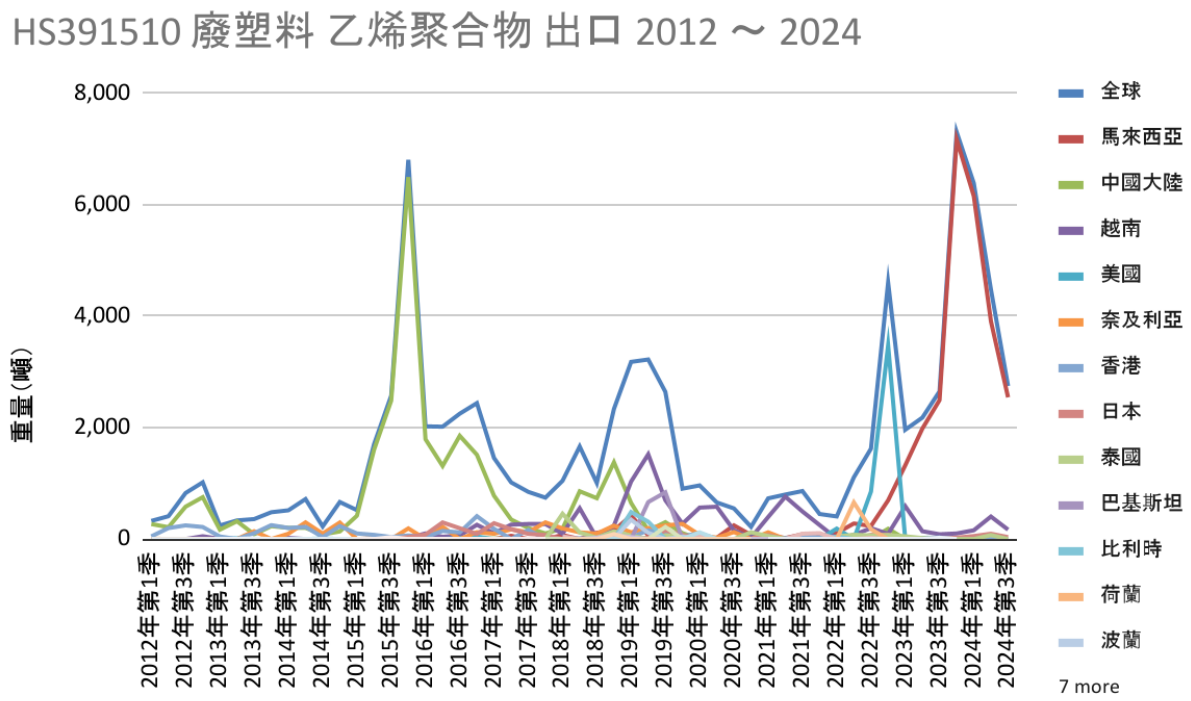


Fig. E：HS391510 Plastic waste of polymers of ethylene (PE) export from Taiwan

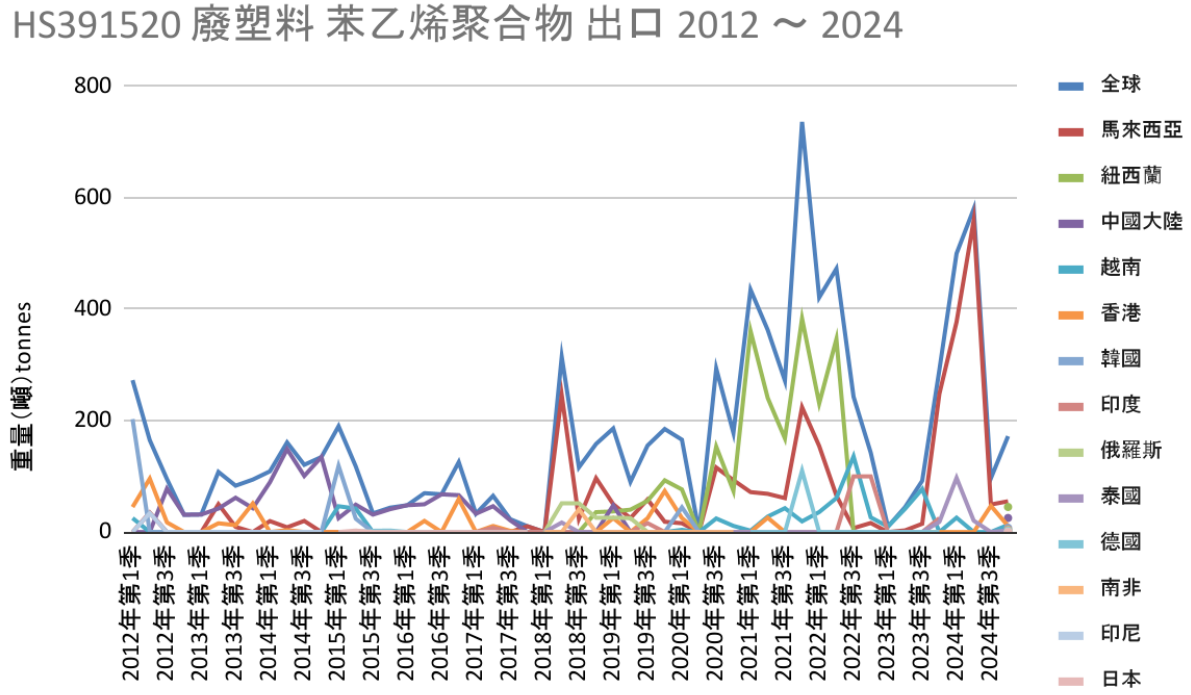


Fig. F：HS391520 Plastic waste of polymers of styrene (PS) export from Taiwan

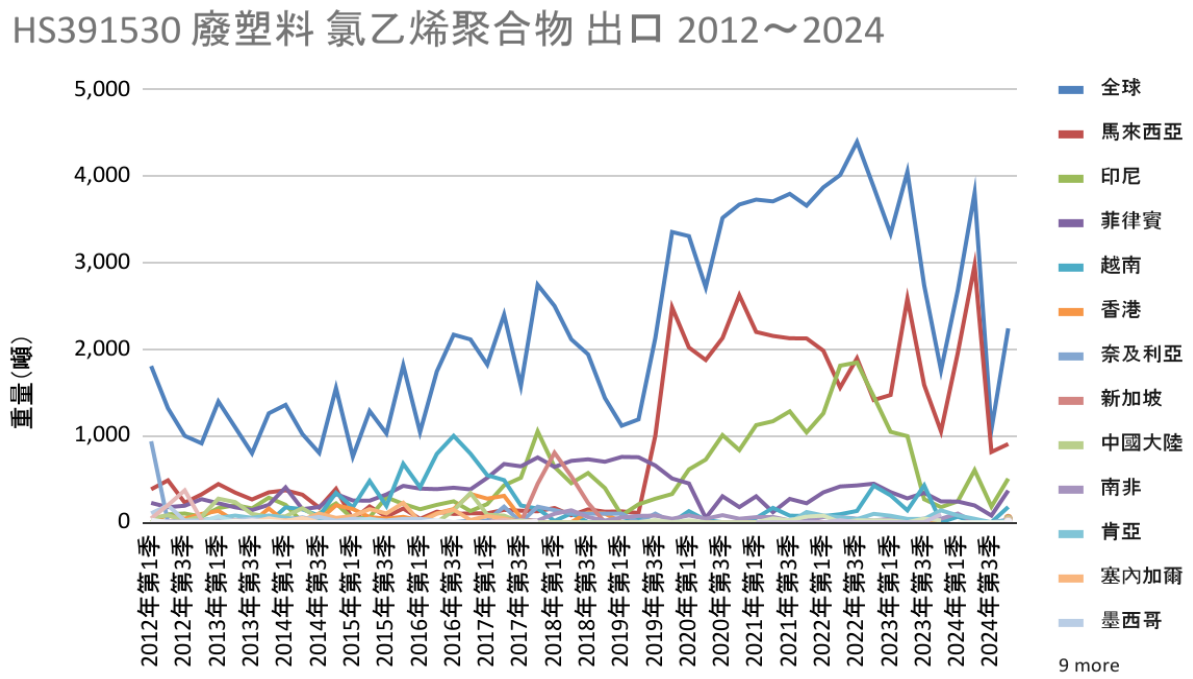


Fig. G：HS391530 Plastic waste of polymers of vinyl chloride (PVC) export from Taiwan

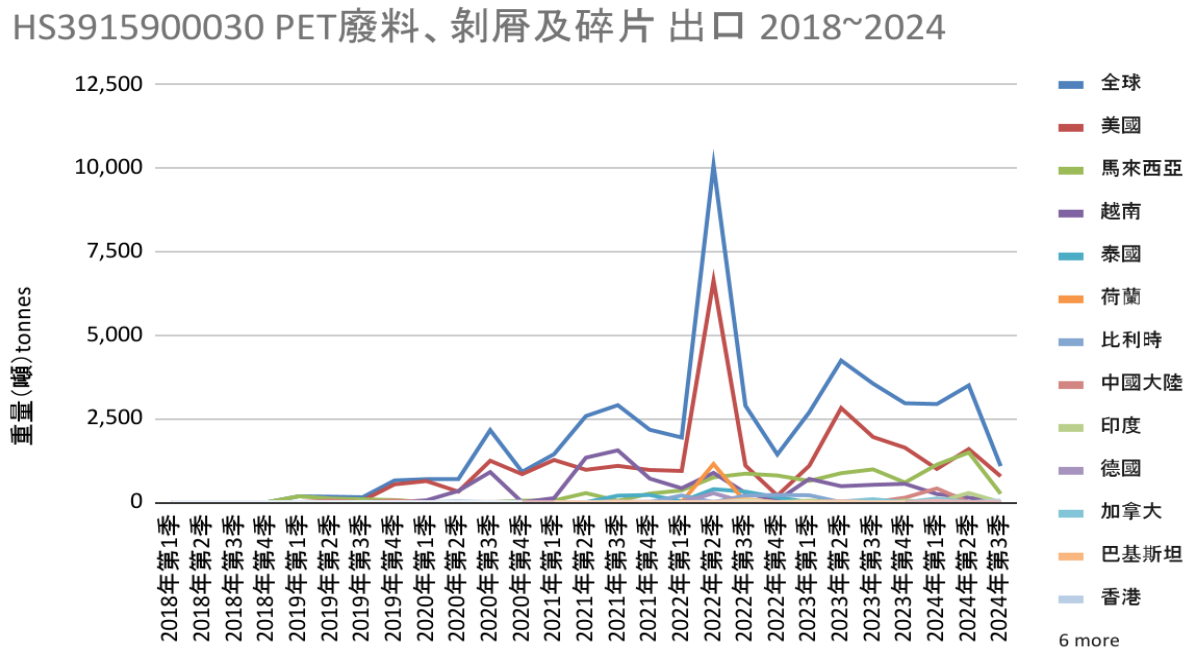


Fig. H：HS3915900030 Plastic waste of polyethylene terephthalate (PET) export from Taiwan

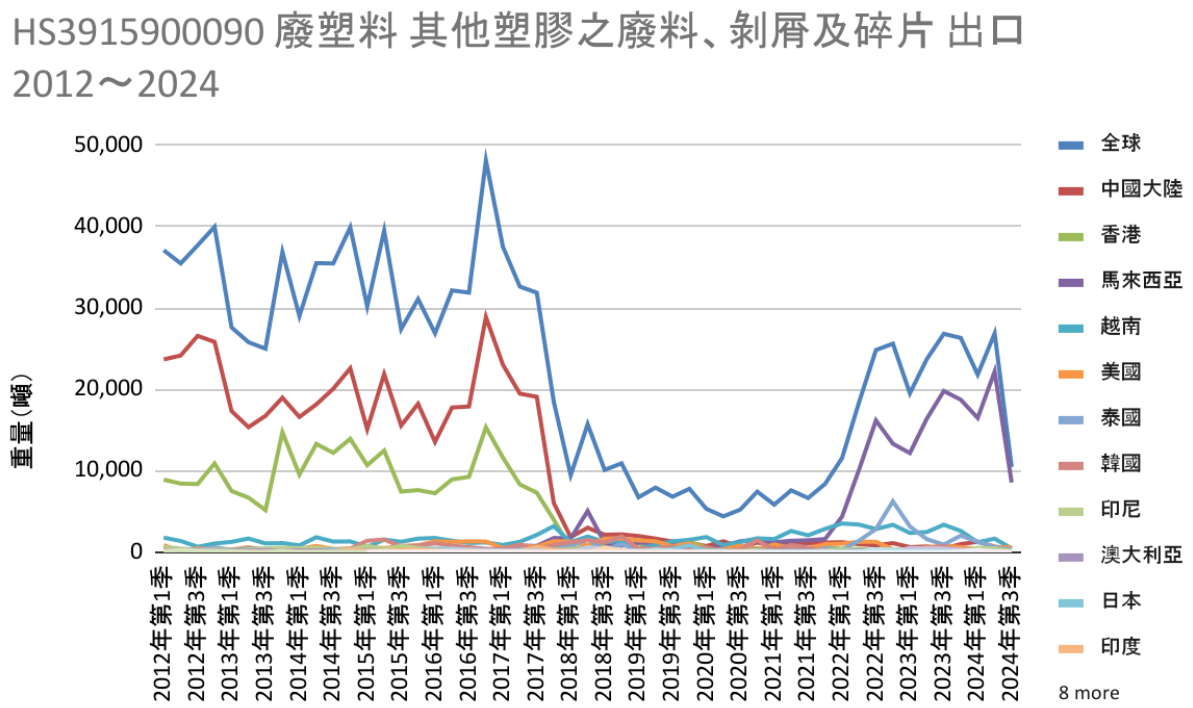


Fig. I：HS3915900090 Plastic waste of other plastics export from Taiwan

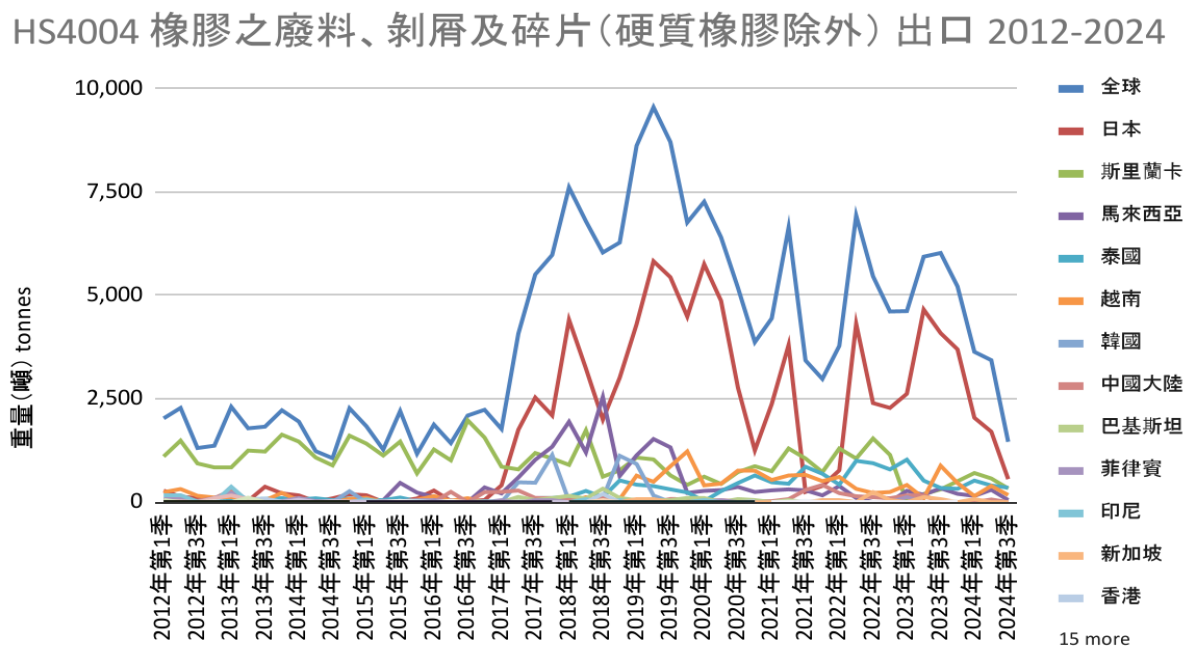


Fig. J：HS4004 Waste, parings and scrap of rubber (other than hard rubber) and powders and granules obtained therefrom

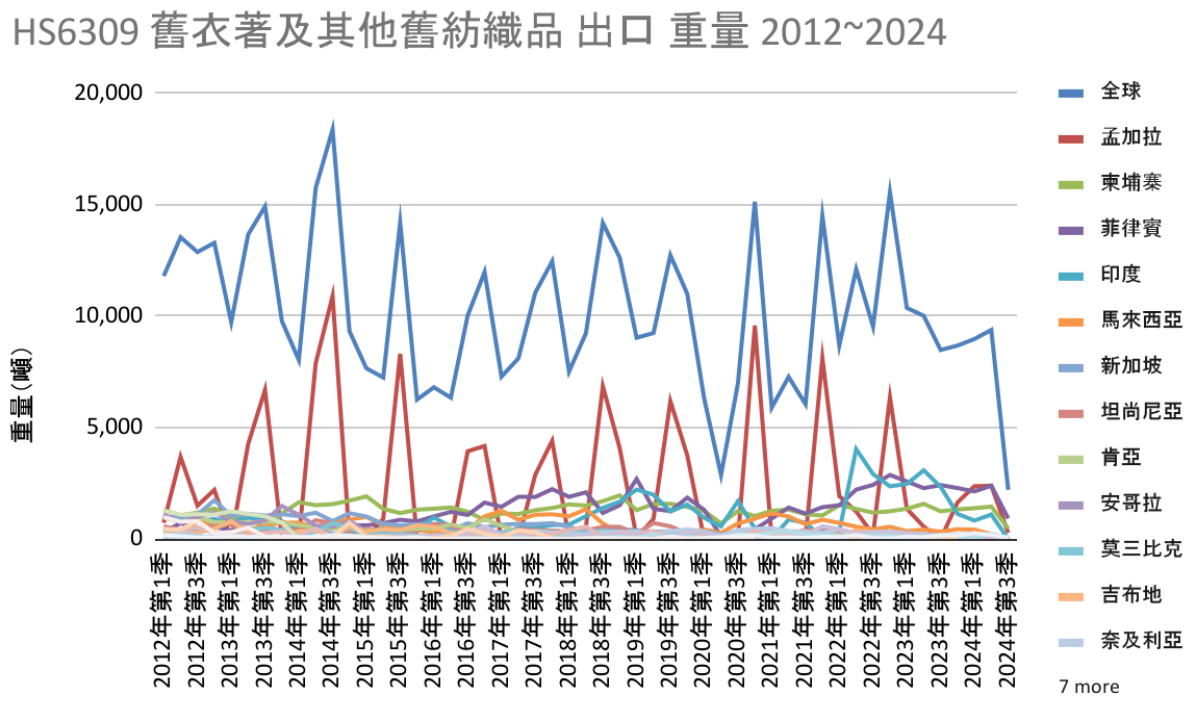


Fig. C：HS6309 Worn clothing and other worn articles export from Taiwan

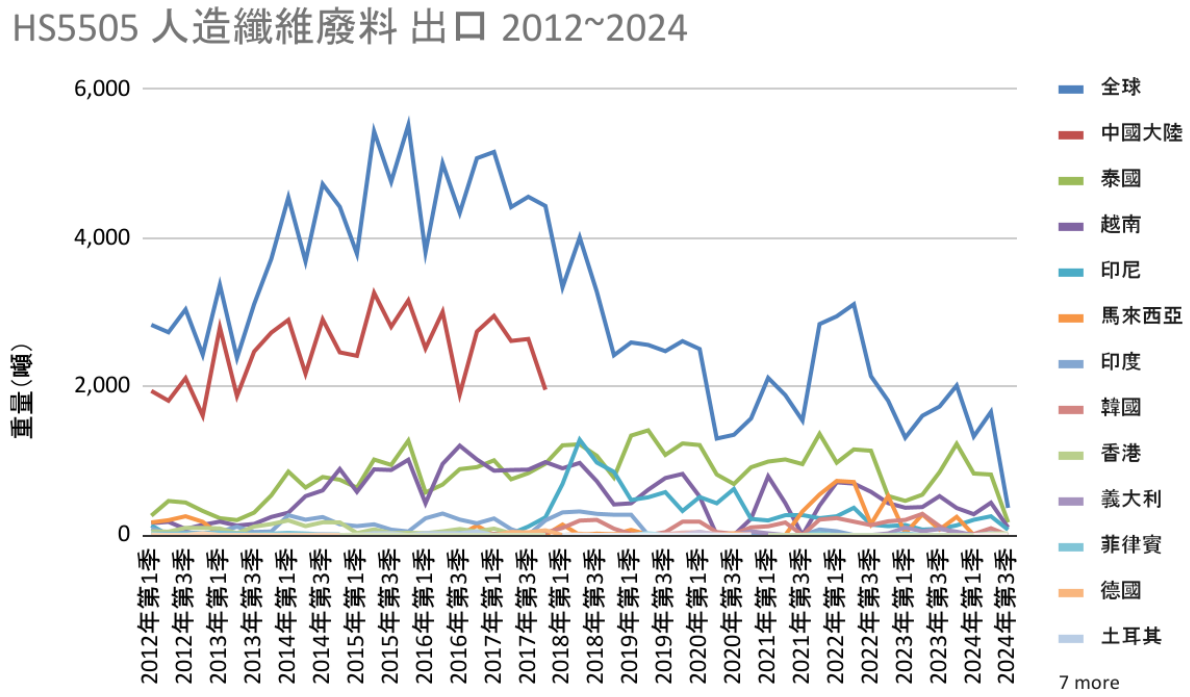
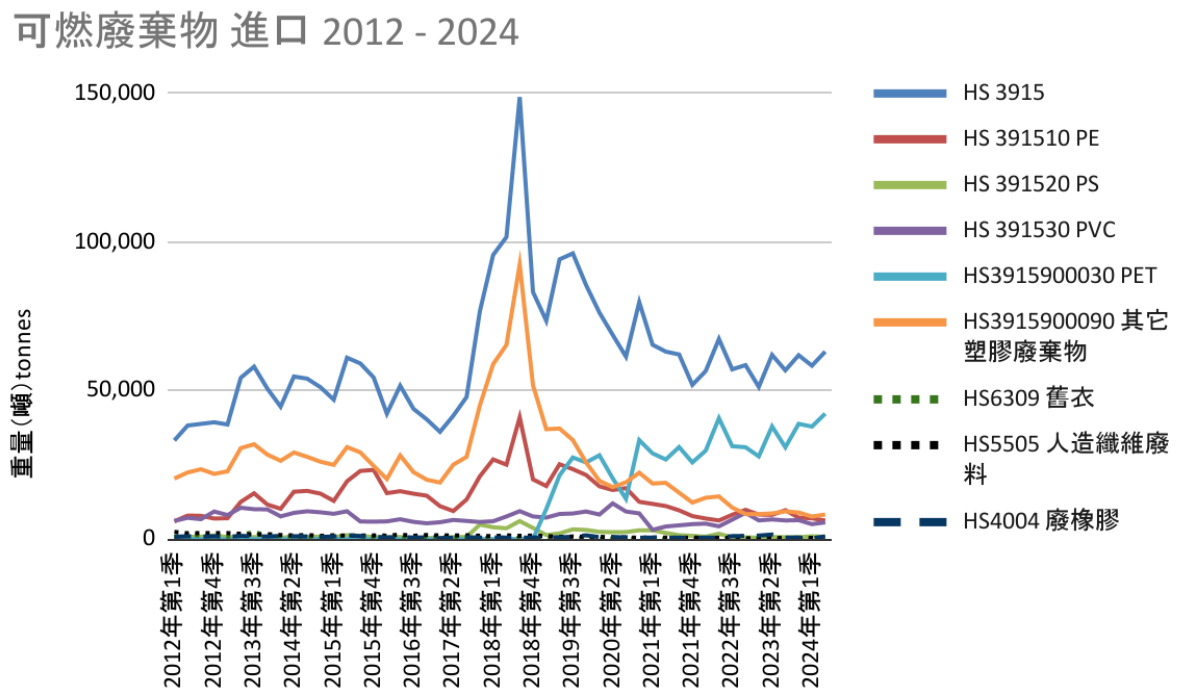


Fig. D：HS5505 Waste (including noils, yarn waste & garnetted stock) of man-made fibres export from Taiwan



圖K / Fig. K：Combustible waste importation into Taiwan

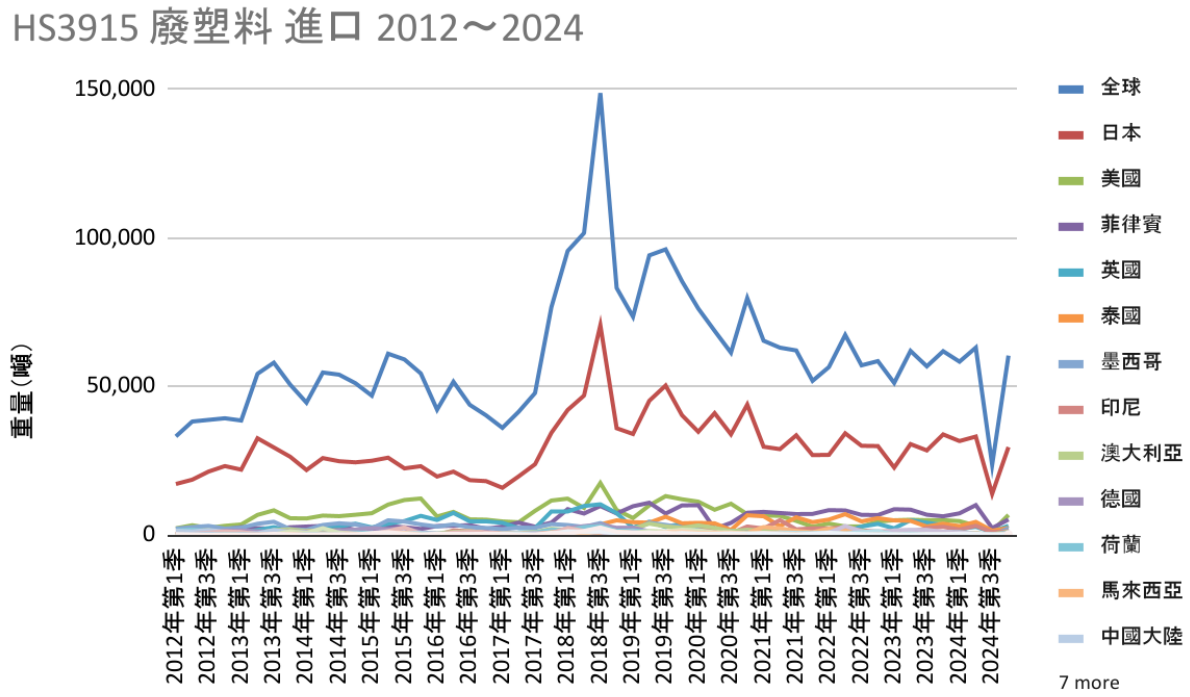


Fig. L：HS3915 Plastic waste importation into Taiwan

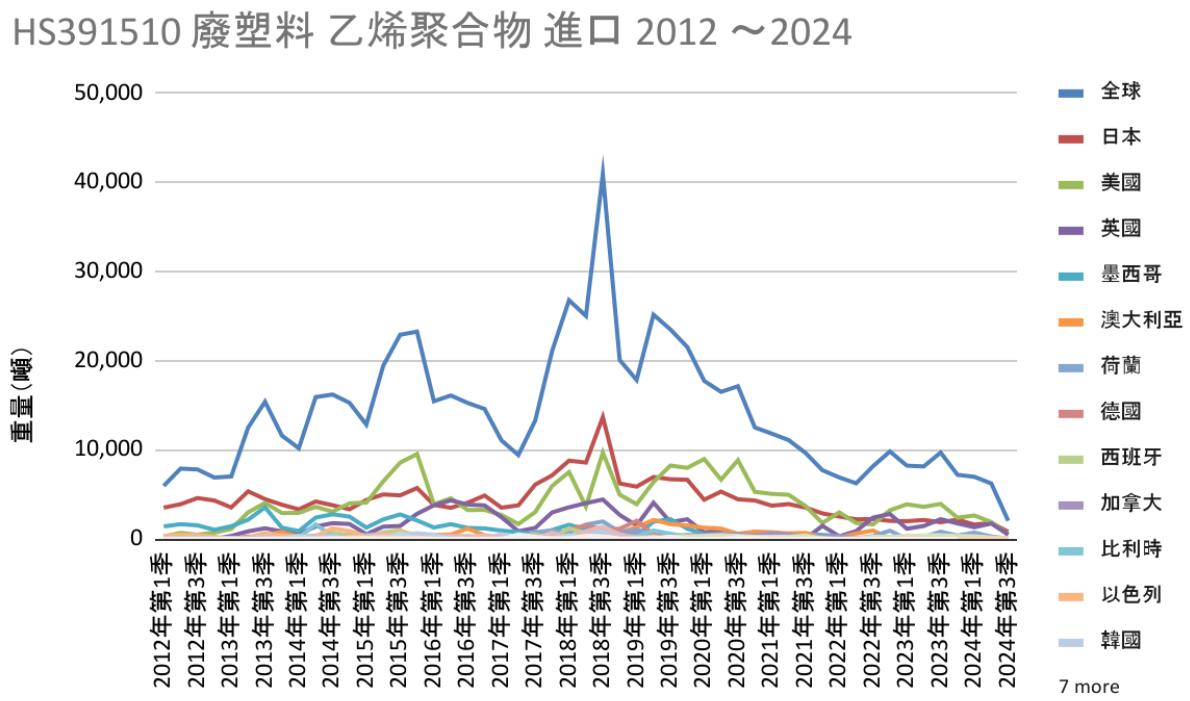


Fig. M：HS391510 Plastic waste of polymers of ethylene (PE) import into Taiwan

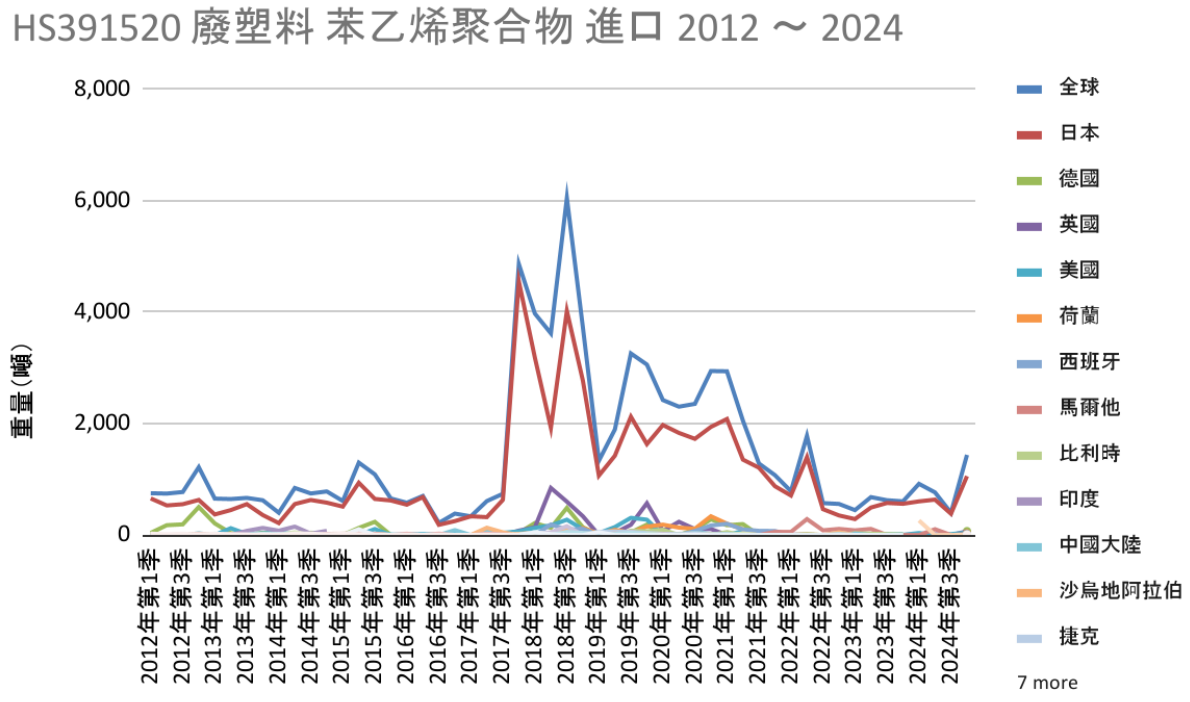


Fig. N：HS391520 Plastic waste of polymers of styrene (PS) import into Taiwan

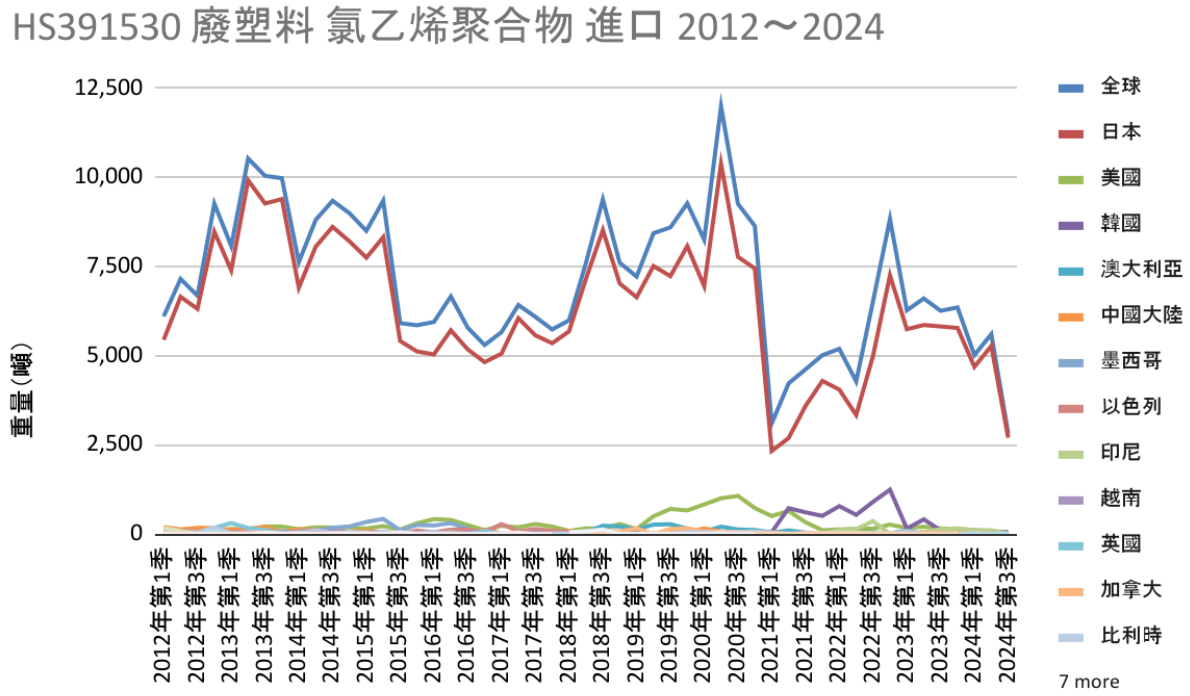


Fig. O：HS391530 Plastic waste of polymers of vinyl chloride (PVC) import into Taiwan

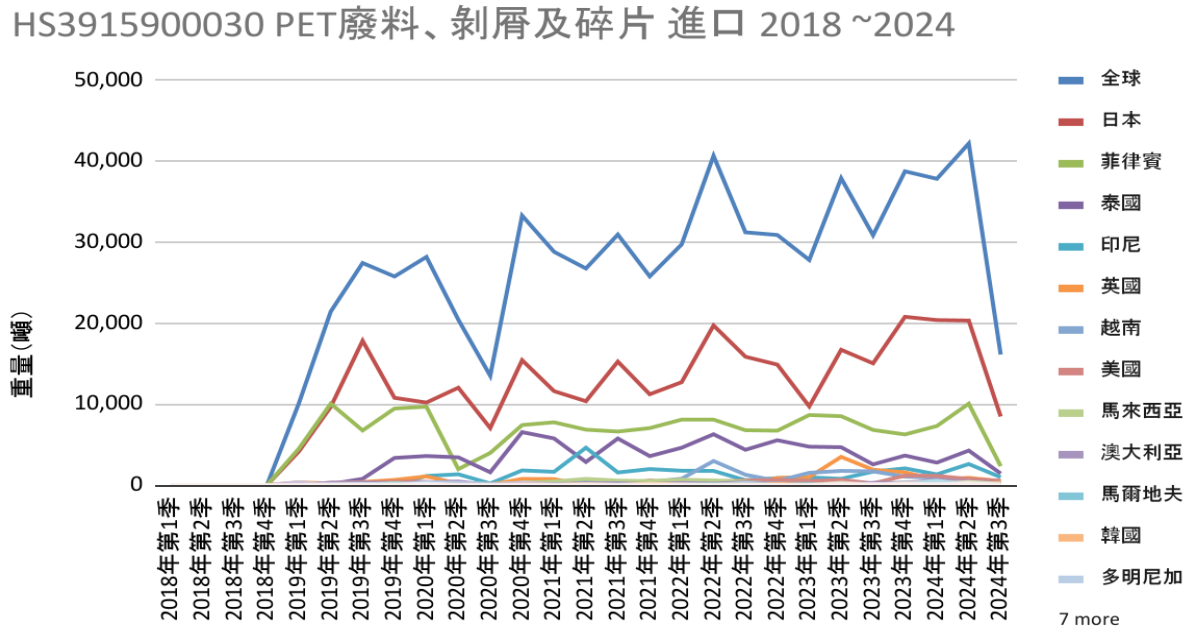


Fig. P：HS3915900030 Plastic waste of polyethylene terephthalate (PET) export from Taiwan

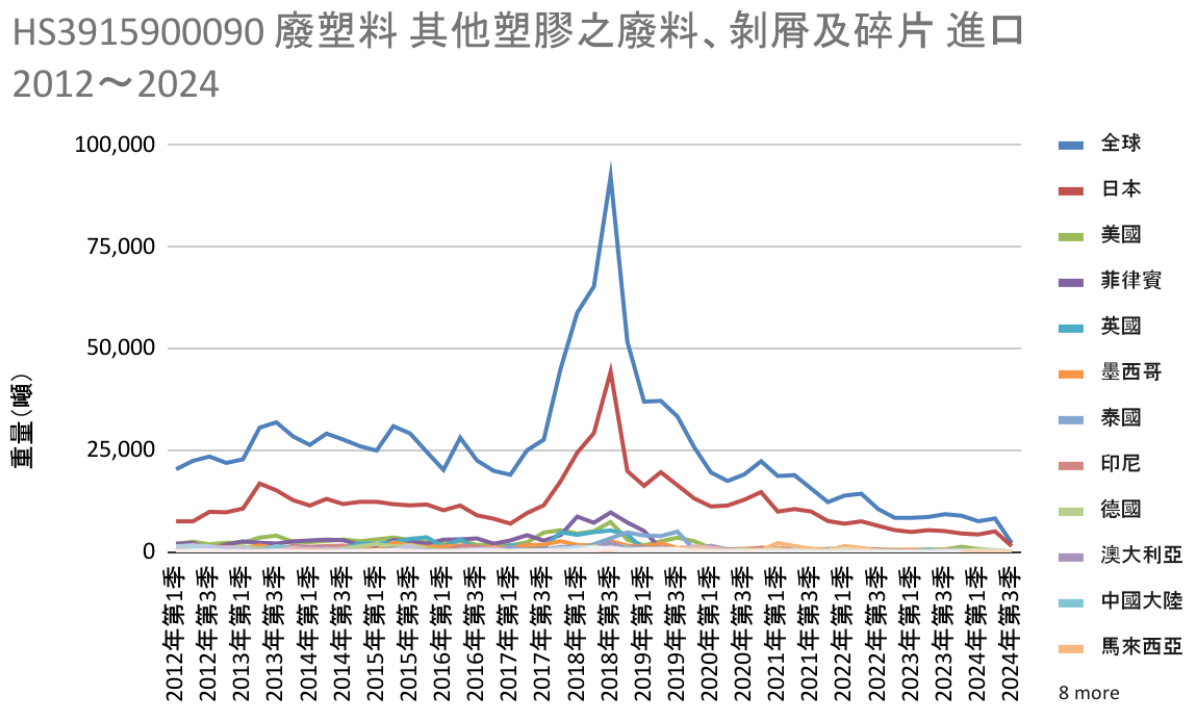


Fig. Q：HS3915900090 Plastic waste of other plastics import into Taiwan

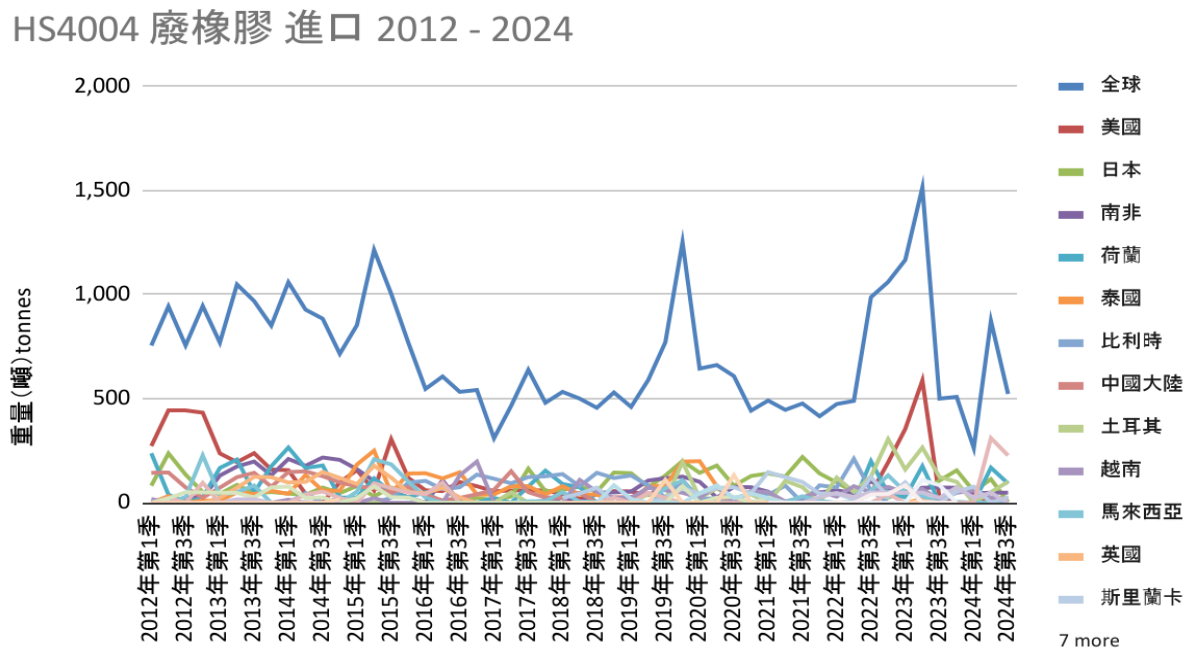


Fig. R：HS4004 Waste, parings and scrap of rubber (other than hard rubber) and powders and granules obtained therefrom, import into Taiwan

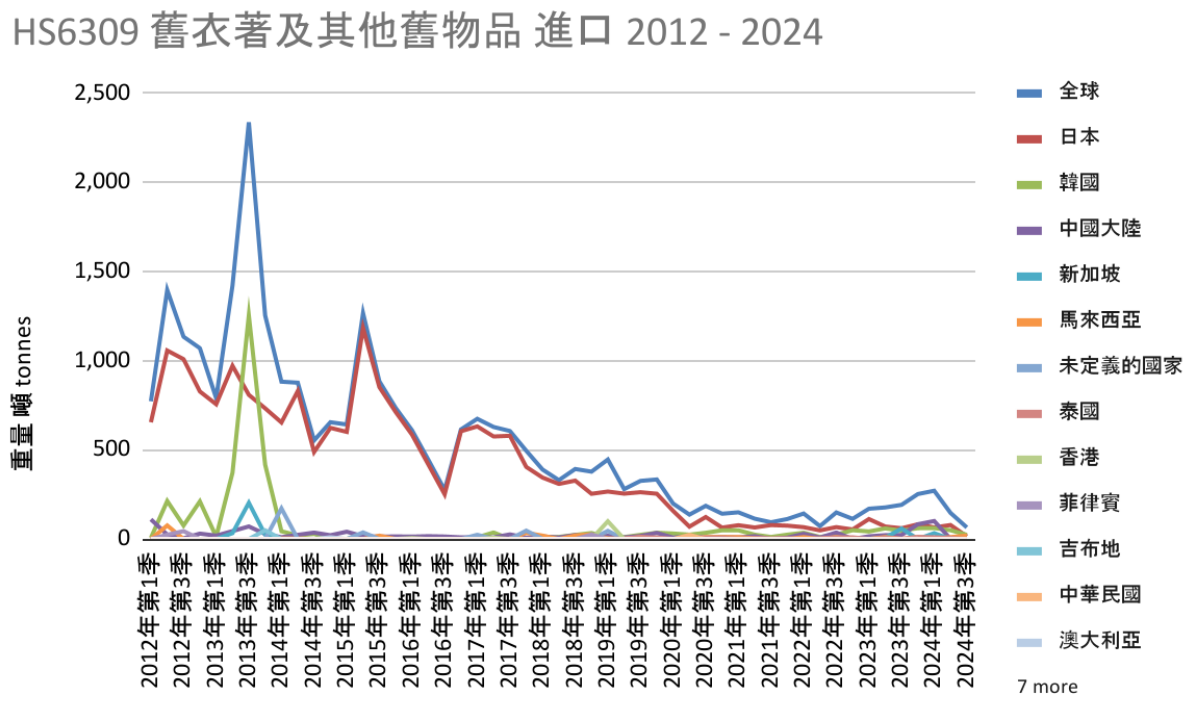


Fig. S：HS6309 Worn clothing and other worn articles import into Taiwan

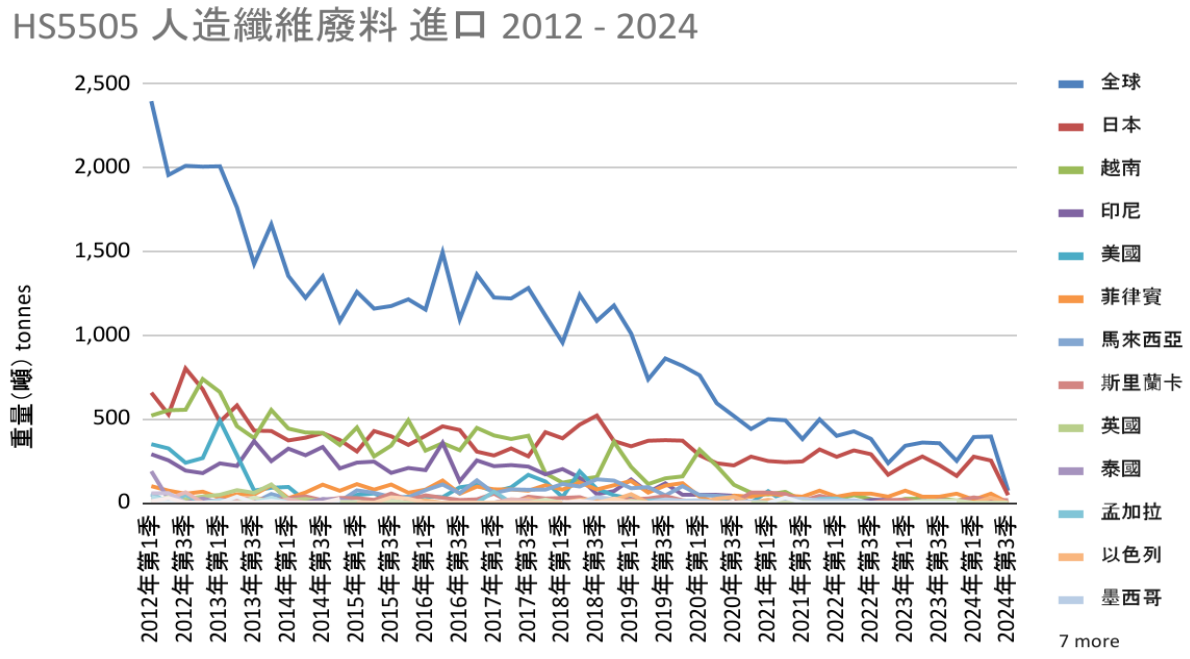


Fig. T：HS5505 Waste (including noils, yarn waste & garnetted stock) of man-made fibres import into Taiwan

Annex B: Flow Diagrams of waste management downstream

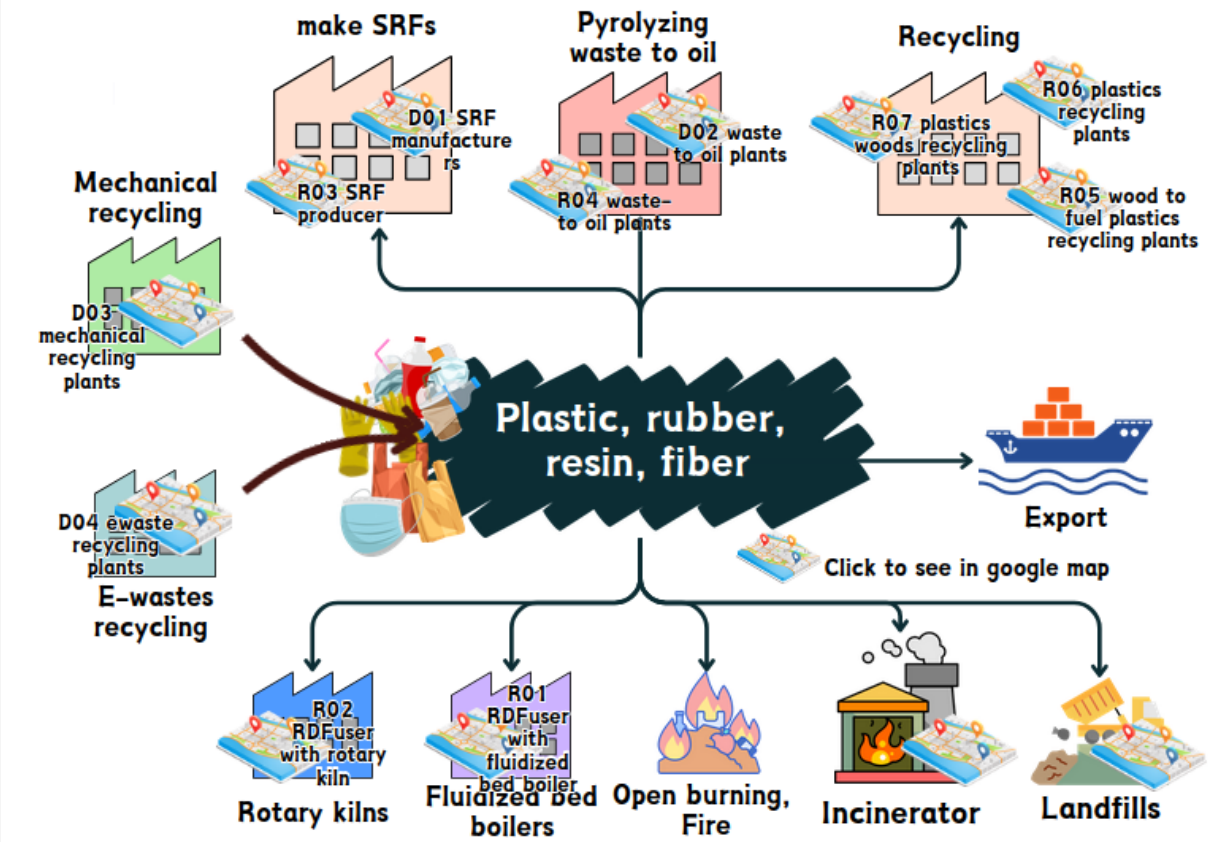


Diagram A：Waste management downstream for plastic, rubber, resin, fiber，Interactable Webpage

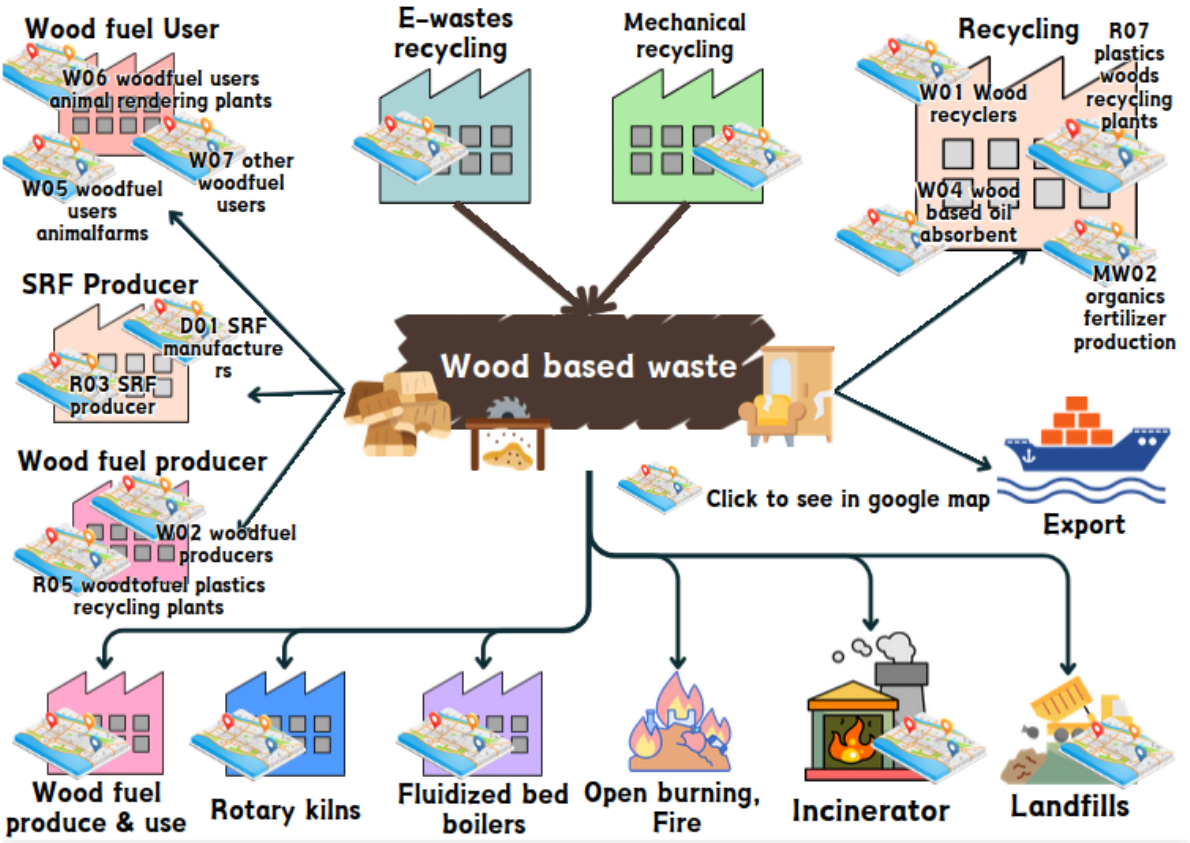


Diagram B：Wood-based waste management downstream，Interactable Webpage

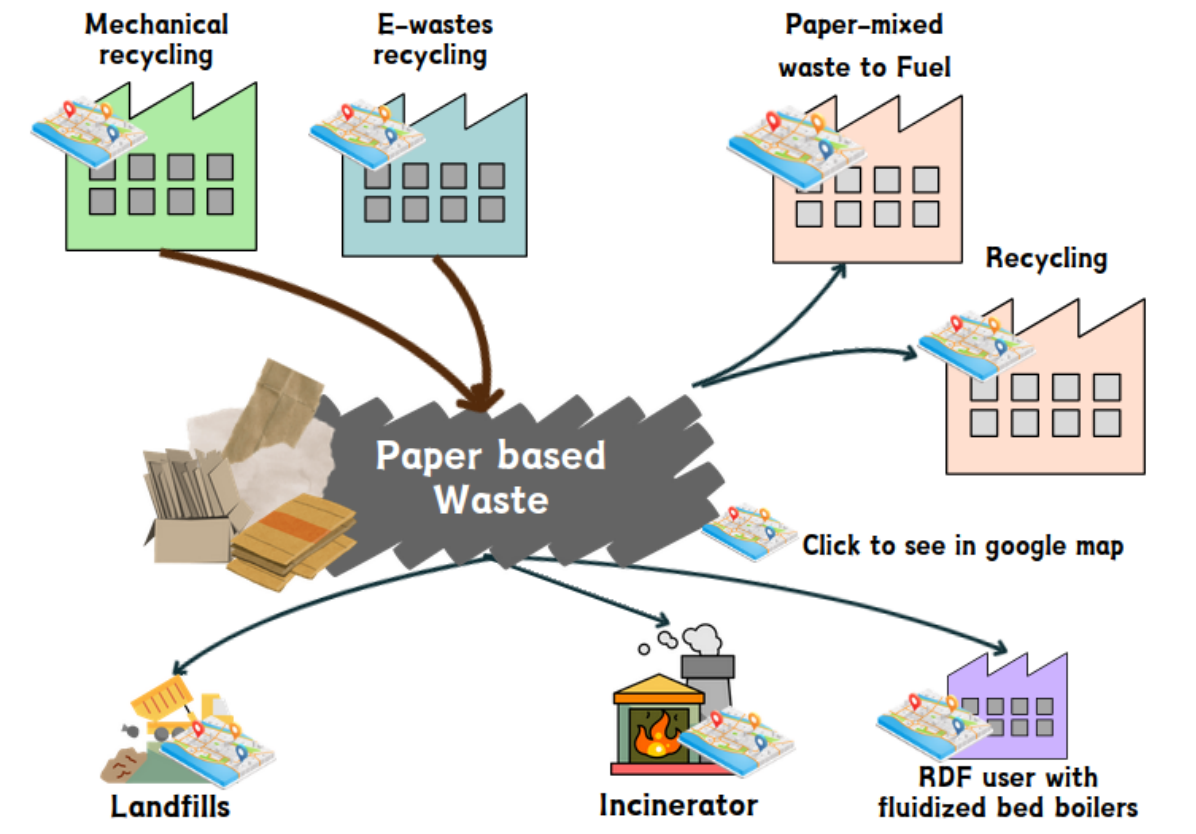


Diagram C：Paper-based waste management downstream，Interactable Webpage

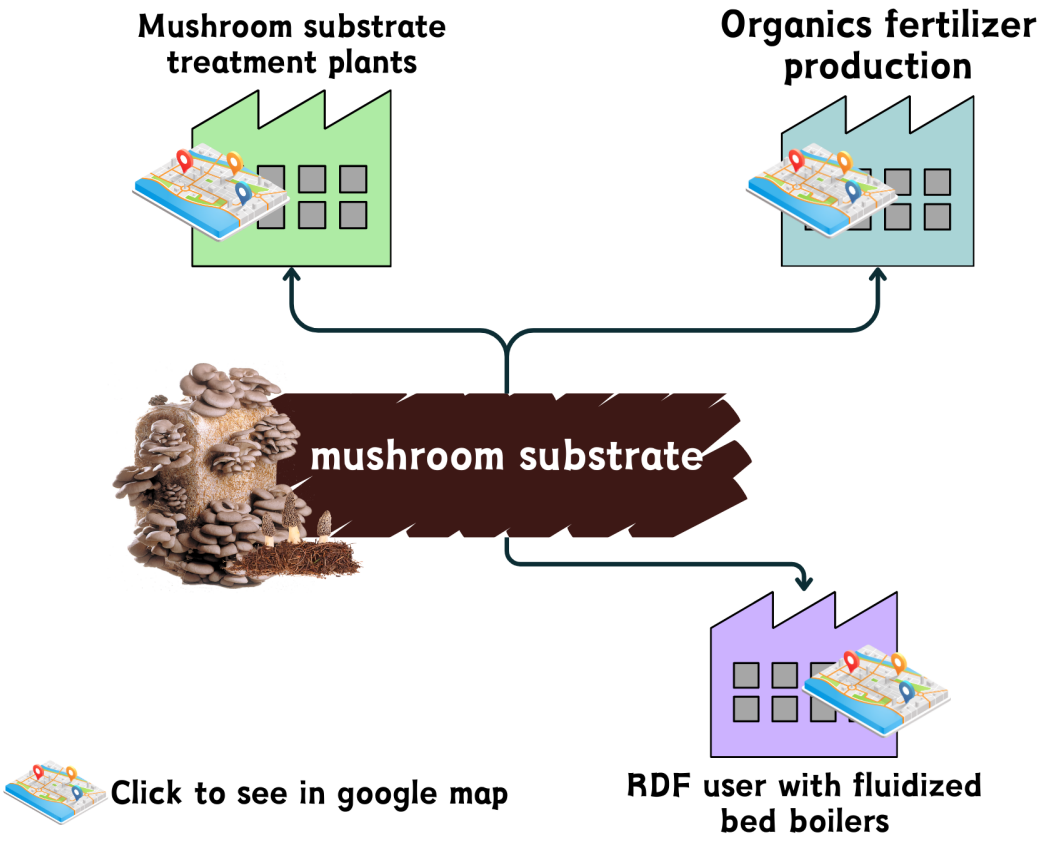
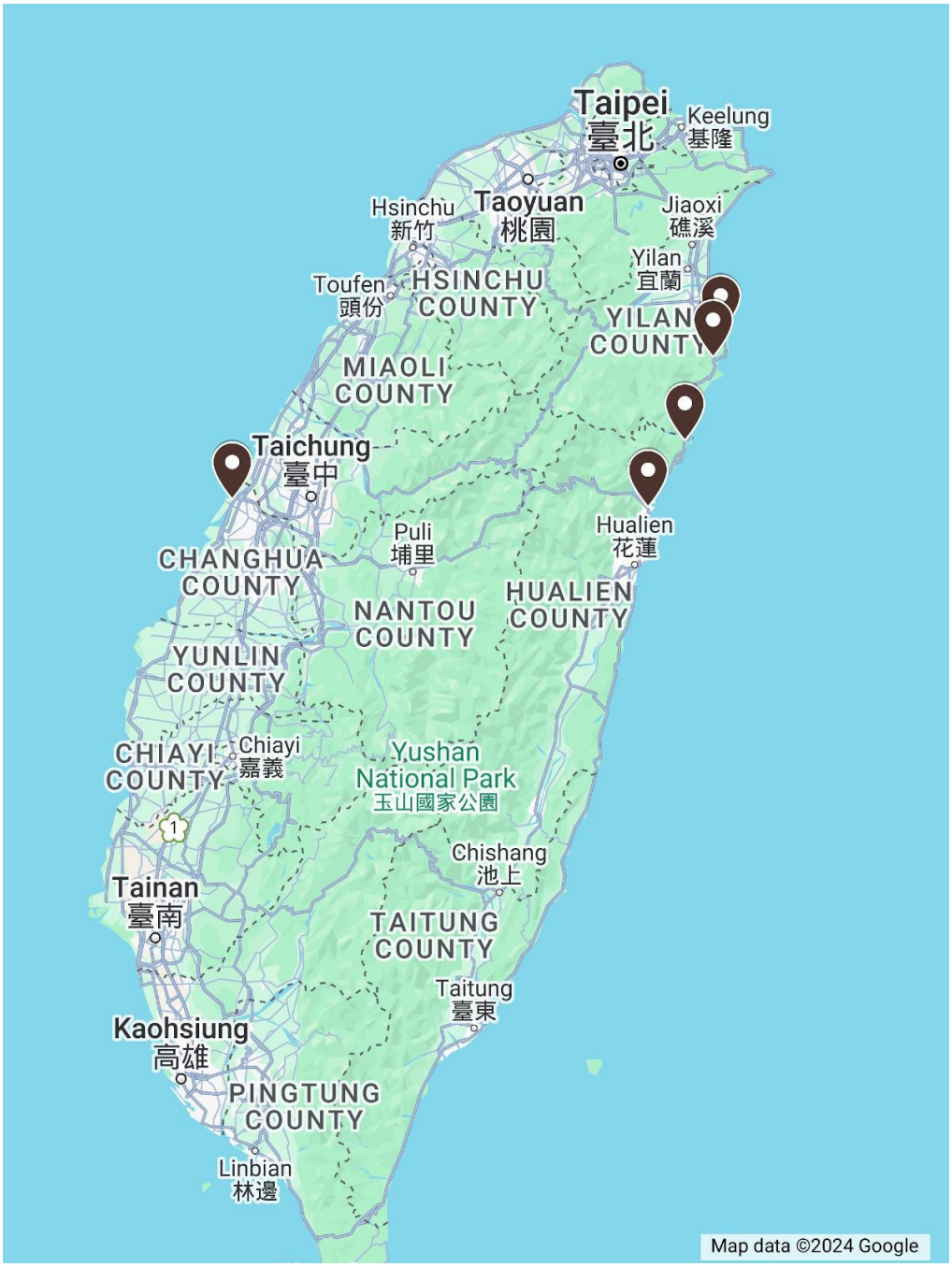


Diagram D：Mushroom substrate waste management downstream，Interactable Webpage

Annex C: Maps of waste treatment organizations

Map 01：SRF producers with recycling organization registration certificate, see on google map



Map 02: RDF users with rotary kilns, see on google map

Map 03: RDF users with fluidized bed boiler, see on google map

Map 04: SRF producers with waste disposal organization permission who use mixed waste (such as automobile shredder residues(ASR), or mixed plastic/wood/textiles screened from demolition waste) as feeds , see on google map

Map 05: Fuel producers who receive wood-based waste, see on google map

Map 06: Plastic waste recycling plants, see on google map

Map 07: MSW and industrial waste incinerators, see on google map