
PWMI Newsletter

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Plastic Waste Management Institute
JAPAN

Plastic Products, Plastic Waste and Resource Recovery [2003]

Background information and notes on the publication of the Flowchart of
Plastic Products, Plastic Waste and Resource Recovery (2003)

The Plastics Waste Management Institute (PWMI) takes annual surveys about the amount of waste plastic recycling, the amount of discharge, industrial waste, and local government policies. The results of these surveys are compiled and published as a flowchart of plastic products, waste, and recycling. This flowchart provides a quantitative macro perspective on processing and disposal by showing how much plastic is produced, what products are made, and whether the waste plastic is recycled into useable material.

To obtain each quantity shown in the flowchart, PWMI used statistical processing of the numeric data and the survey results.

Since the implementation of laws related to building

a recycling-oriented society in 2000, a new type of society has started to take hold. The year 2003 saw the smooth expansion of plastic recycling activities based on various laws coming into force. In the area of PET-bottle recycling, a chemical decomposition method called "bottle to bottle" has emerged as a new technology.

At the same time, to be in compliance with environmental regulations on dioxin, local governments are continuing to update their old incinerators. These efforts have led to the implementation of energy recovery methods and recovery performance enhancements. One such method is present in a gasification fusion facility that is already operational.

2003 Highlights

- (1) Expanded the effective use of waste plastic to 58% of total discharge (an increase of 3.6% from the previous year).
- (2) Expanded energy recovery to 39% (+ 1.8 % from previous year), mechanical recycling to 16% (an increase of 1.0% from previous year), and feedstock recycling to 3% (+ 0.8% from previous year).
- (3) A total of 680,000 tons of scrap plastic (+ 130,000 tons from previous year) was exported to mainly

China.

In 2003, Japan produced 13.98 million tons of plastic, which was 130,000 tons more than the previous year in part due to the economic recovery. Domestic consumption of plastic was 11.01 million tons (+ 440,000 tons from previous year) and the total amount of waste plastic was the same amount (+ 110,000 tons from previous year). Of the waste plastic, 5.13 million tons were domestic waste plastic (+ 50,000 tons from

previous year) and 4.88 million tons were industrial waste plastic (+ 60,000 tons from previous year).

A total of 5.84 million tons of waste plastic was put to effective use, which was a big increase from the previous year (+ 420,000 tons), for an effective use rate of 58% (+ 3.6% from previous year). The rate of increase in the effective use rate (2.1%) was also larger than the previous year.

Of the 3.86-million tons of energy recovery (+ 220,000 tons from previous year), outstanding increases appeared in power generation from waste (2.16 million tons, + 110,000 tons from previous year) and solid fuel (430,000 tons, +110,000 tons). Local governments increased the amount of electricity generated at incinerators, paper factories used more refuse paper & plastic fuel (RPF), more electricity was generated through the combustion of waste plastic, and cement factories increased the use of densified - refuse derived fuel (RDF).

Of the 330,000 tons of mechanical recycling (+ 70,000 tons from previous year) of domestic waste plastic that was recycled, 270,000 tons went toward liquefaction, gasification, and reducing agent in blast furnaces. This smooth expansion is evidence of the positive impact of laws related to container and packaging recycling.

Out of all mechanical recycling, 780,000 tons (+ 90 tons from previous year) came from used items. Individual categories in the recycling system showed 267,000 tons (+ 47,000 tons from previous year) for PET bottles, 49,000 tons (+ 27,000 tons from previous year) for containers and packaging, 18,300 tons (+ 1,200 tons from previous year) for PVC pipes and fittings. The impact of the Home Appliance Recycling Law can also be seen in the smooth increase of waste plastic related to home appliances, which was 79,000 tons (+ 17,000 tons from previous year).

Japan exported 680,000 tons (+130,000 tons from previous year) of its waste plastic as scrap plastic to mainly China. This trend is likely to continue in Japan, Europe, and the US as the world becomes more dependent on economic movement in China.

A variety of recycling methods are expanding smoothly throughout Japan, from feedstock recycling (liquefaction, gasification, and blast furnaces) to energy recovery (conversion to cement fuel and material, RDF, and electricity generated from burning waste). In the future, we can expect these new recycling methods to continue to take deep account of key factors such as environmental, economic and social sustainability and to develop even further.

Explanation of flowchart items

(1) Resin production, resin processing, and marketing of products

1-1 Resin production

This figure was determined on the basis of chemical-industry statistics from the Ministry of Economy, Trade and Industry (METI).

1-2 Reclaimed products

For convenience sake, the figure used here as input is that of mechanical recycling from the previous year taking figures for export and import of plastic waste into account (Ministry of Finance, trade statistics).

1-3 Domestic plastic products consumption

• (Domestic plastic products consumption) = (Resin production) - (Resin export) + (Resin import) - (Liquid resin, etc.) - (Resin processing waste) + (Reclaimed products) - (Product export) + (Product import)

• Resin export and import figures are based on

trade statistics from the Ministry of Finance.

• Figures for liquid resin, synthetic fiber, etc. that fall outside plastic waste discharge are based on chemical-industry statistics from the Ministry of Economy, Trade and Industry.

• Figures for plastic product export and import are based on trade statistics from the Ministry of Finance.

• Figure for processing waste considers discharged waste from the processing step that is not turned into products.

(2) Discharge

2-1 Industrial waste and domestic waste

• Industrial waste is waste generated by business activities as defined by the Waste Disposal and Public Cleansing Law, and includes ashes, sludge, waste oil, waste acid, waste alkali, and waste plastic. Its disposal is generally the responsibility of the party that generates the waste. Domestic waste is

waste other than industrial waste and its disposal is mainly handled by local governments.

2-2 Post-use products discharge

- This figure is determined by an estimation system developed by PWMI based on usage quantities by demand-generating fields and by resin type (usage quantities have been calculated annually for the last 15 years) and on product lifetimes by demand-generating fields (using a PWMI discharge model for the last 15 years).

- Considering that the export/import of new and used automobiles affects the amount of domestic plastic waste, corrections have been made to amounts of reclaimed products and discharge in the transportation field.

- Discharge ratios for domestic waste and industrial waste have been estimated using a PWMI discharge model for demand-generating fields.

2-3 Production and processing waste discharge

- Amount of production waste is not included in amount of resin production, and amount of processing waste is extrapolated from the results of questionnaires.

2-4 Total plastic waste discharge

- This figure is the sum total of post-use products discharge and production and processing waste discharge.

2-5 Breakdown of total plastic waste discharge by resin type

- These breakdown figures were estimated from amounts for post-use products discharge, production and processing waste discharge, breakdown of resin production, etc.

(3) Disposal and recovery

3-1 Mechanical recycling

- All mechanical recycling figures and breakdowns are extrapolated from the results of questionnaires sent to recycling companies.

- “Recycled material” indicates pellets, flakes, fluff, blocks, and ingots, while “recycled products” refer to film sheets, stakes, pipes, etc.

- The export figure under “destination of recycling use” for mechanical recycling is based on “scrap plastic” statistics from Ministry of Finance trade figures.

3-2 Densified-refuse derived fuel, liquefaction, gasification, blast furnace raw material

- Figures for liquefaction, gasification, blast

furnace raw materials, and coke-oven chemical materials approved as product recycling procedures by the Containers and Packaging Recycling Law have been determined on the basis of bids announced by the Japan Containers and Packaging Recycling Association and results of questionnaires.

- The figure for densified-refuse derived fuel includes energy recovery as cement kiln fuel.

3-3 Disposal and recovery of domestic waste

- Incineration/landfilling ratio

This ratio is determined on the basis of past surveys conducted by PWMI.

- Incineration with power generation

This figure refers to incineration processing by an incinerator equipped with power-generation facilities in waste processing conducted by local governments. The ratio shown is determined on the basis of PWMI surveys.

- Incineration with heat utilization facility

This figure refers to incineration processing by an incinerator that, while not equipped with power-generation facilities, has external facilities for utilizing heat. The ratio shown is determined on the basis of PWMI surveys.

3-4 Disposal and recovery of industrial waste

- Disposal and recovery of industrial waste is partially commissioned to local governments as business-related waste. The ratio of such processing by business to that commissioned to local governments is determined on the basis of PWMI surveys. The percentage breakdown of commissioned processing into incineration with power generation, incineration with heat utilization facility, incineration without power generation or heat utilization facility, and landfilling is based on figures for domestic waste processing.

- The incineration/landfilling ratio in the processing of industrial waste is based on the results of PWMI surveys.

- The ratios for energy recovery such as power generation in incineration handled by industrial waste management contractors are based on the results of PWMI surveys.

- Incineration with heat utilization facility

Ratios for heat utilization in industrial-waste incineration processing by local governments and industrial waste management contractors are based on the results of PWMI surveys.

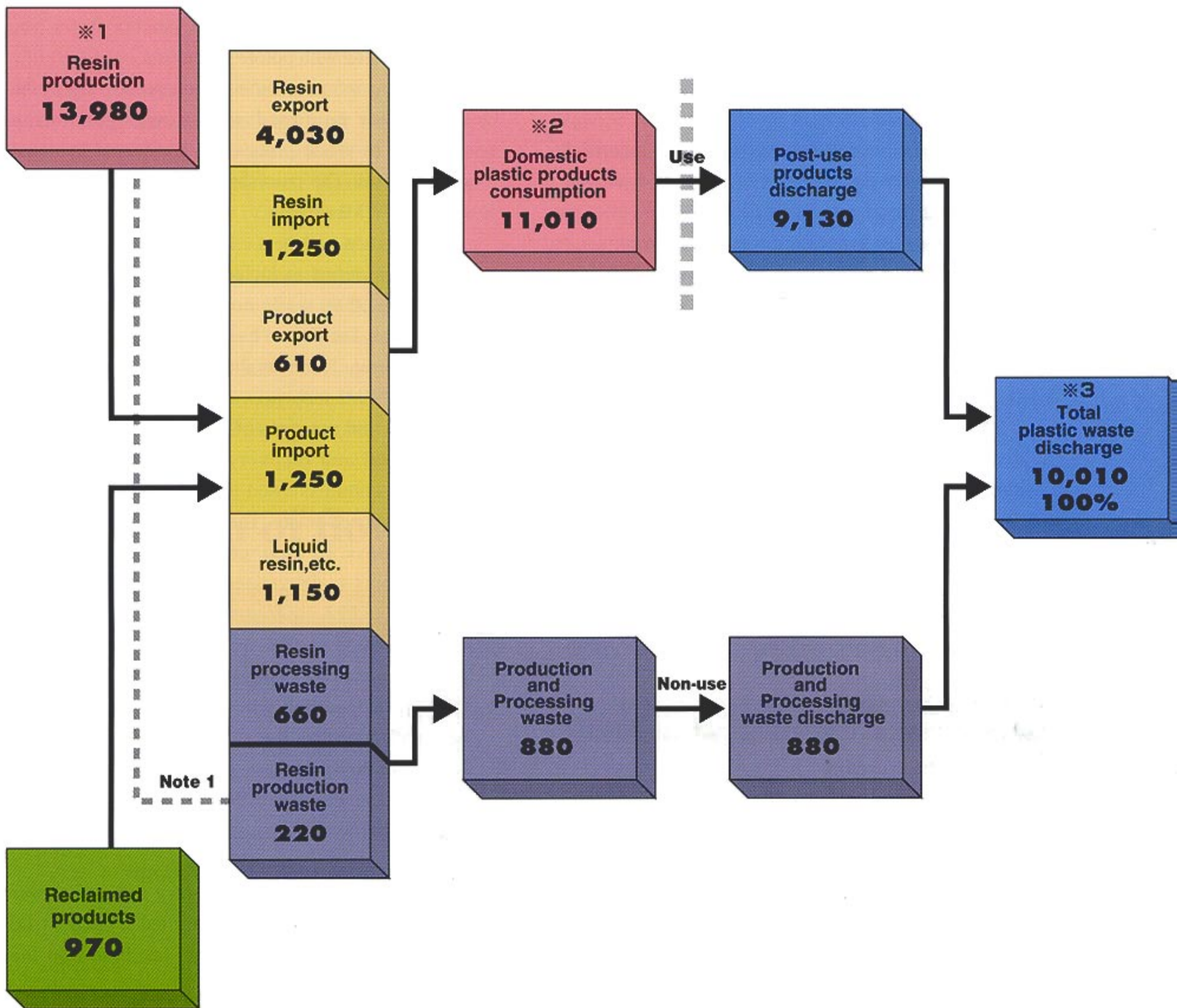
Flowchart of plastic products, plastic waste and resource recovery

2003

[Unit; thousand tons]

Resin production, resin processing, and marketing of products

Discharge

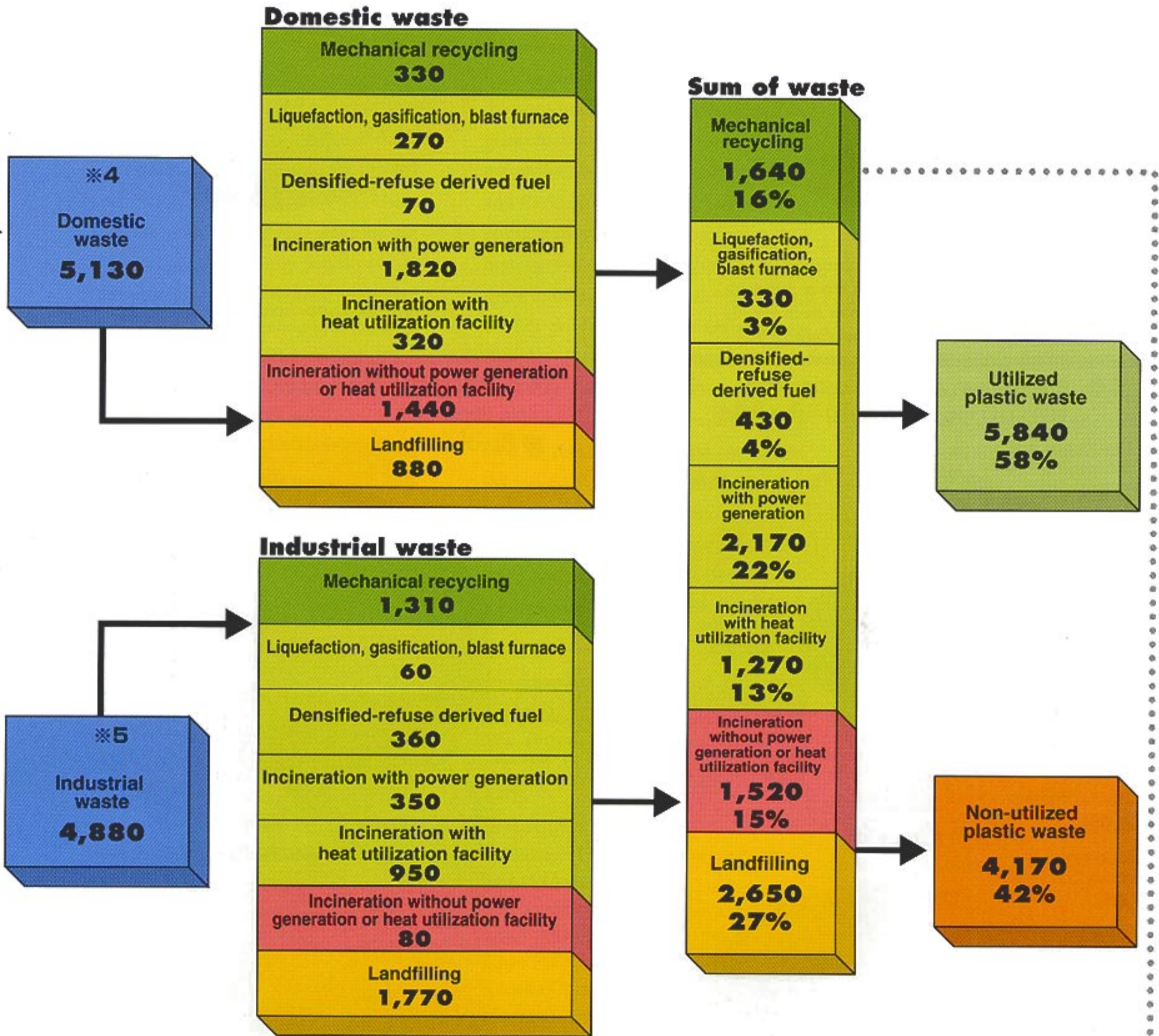


Note 1: Resin production does not include the quantity shown for resin production waste

Note 2: The quantity shown this year for reclaimed products is based on that of mechanical recycling from the previous year (1,520 thousand tons) excluding exported portion (550 thousand tons) for convenience sake.

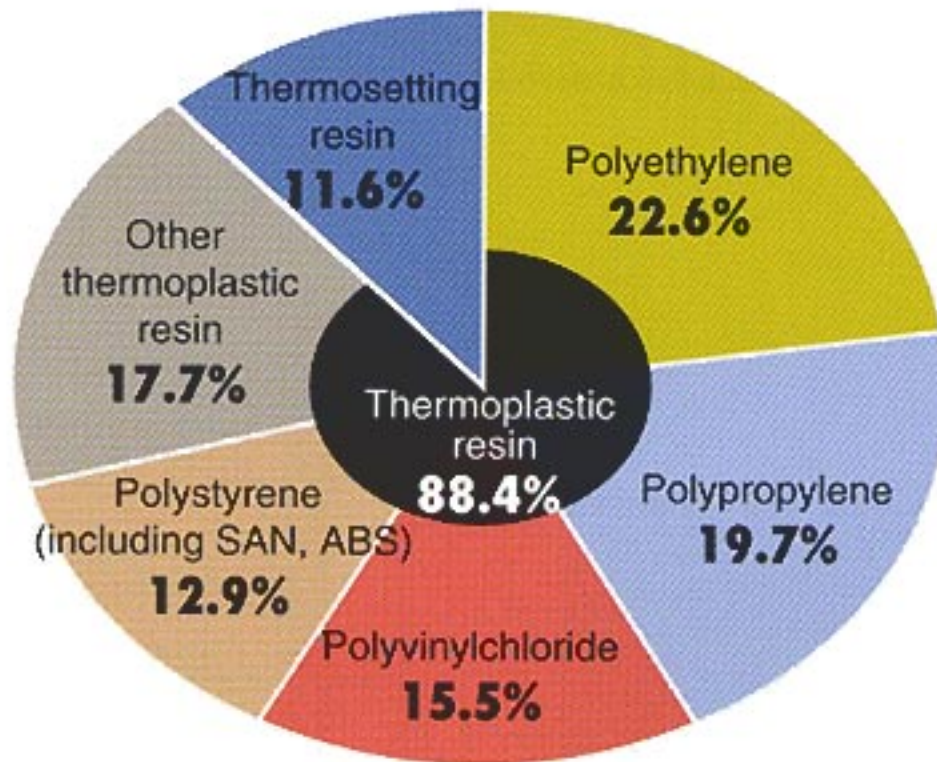
Note 3: Some figures may not exactly match due to rounding.

Disposal and recovery



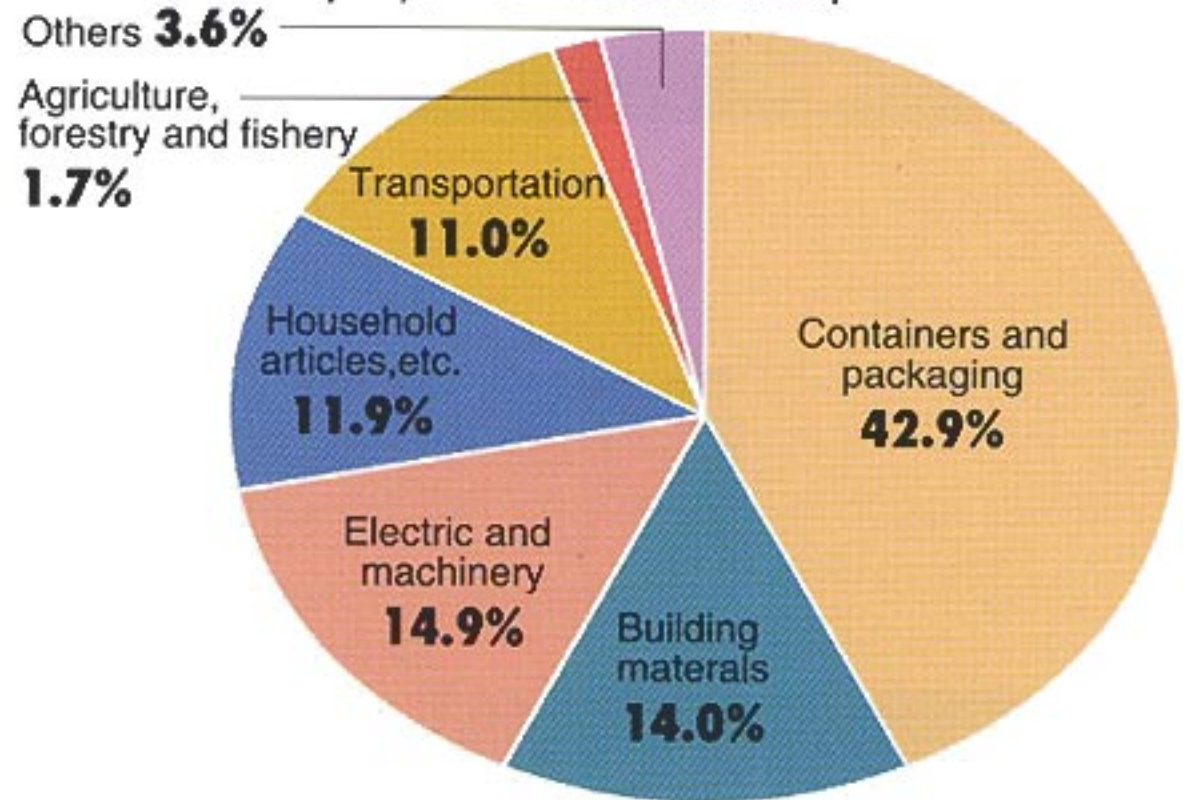
Details of flowchart elements

※1 Breakdown of resin production (13,980 thousand tons) by resin type



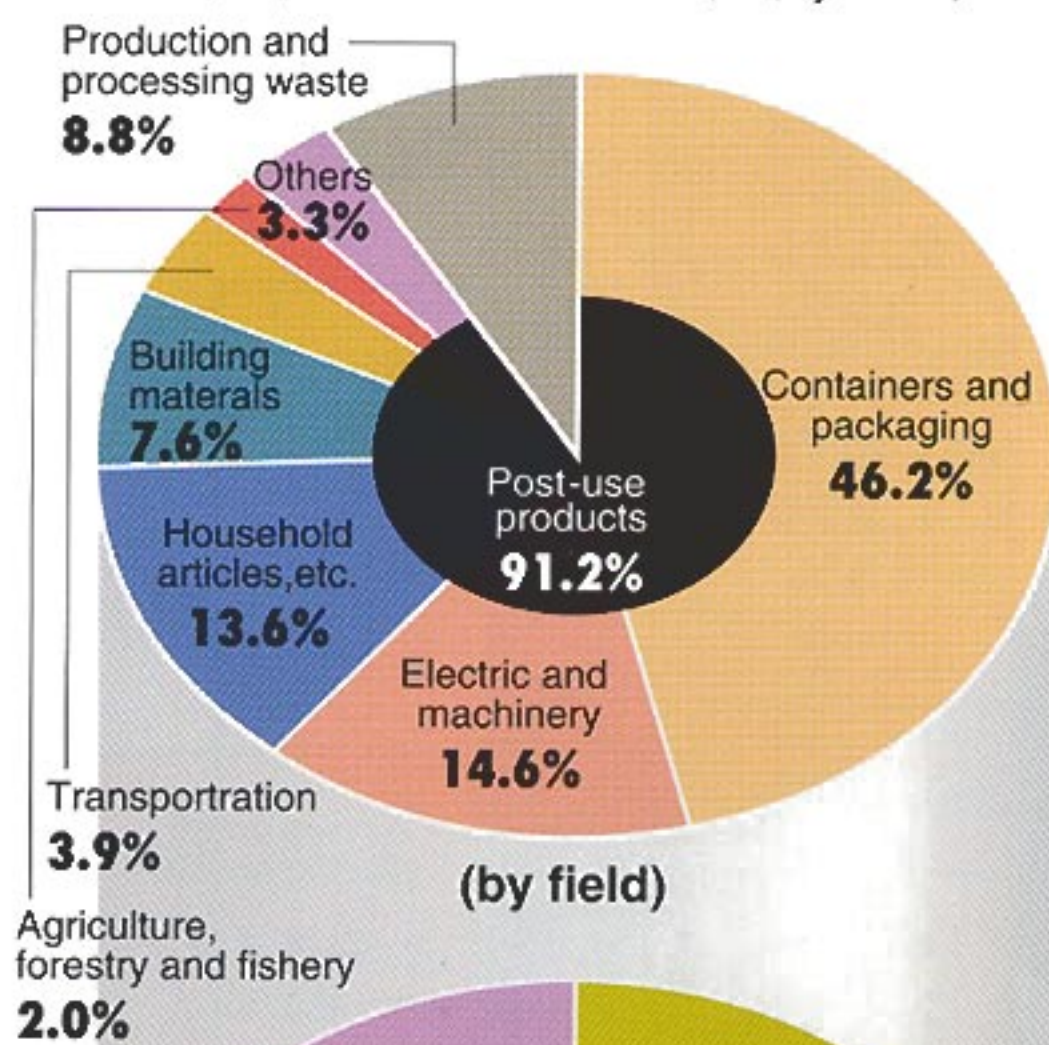
(Source: METI chemical-industry statistics)
For convenience sake, the other 1.4% of resins not categorized as thermosetting resin or thermoplastic resin are included in "other thermoplastic resin."

※2 Breakdown of resin products by field (11,010 thousand tons)

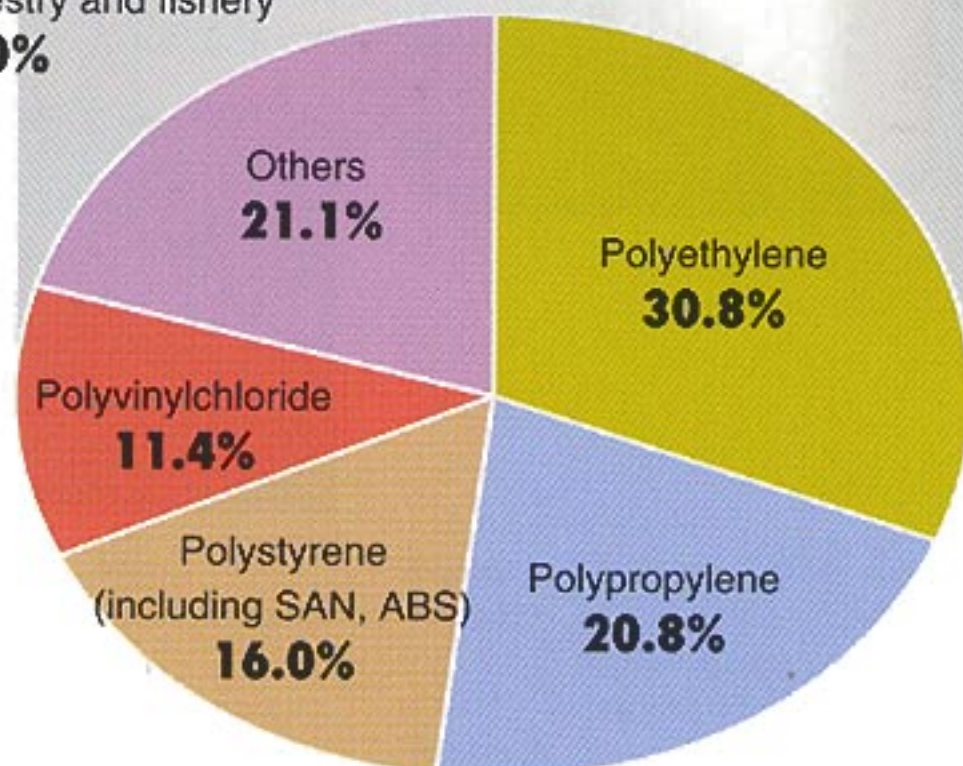


(Source: estimates from related organizations)

※3 Breakdown of total plastic waste (10,010 thousand tons) (by field)



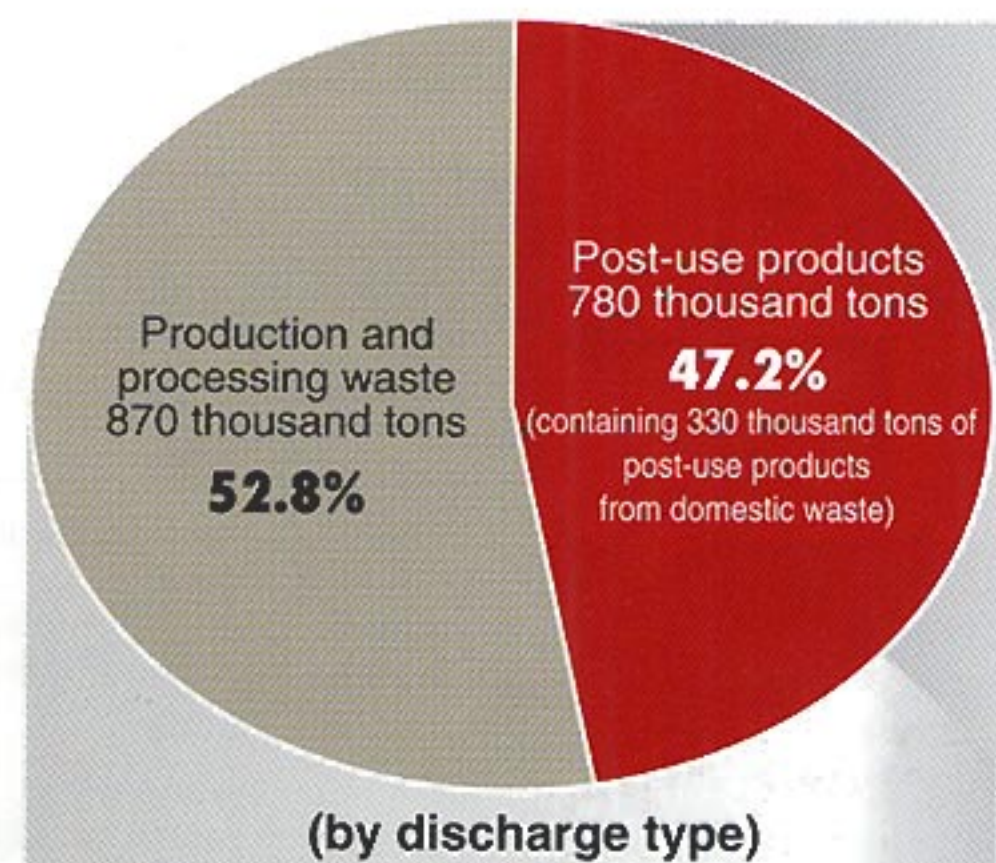
(by field)



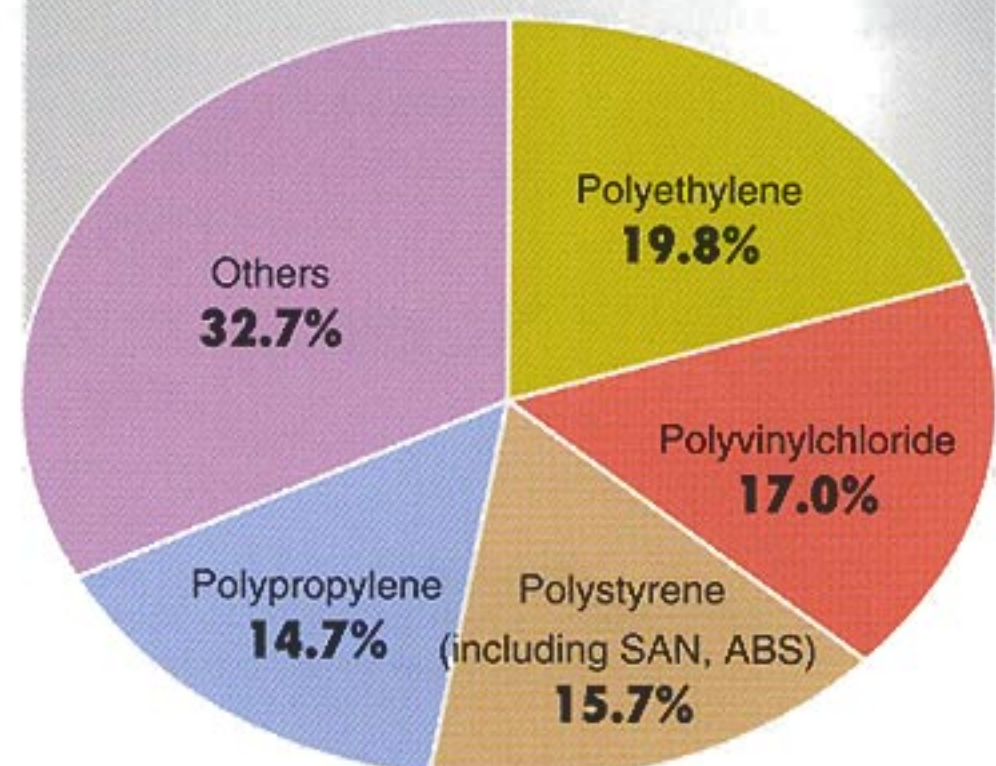
(by resin type)

※6 Breakdown of mechanical recycling (1,640 thousand tons)

● Breakdown of mechanical recycling resources

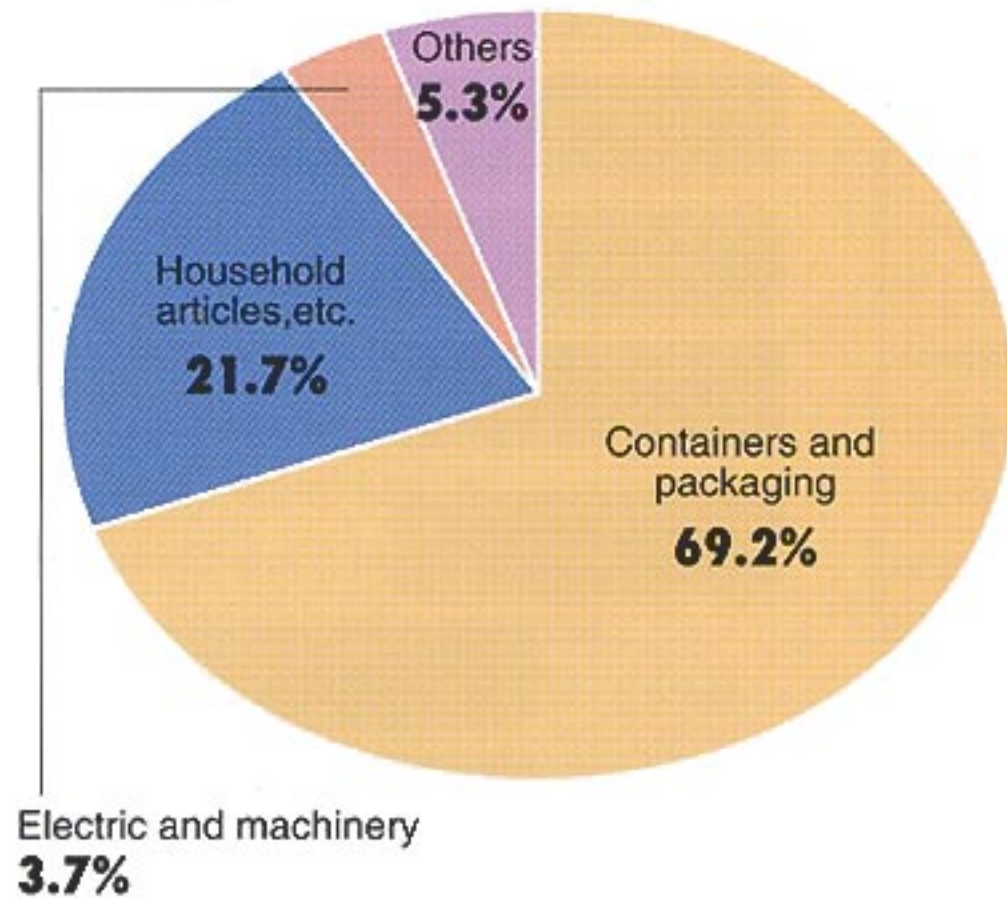


(by discharge type)

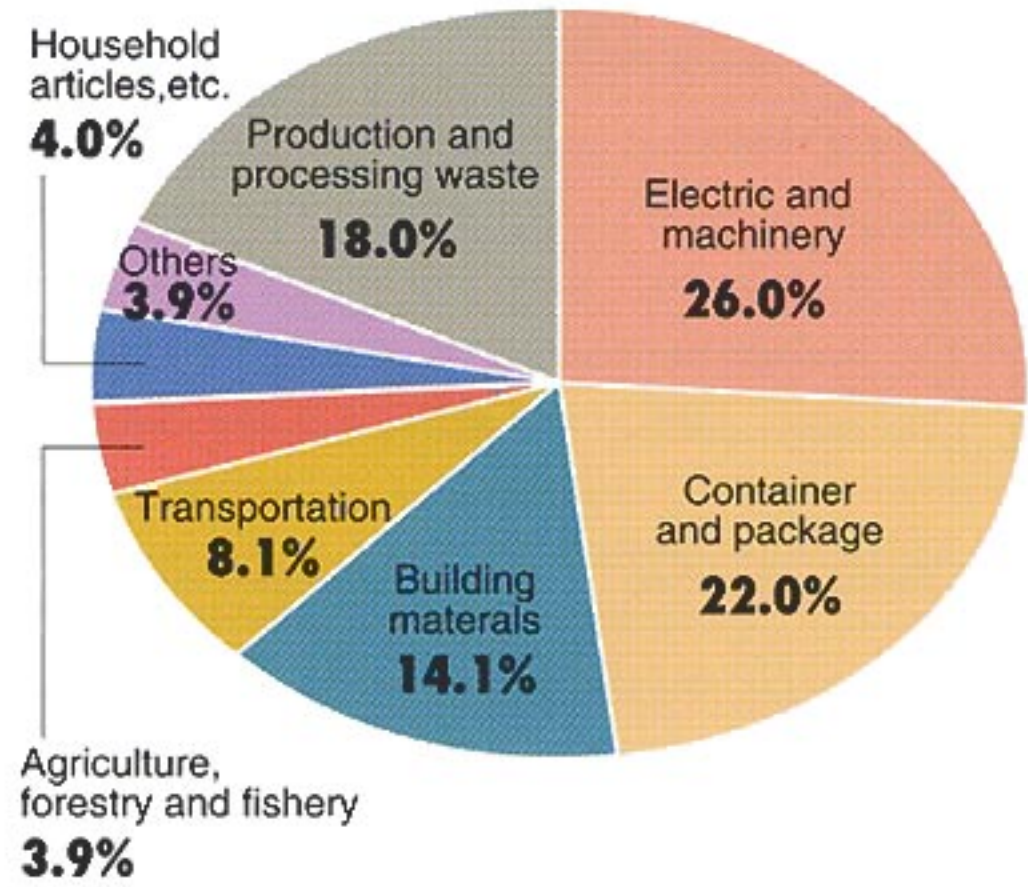


(by resin type)

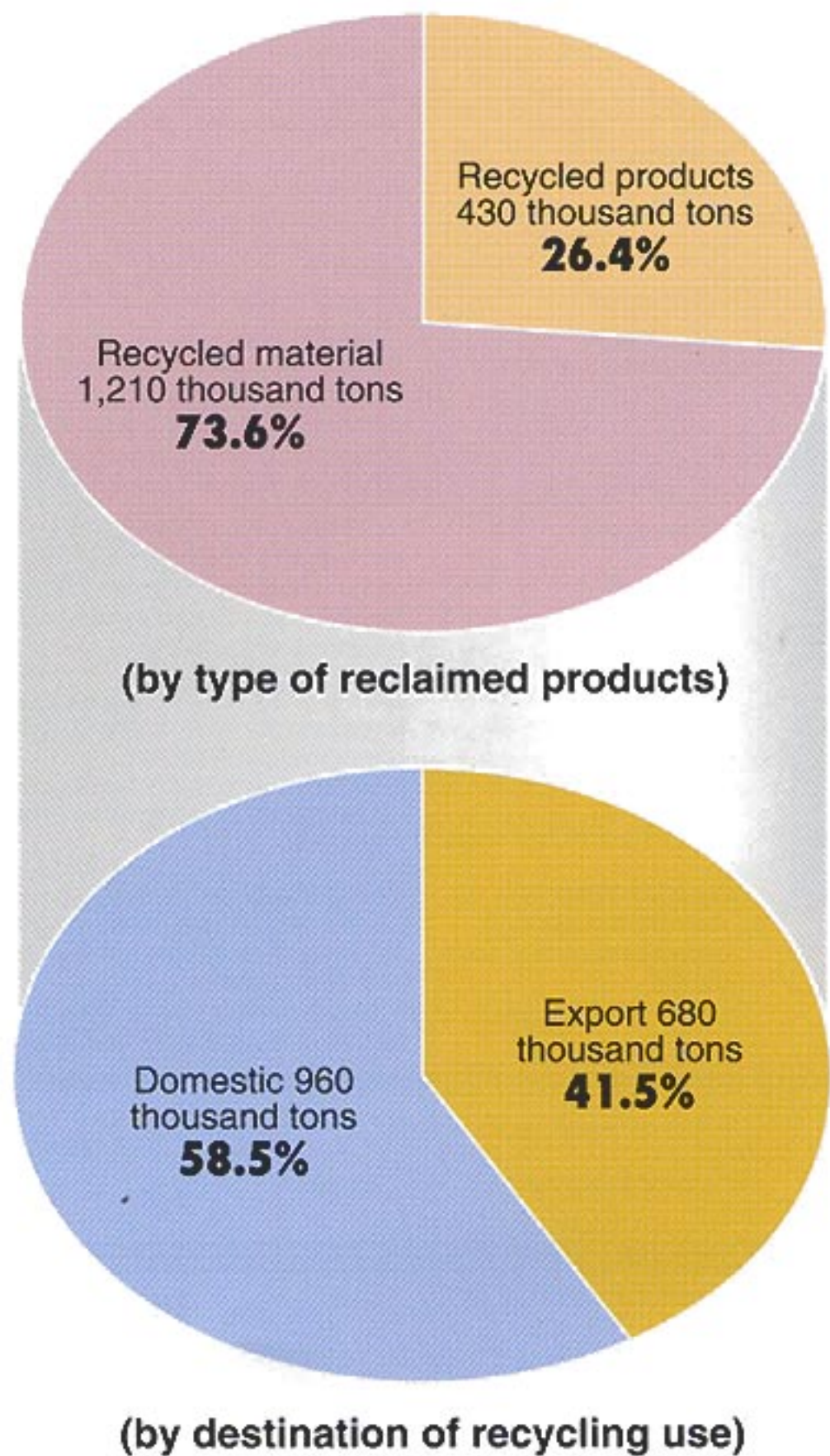
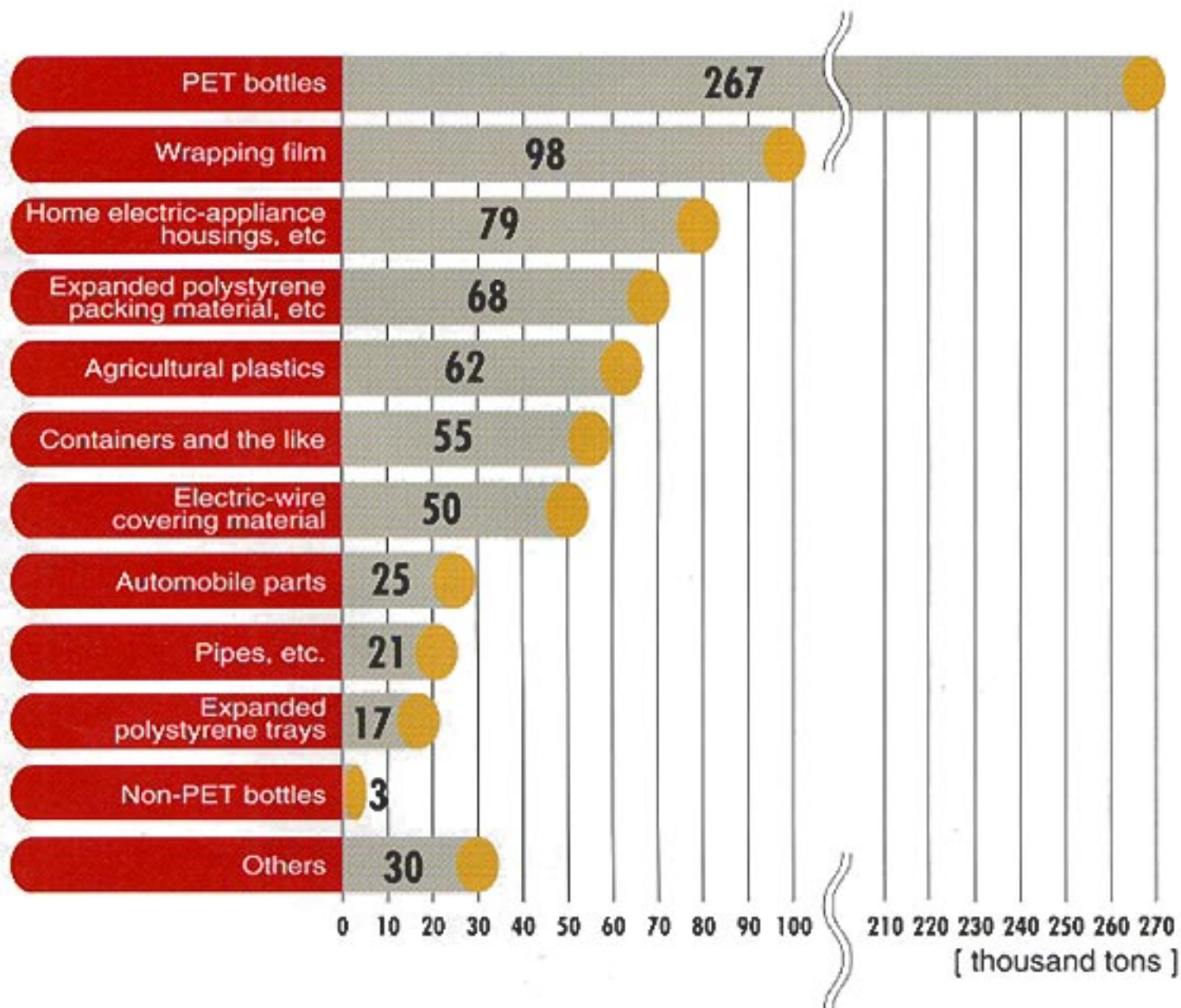
※4 Breakdown of domestic waste by field (5,130 thousand tons)



※5 Breakdown of industrial waste by field (4,880 thousand tons)



○ Breakdown of post-use products for mechanical recycling (780 thousand tons)



Plastics production and waste discharge

Year	Resin production	Domestic plastic products consumption	Total plastic waste discharge	Domestic waste		Industrial waste	
	1,000 t/year	1,000 t/year	1,000 t/year	1,000 t/year	%	1,000 t/year	%
1975	5,170	3,150	2,610	1,470	56	1,140	44
1980	7,520	5,520	3,250	1,780	55	1,470	45
1985	9,230	6,990	4,190	2,320	55	1,870	45
1986	9,370	7,300	4,530	2,500	55	2,030	45
1987	10,030	7,920	4,650	2,600	56	2,050	44
1988	11,020	8,610	4,880	2,760	57	2,120	43
1989	11,910	9,570	5,060	2,910	58	2,150	42
1990	12,630	9,990	5,570	3,130	56	2,440	44
1991	12,800	10,070	6,220	3,450	55	2,770	45
1992	12,580	9,280	6,920	3,910	56	3,010	44
1993	12,250	9,020	7,560	4,190	55	3,370	45
1994	13,040	9,660	8,460	4,230	50	*4,230	50
1995	14,030	9,790	8,840	4,430	50	4,410	50
1996	14,660	10,810	9,090	4,550	50	4,540	50
1997	15,210	11,360	9,490	4,780	50	4,710	50
1998	13,910	10,200	9,840	4,990	51	4,850	49
1999	14,570	10,810	9,760	4,860	50	4,900	50
2000	14,740	1,0980	9,970	5,080	51	4,890	49
2001	13,880	1,0960	10,160	5,280	52	4,890	48
2002	13,850	10,570	9,900	5,080	51	4,820	49
2003	13,980	11,010	10,010	5,130	51	4,880	49

* The method for making estimations was changed in 1994 so that non-use resin production and processing waste would be added to the figure for industrial waste.

Change in Utilized Plastic Waste by Amount and Rate Over Time

Year	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Utilization amount (thousand tons)	1,440	2,210	3,580	3,990	4,350	4,520	4,940	5,350	5,420	5,840
Utilization rate(%)	26	25	39	42	44	46	50	53	55	58

Please see the PWMI Web site for detailed data on the production, discharge, reuse, and disposal of plastic products.

Introduction To PWMI

Goals and Tasks

The Plastic Waste Management Institute (PWMI) was originally founded as the Plastic Management Research Association in November 1971, and received its current name in July 1972 as a result of expanded operations.

The goals of PWMI are to research and develop systems for optimal processing of plastic waste and effective use of processed waste as a resource, and to promote the use of these systems.

To accomplish these goals, PWMI performs a wide variety of tasks. These include researching and developing technologies for using plastic waste effectively, performing model experiments, disseminating technologies, conducting research surveys, publicizing the work of PWMI, and providing loan guarantees to recycling ventures.

Activities

Ongoing R&D, Surveys, and Public Relations

Since its founding, PWMI has been engaged in various activities related to plastic waste. These range from the development of processing and recycling technologies to the surveying of discharge amounts and waste-processing conditions and publicity work to raise the level of consciousness regarding the processing and recycling of plastic waste. PWMI has also implemented a loan guarantee system to promote the growth of the plastic-waste recycling business. The main activities at PWMI are presented below in the section titled "Operations (1971-2003)." For the future, PWMI plans to continue its work on plastic waste through activities of this nature.

Responding to New Challenges

In the last few years, under the keyword of the 3Rs (reduce, reuse, and recycle), Japan

has enacted a number of laws related to recycling, including The Basic Law for Establishing a Recycling-based Society. In January 2005, the End-of-Life Vehicle Recycling Law (Automobile Recycling Law) became effective and other full-scale activities were launched toward achieving the goal of sustainable development. These efforts are helping to gradually decrease the quantity of final waste disposal and to ease the pressure on final disposal sites. For the past several years, the PWMI has made great efforts toward the enforcement of and the smooth operations of the Containers and Packaging Recycling Law. Efforts include recycle technology related to liquefaction, gasification, and reducing agent in blast furnaces. At the same time, PWMI provides relevant information about law provisions and enforcement.

Recently PWMI has been advancing activities to help comply with recycling laws for home appliance and automobile. We are concentrating efforts to develop feedstock recycle technology that effectively uses shredder dust, which is a main component of plastic. We are also concentrating efforts to develop recycle

technology for individual plastic products like the material used to make a CD-ROM, which is an area of recycling expected to expand rapidly in the future.

Since 1991, PWMI has energetically used life cycle inventory and the life cycle assessment methods to examine plastic recycling. Making use of the results of these studies accumulated over the years, PWMI is also developing a new assessment tool to determine the best recycling method based on how the plastic waste is generated. The eco-efficiency analysis tool integrates resource preservation, environmental burden, and economic (social) cost factors.

A frequent request from educational institutions is access to learning material related to plastic waste and recycling for environmental studies. In response, PWMI has placed high priority on developing its website as a means to publicize activities. In addition, as people grow increasingly concerned about matters related to health and safety, PWMI will distribute information about the high safety of materials that have been recycled from plastic waste.

Members

The current members consist of the following 18 corporations, 3 organizations and 5 supporting members (as of April 2005).

● Regular members

Asahikasei Chemicals Corporation.
Chisso Corporation
DuPont-Mitsui Polychemicals Co., Ltd
Japan Polyethylene Corporation
Japan Polypropylene Corporation
Kaneka Corporation
Maruzen Petrochemical Co., Ltd.
Nippon Unicar Co., Ltd.
Prime Polymer Co., Ltd.
Shin Dai-Ichi Vinyl Corporation
Shin-Etsu Chemical Co., Ltd.
Sumitomo Chemical Co., Ltd.
SunAllomer Ltd.
Taiyo Vinyl Corporation
Tosoh Corp.

Tokuyama Sekisui Co., Ltd.
Ube-Maruzen Polyethylene Co., Ltd.
V-Tech Corporation

● Trade Organizations

Japan Petrochemical
Industry Association
Japan Plastics Industry Federation
Vinyl Environmental Council

● Supporting Members

Japan PET Bottle Association
Japan Expanded Polystyrene
Recycling Association
Japan PVC Environmental
Affairs Council
Japan Urethane Industries Institute
Vinylidene Chloride Health Conference

Operations(1971-2004)

	Target Field	Recent Projects
Technology development	Sorting, volume reduction	Research of PET-bottle recovery system. Development of automatic sorting/separation technology using near-infrared radiation (spectroscopic analysis). Development of volume-reduction technology for raising waste-transport efficiency. Develop automatic sorting/separation technology and systems using near-infrared radiation (for shredder dust), static electricity, and buoyancy.
	Recycling promotion	Research and develop mechanical-recycling system for plastic waste. Survey current state of mechanical recycling/processing industry
	Feedstock recycling	Develop technologies for using plastic waste as raw material for liquefaction and gasification through thermal breakdown techniques. Develop technology for using plastic waste as a blast-furnace reducing agent in steel production.
	Incineration, energy recovery	Investigate conditions for suppressing generation of toxic substances and technologies for removing them when incinerating plastic waste. Develop energy-recovery technologies through densified-refuse derived fuel.
	Technology development support	Make extensive calls for new technology-development themes in relation to recycling technologies, reclaimed products, and combustion techniques, and fund R&D expenses. Survey and develop techniques for evaluating environmental effects and environmental load-economy of recycling. (LCI, LCA, eco-efficiency analysis)
Surveys	Domestic waste systems	Survey local-government activities to determine amount of plastic waste occupied by domestic waste. Survey progress in constructing PET-bottle recycling systems. Obtain basic data for performing life cycle analyses (LCA).
	Industrial waste systems	Survey discharge, processing, and reuse of industrial plastic waste. Perform a basic survey on the reuse of plastic waste generated in construction.
	Production to processing/disposal flow	Survey current state of plastic production, discharge, reuse, and processing/disposal in Japan, quantify its macro flow, and publish an annual report.
	Overseas surveys	Survey overseas trends in plastic recycling and processing. Participate in international conferences and exchange information in conjunction with European and U.S. organizations (Plastics Europe/APC) and Far East Asian countries (Korea, Taiwan, etc.).
Public relations	Exhibits, etc	Hold "Recycled Products Exhibition" as a cosponsor with the Ministry of Economy, Trade and Industry (METI) and the Japan Plastics Effective Utilization Union. Support recycling exhibits held by local governments and recycling organizations.
	Dissemination of information through print media	Gather materials at recycling sites and local governments and disseminate recycling-related information through periodical publications. Announce and publicize results of PWMI activities and current state of plastic recycling in newspapers, mass media, etc.
	Dissemination of information through digital and audio/visual media	Disseminate explanatory material on PWMI activities and plastic recycling to local governments, general public, and students through pamphlets, movies, videos, CD-ROMs, and Web sites. Prepare a Web site for recycling and environmental studies targeting elementary and junior high schools

Organization

