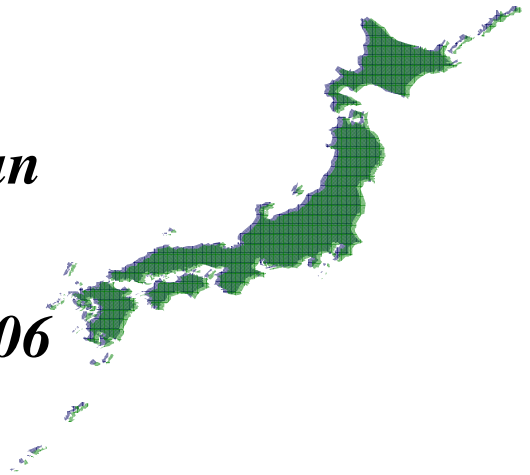
Current Status of Plastics Recycling in Japan

Hisao Ida

Executive Director

Plastic Waste Management Institute, Japan

December 12, 2006



Presentation Topics

I. Current Status of Plastics Recycling in Japan
   1. Legislative & Voluntary Framework
   2. Flow of Plastic Products, Wastes and Recycling
   3. Method of Plastics Recycling

II. Life Cycle Thinking
   1. Choice of the waste utilization method based on LCA and economic efficiency thinking
   2. Case studies

III. Issues under discussion
   1. Overdependence upon Mechanical Recycle
   2. Expanding export to rapidly developing Asian countries

Introduction 1

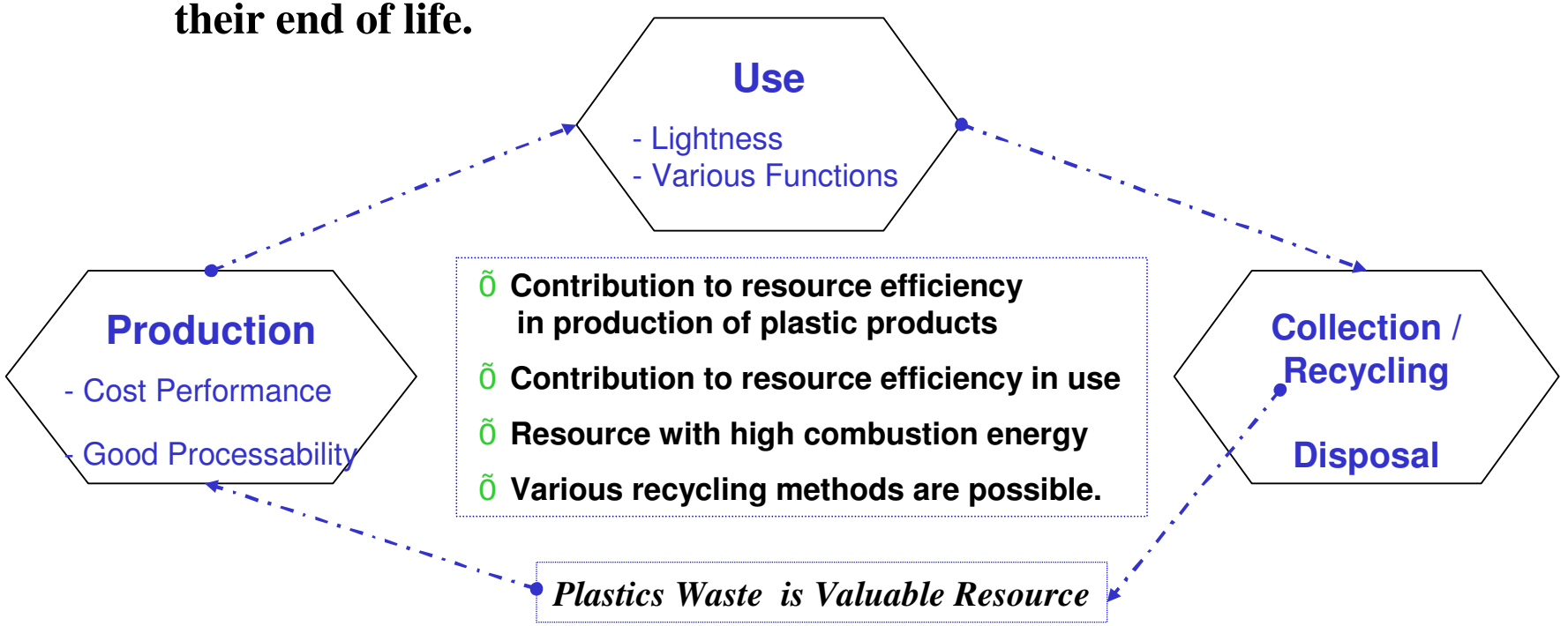
Plastic Waste Management Institute, Japan

- Foundation: Nov. 1971
- Present Members: 18 corporations (resin manufactures),
  3 organization, 4 supporting members
- Mission:
  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.
- Recent activities with emphasis:
  - Development of recycling technologies for plastics waste.
    (Recycling of CD products, agriculture PO films)
  - LCA based study on benefit of plastics use and recycling method of plastics
    (Eco-efficiency analysis of plastic containers & packaging waste treatment under the recycling law)
  - Communication on usefulness of plastics and understanding on energy recovery, and promotion of correct understanding on plastics among children
    (Environmental education in school)

Introduction 2

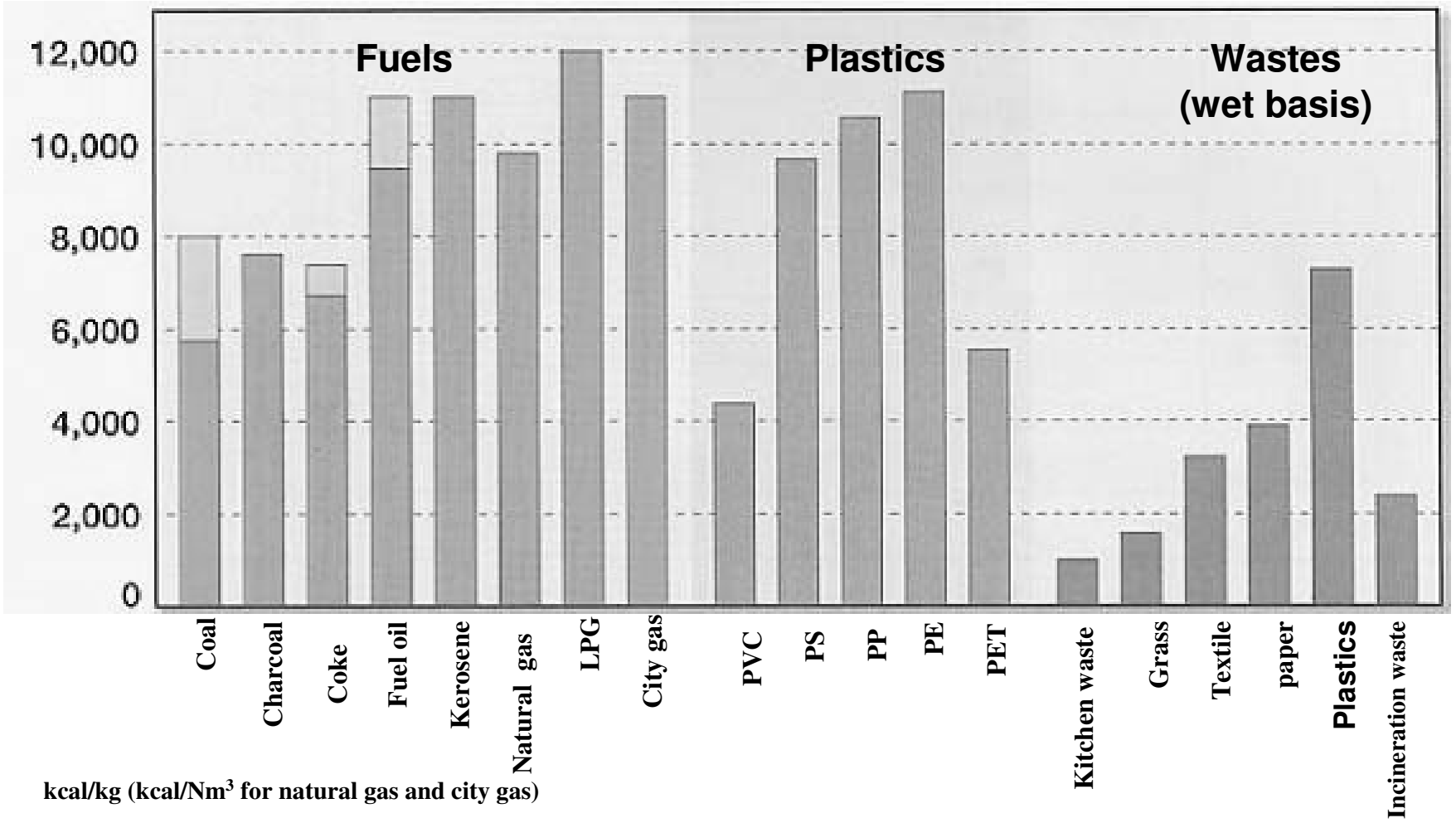
Life Cycle Benefit of Plastics

- ü **Today plastics are everywhere. It is used in cars, homes, offices, clothes, etc.**
- ü **Plastics are the material of choice because they make it possible to balance modern day needs with environmental concerns.**
- ü **This benefit can been realized through their total life cycle, even after their end of life.**



Calorie of Fuels, Plastics and Wastes

- **Plastics Waste is Valuable Resource with High Calorie**



kcal/kg (kcal/Nm^3 for natural gas and city gas)

I-1

Legislative Framework for Formation of Sustainable Development Society

(Basic framework law) (Enforcement: Jan 2001)

Fundamental Law for Establishing a Sound Material-Cycle Society

(Proper waste management) (Enforcement: Apr 2001)

Revised Waste Management Law

(Promotion of recycling) (Enforcement: Apr 2001)

Law for Promotion of Effective Utilization of Resources

(Individual product recycling law)

(Full enforce.: Apr 2000)	(Enforcement: Apr 2001)	(Enforcement: May 2002)	(Enforcement: Apr 2001)	(Enforcement: Jan 2005)
Containers & Packaging Recycling Law	Home Appliance Recycling Law	Construction Materials Recycling Law	Food Recycling Law	End of Life Vehicles Recycling Law

(Enforcement: Apr 2001)

Green Purchasing Law

Source: Ministry of Economy, Trade and Industry

Industrial Structure Council Guidelines for Waste and Recycling

The guidelines Indicate measures to be taken by businesses for waste treatment and recycling with aim of promoting voluntary actions, with respect to 35 product categories and 18 business sectors.

Plastic product category:

Item	Voluntary Target
PET bottles	Collection rate 80% (2014)
EPS fish boxes and packaging for home appliance	Recycling rate 75% (2010)
PVC agriculture films	Recycling rate 70% (2006)
PVC pipes and fittings	Recycling rate 70% (2010)

Position of Guidelines in Legislative Framework

Others (PC, etc.)
Furniture
Clothes
Home appliance

Municipal Solid Waste

Industrial Waste

Law for Promotion of Effective Utilization of Resources

Home Appliance Recycling Law

ELV Recycling Law

Industrial Structure Council Guidelines by Product Category

Containers and Packaging Recycling Law

Food recycling Law

(business waste only)

2%
2%
2%
Automobiles: ca. 10%
Paper: ca. 25%
Containers/ Packaging: ca. 25%
Kitchen waste, (Business waste, Household waste): ca. 30%

Annual total: ca. 50 million t

Reducing waste generation ('Reduce' policy)

Reusing parts etc. ('Reuse' policy)

Recycling as raw materials ('Recycling' policy)

Product Related Measures

- Save resources
- Design for environment
- Selectively collect and recycle products, etc.

By-products (waste) Related Measures

- Prevent by- product generation
- Promote recycling of by- products, etc.

Effective use of resources

Green Purchasing Law

Construction: 18%

Agriculture: 22%

Food processors: 3%

Electricity, gas, heat, water utilities: 22%

Pulp/paper: 9%

Steel: 8%

Chemical: 5%

Mining: 7%

Others: 10%

Annual total: ca. 400 million t

Construction Materials Recycling Law

Law for Management of Animal Excrement

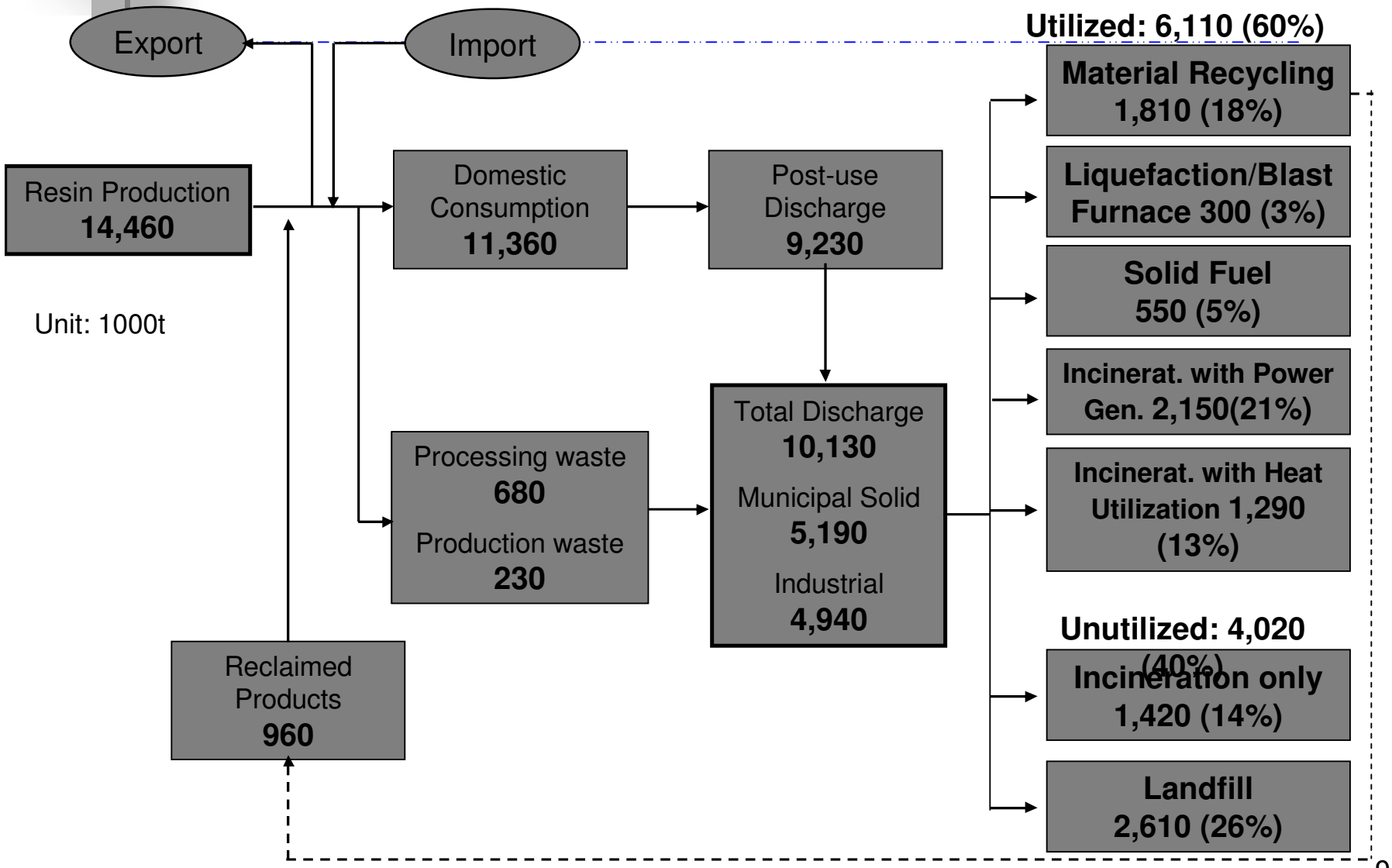
Food Recycling Law

Industrial Structure Council Guidelines By Industry Sector

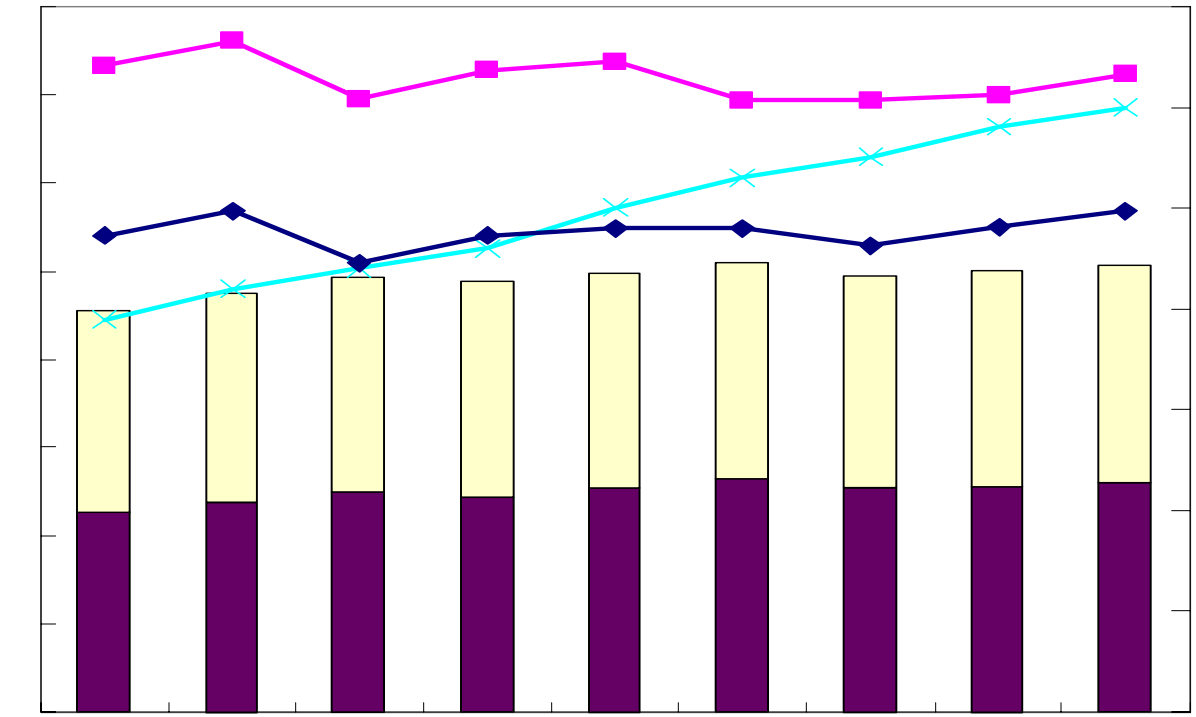
Source: METI

I-2

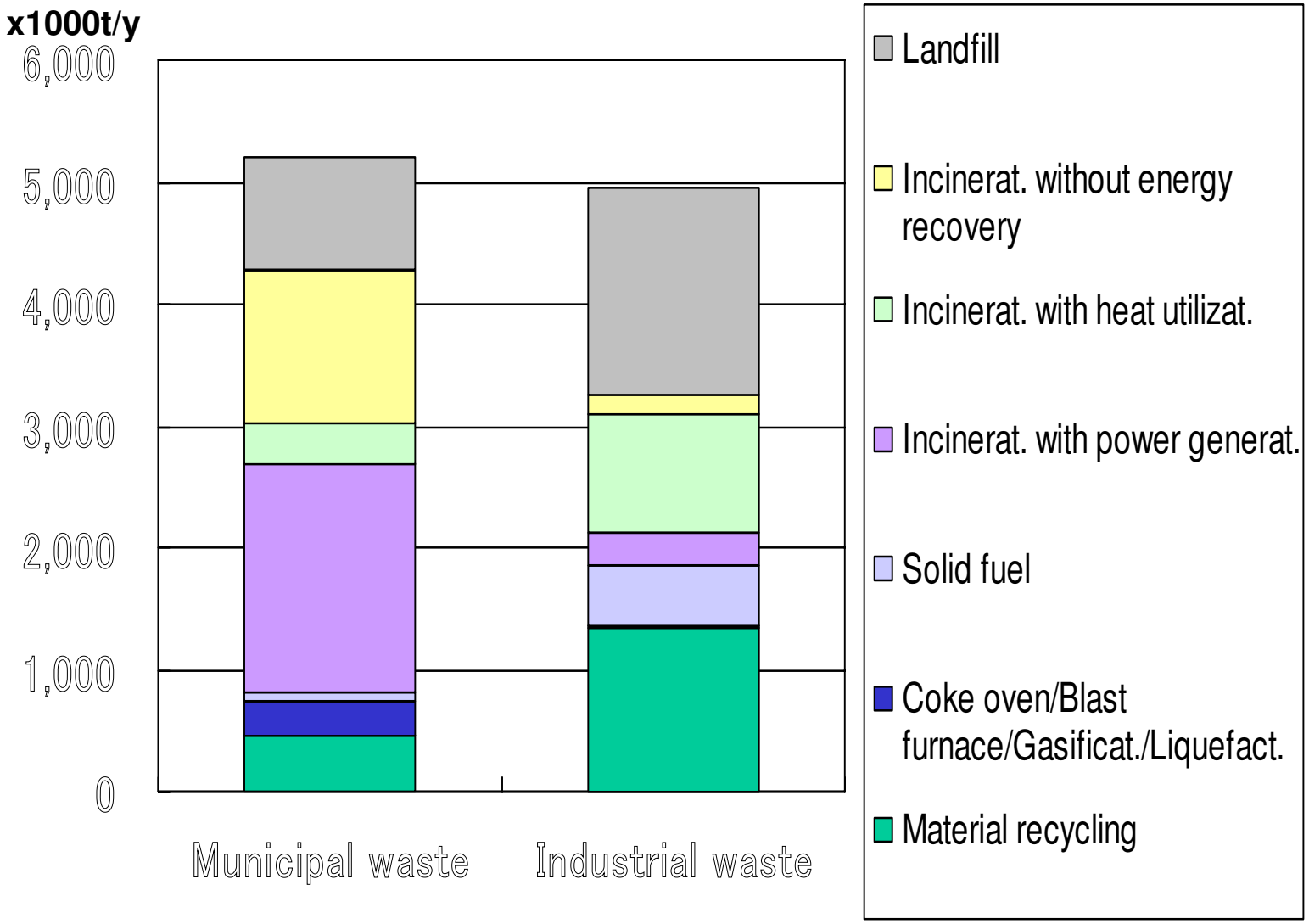
Flow of Plastic Products, Wastes, and Recycling (2004)



Trend of Plastics Production, Consumption, Waste Discharge, Recycling Ratio



Treatment of Plastics Waste (2004)



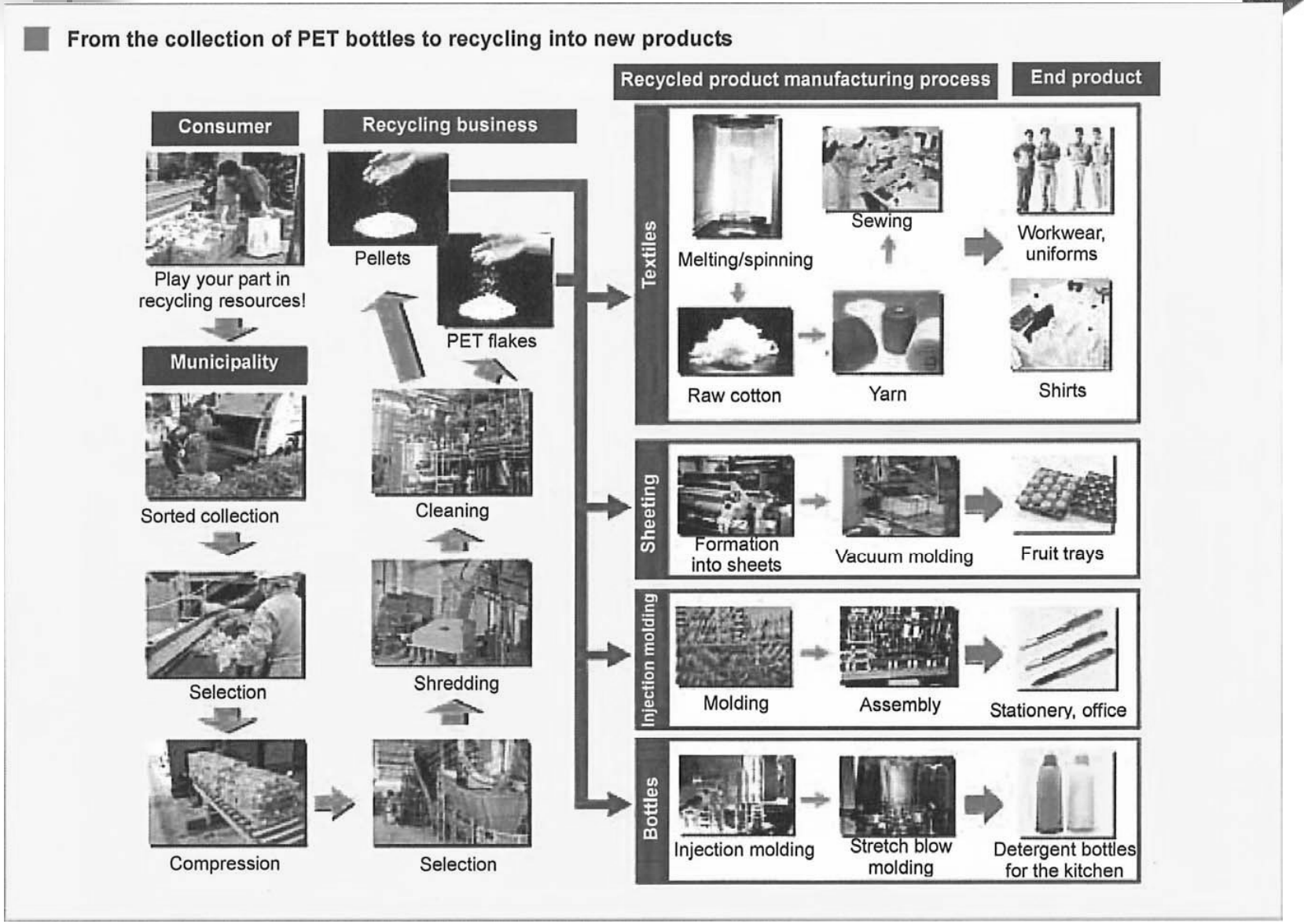
I-3

Method of Plastics Recycling

Category	Method of recycling		Positioning under law
Material recycling (Mechanical recycling)	Recycling to make - Plastic raw material - Plastic product		Prevail over chemical recycling in C&P recycling law
Chemical recycling (Feedstock recycling)	Degradation to monomer		
	Blast furnace (as reducing agent)		
	Coke oven		
	Gasification, Liquefaction	Chemical feedstock	
		Fuel	
Energy recovery	Cement kiln		- Not accepted by home appliance recycling law. - Being positioned by amended C&P recycling law
	Incineration with power generation		
	Solid Fuel (RDF, RPF)		

Material Recycling Process (PET Bottles)

Source: Council for PET Bottle Recycling



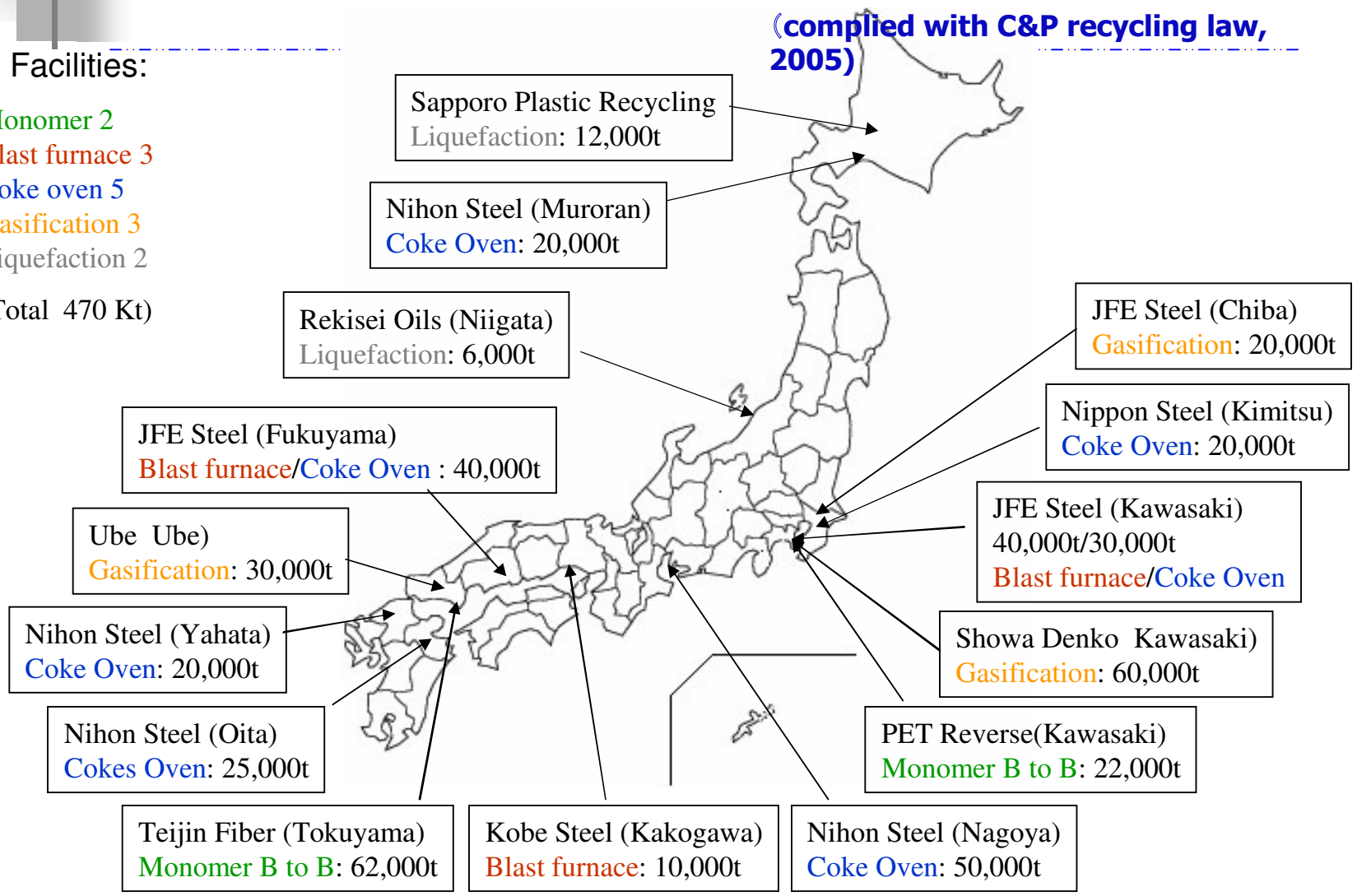
Large Scaled Chemical Recycling Facilities

(complied with C&P recycling law, 2005)

15 Facilities:

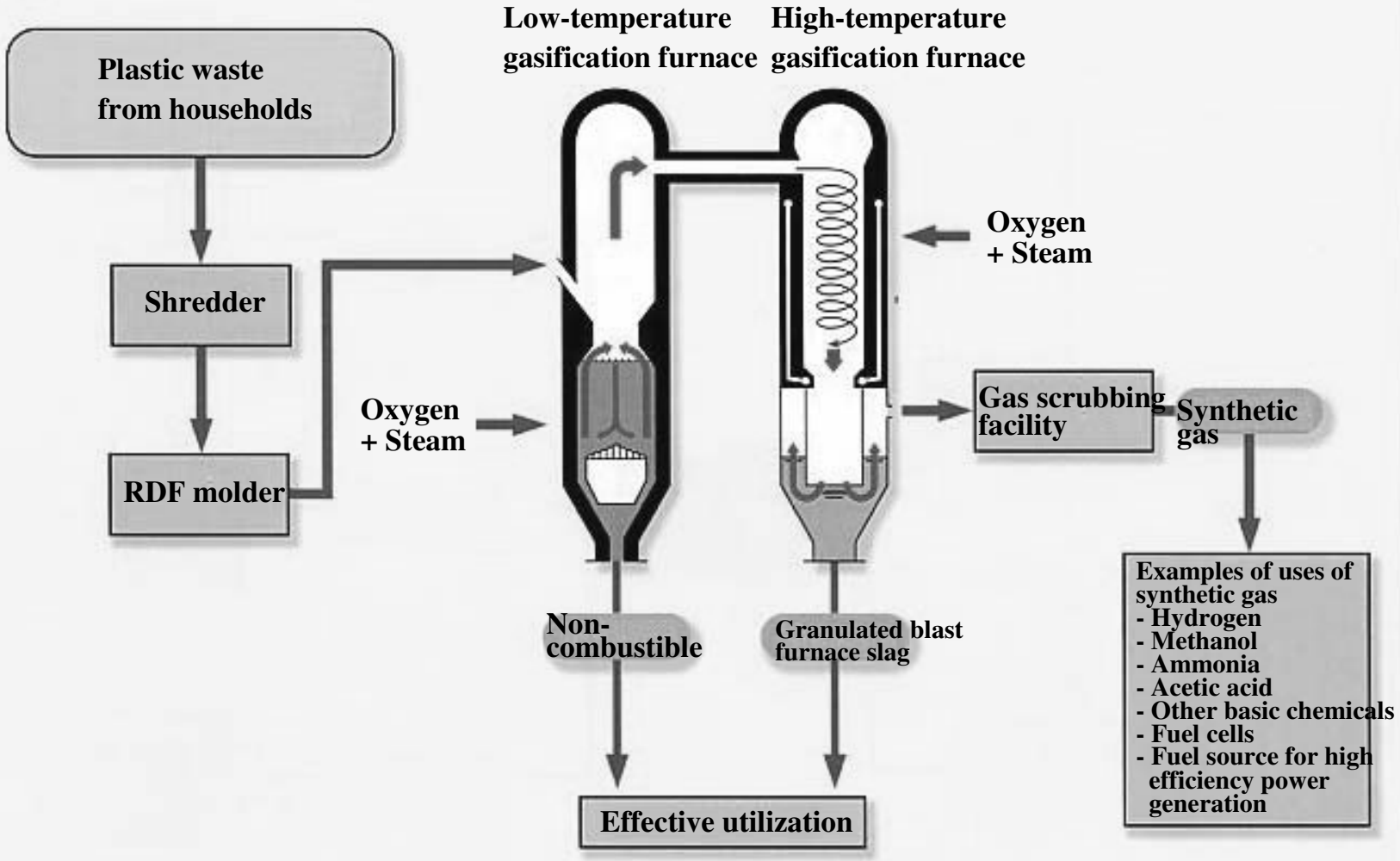
Monomer 2
Blast furnace 3
Coke oven 5
Gasification 3
Liquefaction 2

(Total 470 Kt)

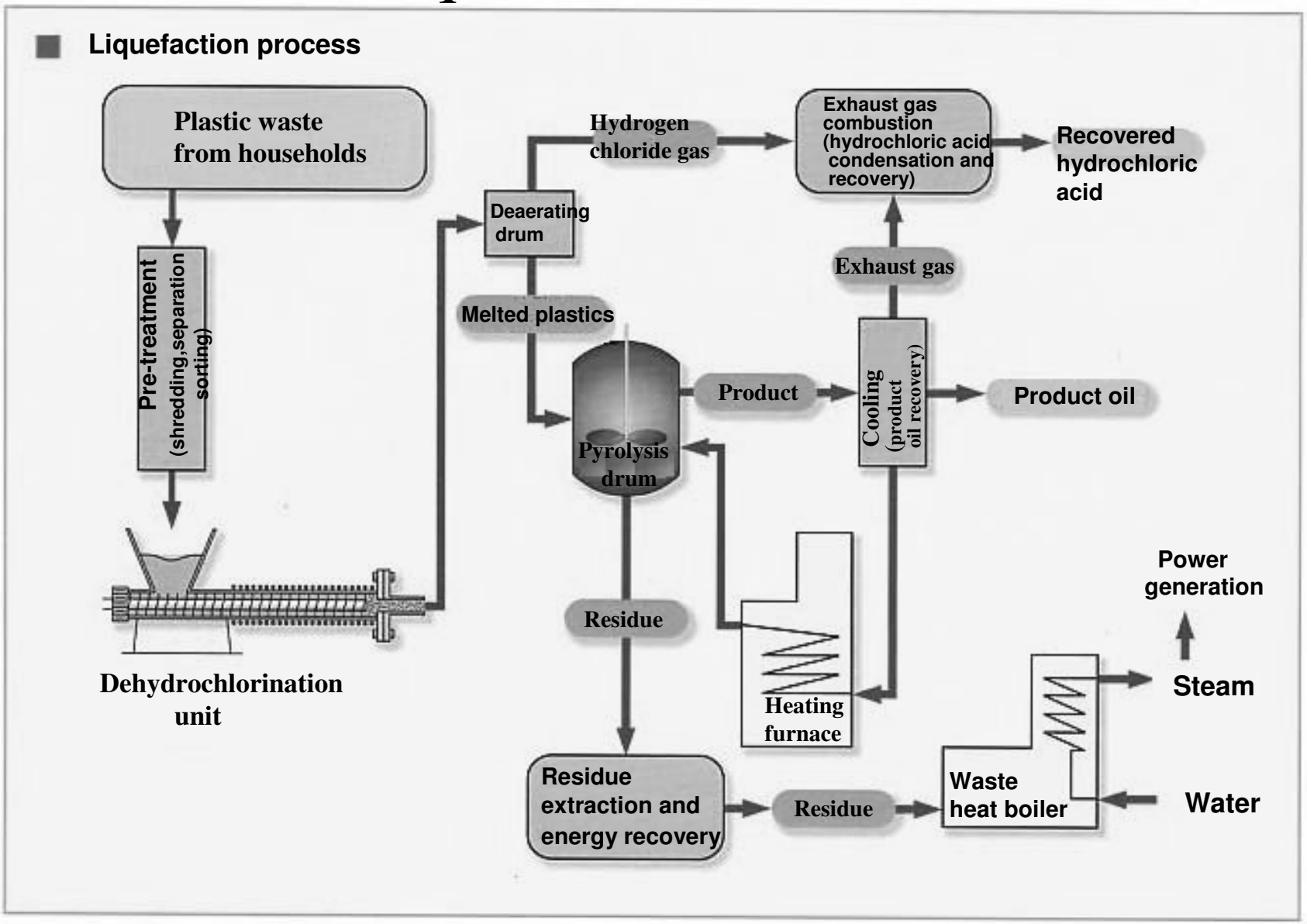


Gasification Process

■ **Gasification process**

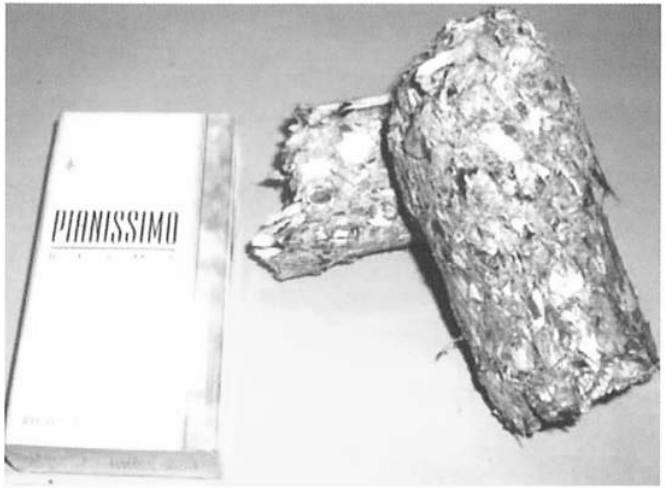


Liquefaction Process



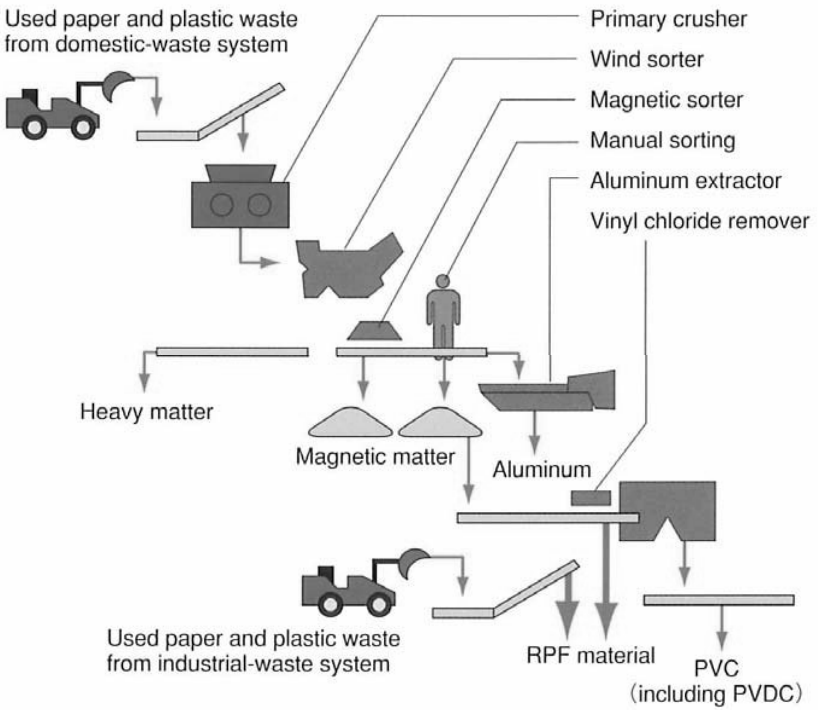
RPF (Refuse Paper & Plastic Fuel)

Appearance of RPF



RPF products (diameters of 40 mm)

RPF Production process



Diameter: 6 – 50 mm

Calorie: 5,000 – 10,000 kcal/kg
(Can be adjusted by varying paper content.)

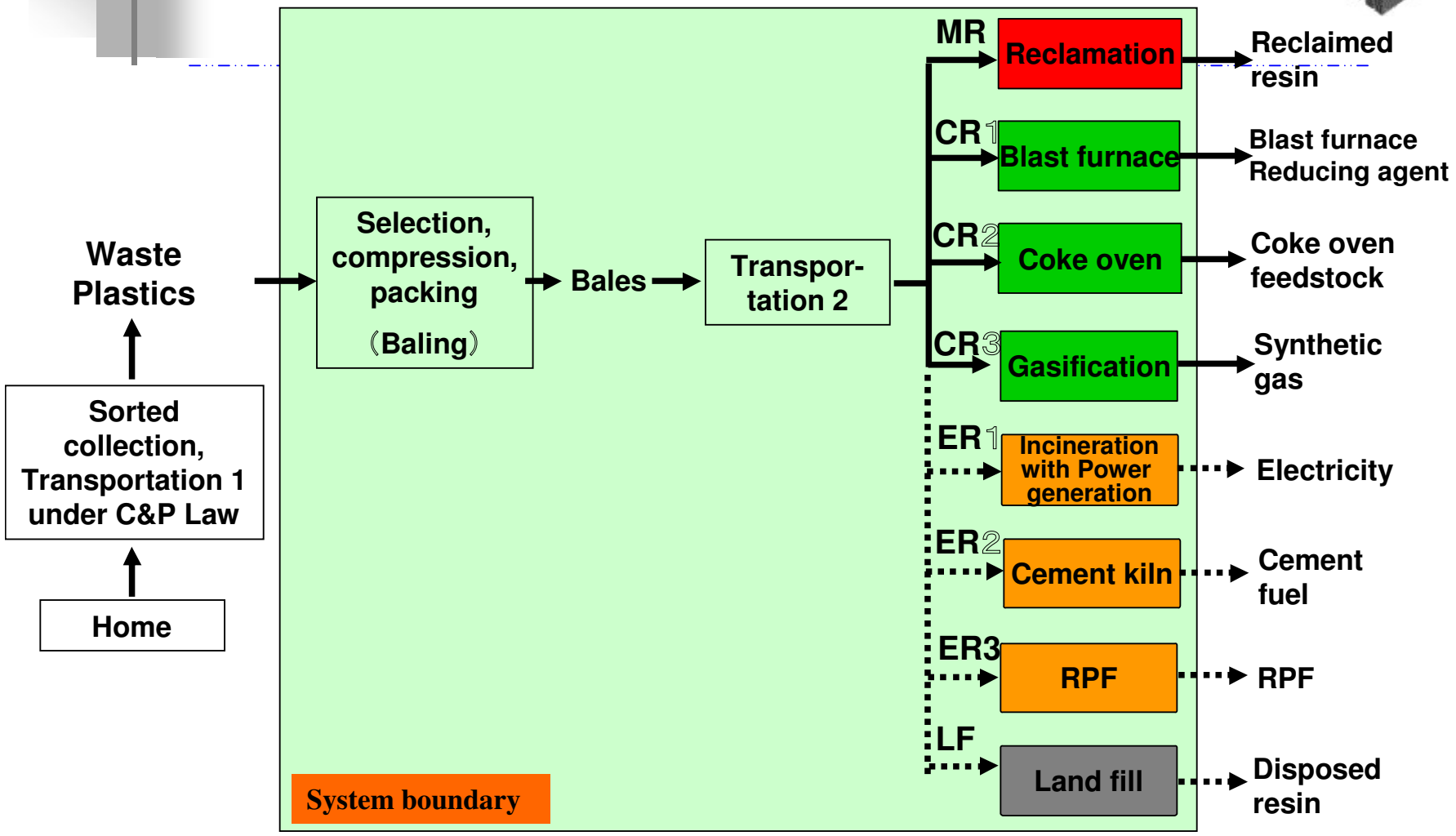
Ash content: 7 % max.

Application: Boiler fuel, RPF power generator, etc.

Demand for RPF	2006	1,210 Kt
	2010	2,000 Kt
Production	2005	600 Kt

Source: Japan RPF Association,
The Nikkan Kogyo Shimbun

II-1 Eco-efficiency Analysis of Plastic C&P Waste Treatment under C&P Recycling Law – Boundary- (2006)



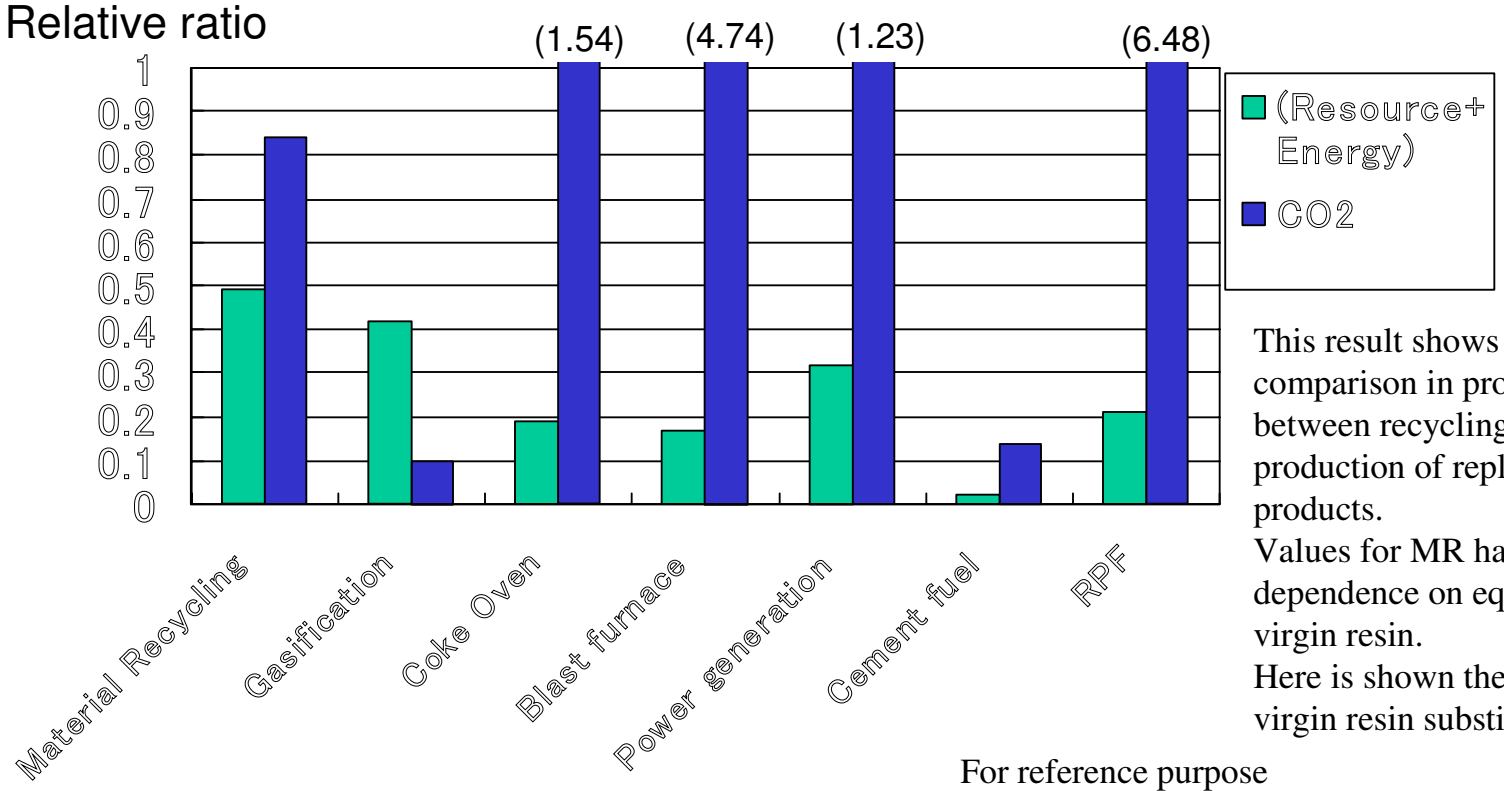
Note 1: MR: Mechanical Recycling, CR: Chemical Recycling, ER: Energy Recovery

Note 2: ——— : Processing complied with C&P Recycling Law

------ : Processing not complied with C&P Recycling Law

Efficiency of Recycling of Plastic C&P Waste under Law

- Relative Ratio to produce replacing products -



This result shows the comparison in processing between recycling and production of replacing products.
Values for MR have a big dependence on equivalency to virgin resin.
Here is shown the case of 30 % virgin resin substitution ratio.

Recycling method	Replacing product
Material recycling	Virgin resin (30%)
Gasification	Synthetic gas
Coke oven	Coal
Blast furnace	Coal

For reference purpose

Recycling method	Replacing product
Incineration with power generation	Electricity
Cement fuel	Coal
PRF	Coal

Resource saving effect of Recycling of Plastic C&P Waste under Law (2005)

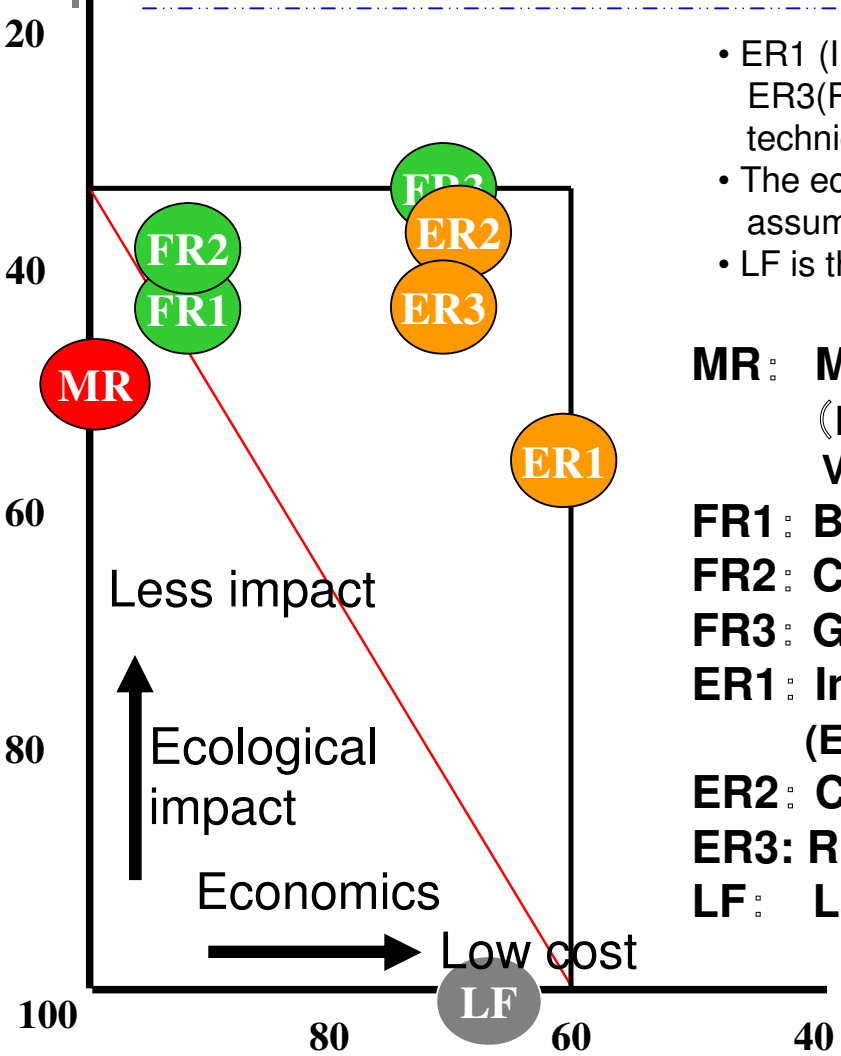
- Equivalent Petroleum -

Recycling method	Output		Saving to get replacing product	
	Replacing product	Quantity (1,000 t)	Resource + Energy (1,000 GJ)	Equivalent petroleum (1,000 t)
Material recycling*	Virgin plastics (30%)	89	949	20
Gasification	Synthetic gas	172	818	17
Coke oven	Coal	174	3,755	79
Blast furnace	Coal	36	813	17

* Values for MR have a big dependence on equivalency to virgin resin.
Here is shown the case of 30 % virgin resin substitution ratio.

Calorific value of petroleum: 47.6GJ/t

II-2 Eco-Efficiency Analysis Result of Plastic C&P Waste Treatment (2006)



- ER1 (Incineration with power generation), ER2(Cement kiln), ER3(RPF), FR3(Gasification) are the most desirable techniques in terms of eco-efficiency.
- The eco-efficiency of MR is about the same as that of LF assuming that virgin resin substitution ration is 30% .
- LF is the worst choice among all cases.

MR： Mechanical Recycling
（MR Yield: 50% residue (incineration):50%
Virgin Resin Substitution Ratio: 30%）
FR1： Blast Furnace
FR2： Cokes Oven
FR3： Gasification
ER1： Incineration with electricity Generation
(Electricity Generation Efficiency: 20%)
ER2： Cement Kiln
ER3: RPF
LF： Landfill

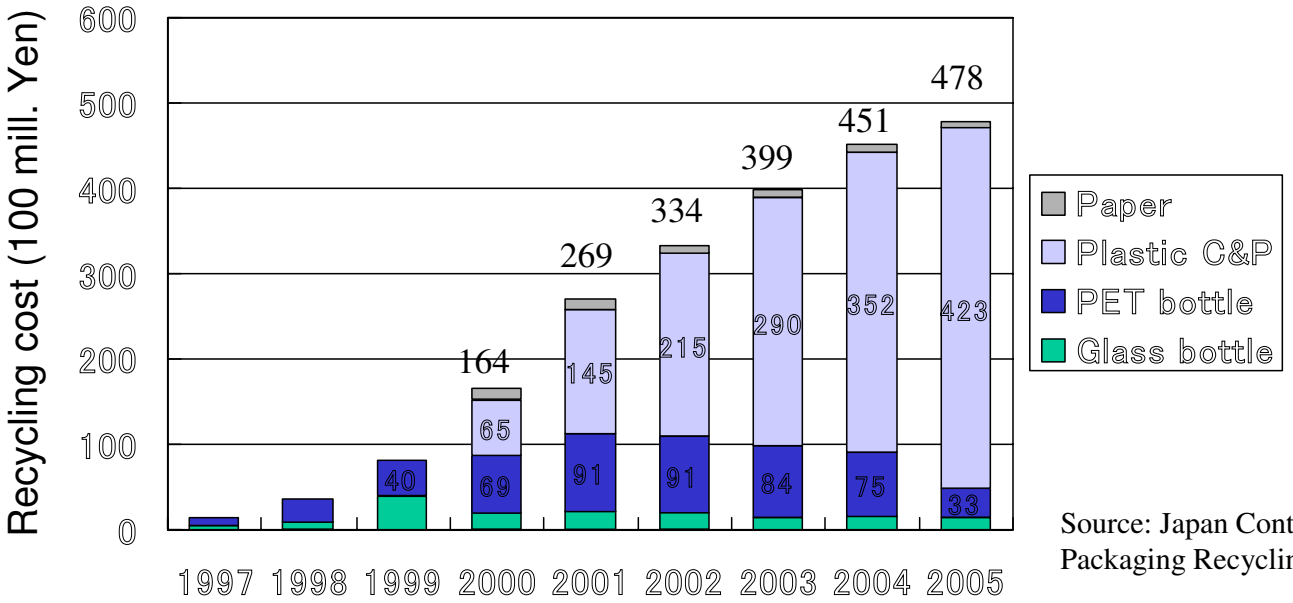
II-3 *Image on Plastic Recycling in Future*

<table>
<tr><td rowspan="3">Municipal Plastics Waste</td><td rowspan="2">Sorted plastics
ca. 1 mil. tons</td><td>Unmixed plastics:
PET bottles</td><td>Material recycling</td><td rowspan="2">C&P Recycling Law</td></tr>
<tr><td>Mixed plastics</td><td>Blast furnace /
Coke oven</td></tr>
<tr><td colspan="2">Unsorted plastics
ca. 4 mil. tons</td><td colspan="2" rowspan="3">Incineration, together with kitchen waste and sludge, with power generation/heat utilization (Gasification and melting power generation system)
Cement kiln, RPF and Blast furnace are alternatives for plastic waste with lower halogen content</td></tr>
<tr><td rowspan="3">Industrial Plastics Waste</td><td colspan="2">Mixed plastics
ca. 3 mil.tons</td></tr>
<tr><td colspan="2">Unmixed plastics
ca. 1.5 mil.tons</td></tr>
<tr><td rowspan="2">Collection under Home Appliance / ELV Recycling Law
ca. 0.5 mil.tons</td><td>Unmixed plastics</td><td>Material recycling</td><td rowspan="2">Home Appliance / ELV Recycling Law</td></tr>
<tr><td>Mixed plastics</td><td>Blast furnace / Gasification / Power generation / Thermal recovery</td></tr>
</table>

III-1

Recycling Costs and Costs in Sorted Collection

•Recycling costs borne by businesses continue to increase, due to the drastic increase of plastic C&P recycling cost.

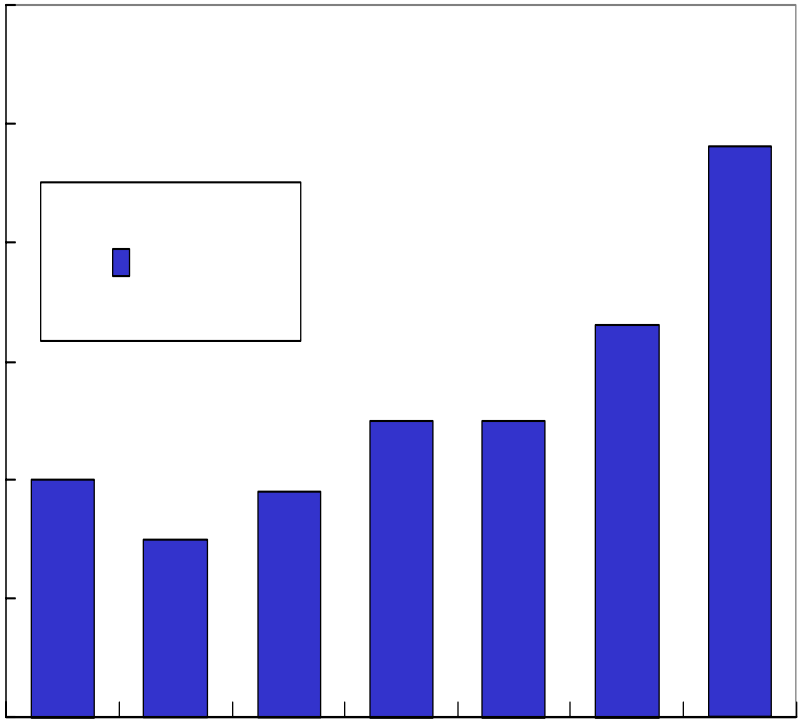


Source: Japan Containers and Packaging Recycling Association

• Additionally nominal cost borne by municipalities in sorted collection, rough selection & storage of C&P waste ca. 300 Billion Yen (Estimated by Ministry of Environment)

MR's Priority and its Consequence

MR ratio(%)



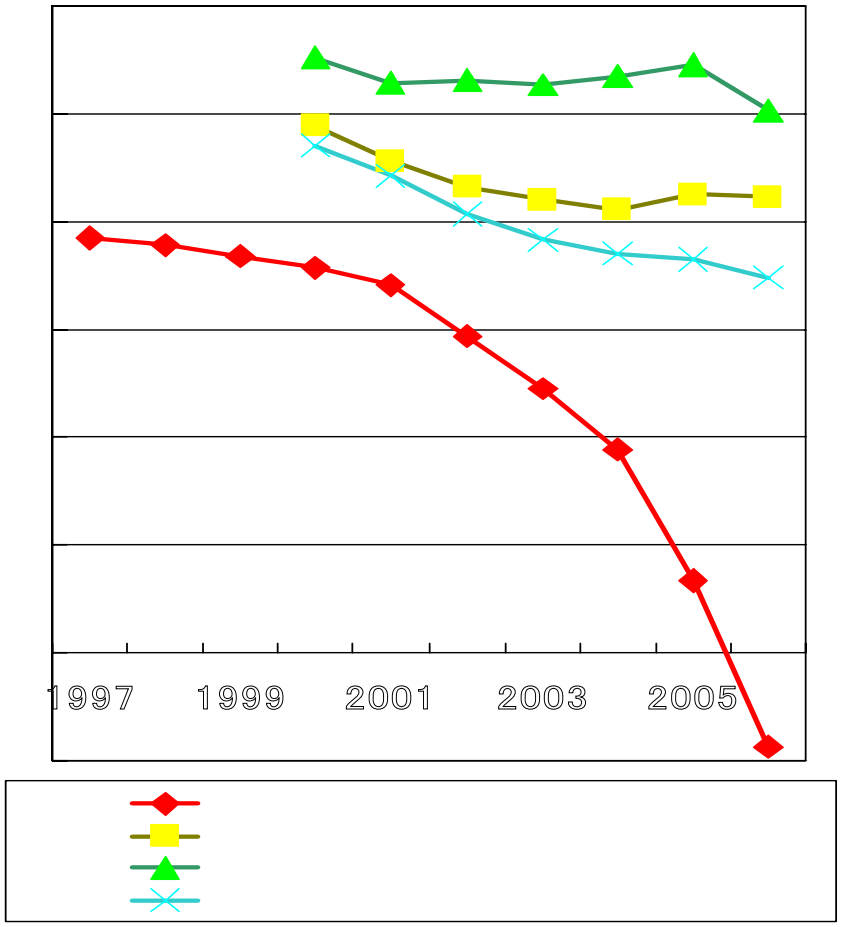
MR ratio among total recycling methods recently shows a big increase, due to its priority over chemical recycling methods.

Source: Japan Containers and Packaging Recycling Association

Reason of High Recycling Cost

Contract Price for Recycling

1,000Vt



- **Average contract recycling price of plastic C&P stays high, due to high price of material recycling arising from its priority over other recycling methods.**
- **Increase of collection volume continues.**
- **Balance in recycling capacity / collection volume is tight.**

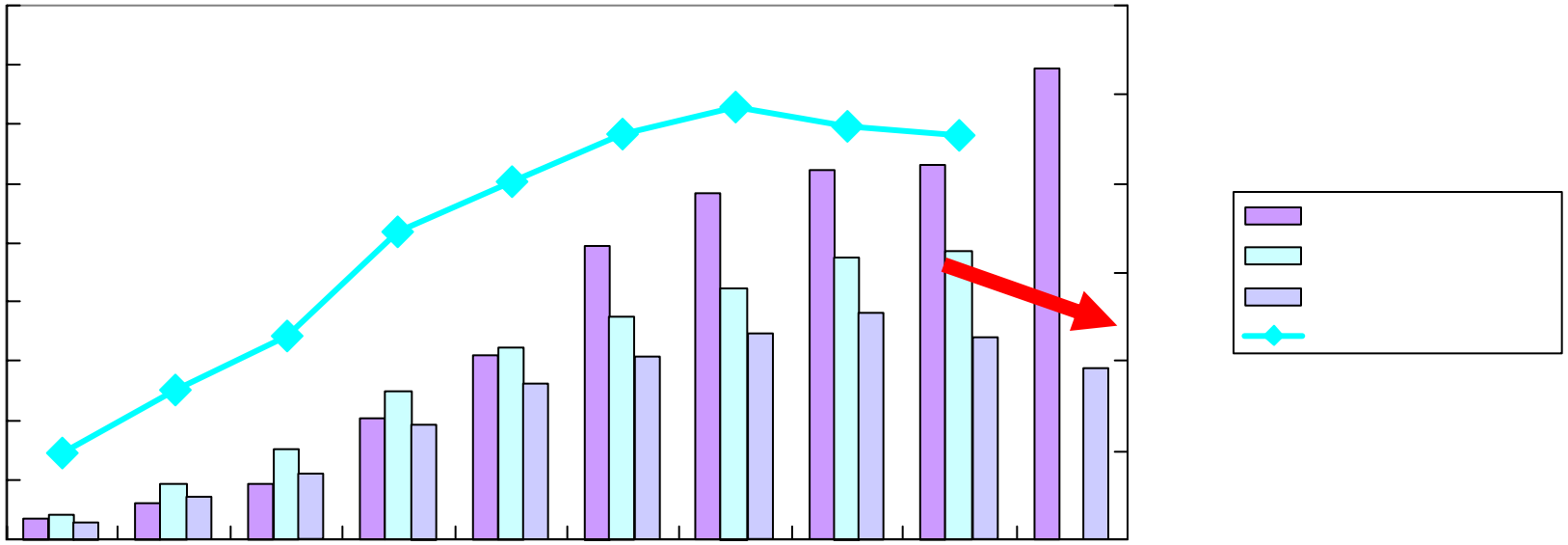
Source Japan Container and Package Recycling Association

III-2

Issue of Recycling of PET Bottles

- Burden of collection cost on municipalities and strong demand for PET in China caused some municipalities' movement to export collected PET bottles in order to recover a cost in their sorted collection.
- Consequently the decrease of recycling quantity under the law is taking place.

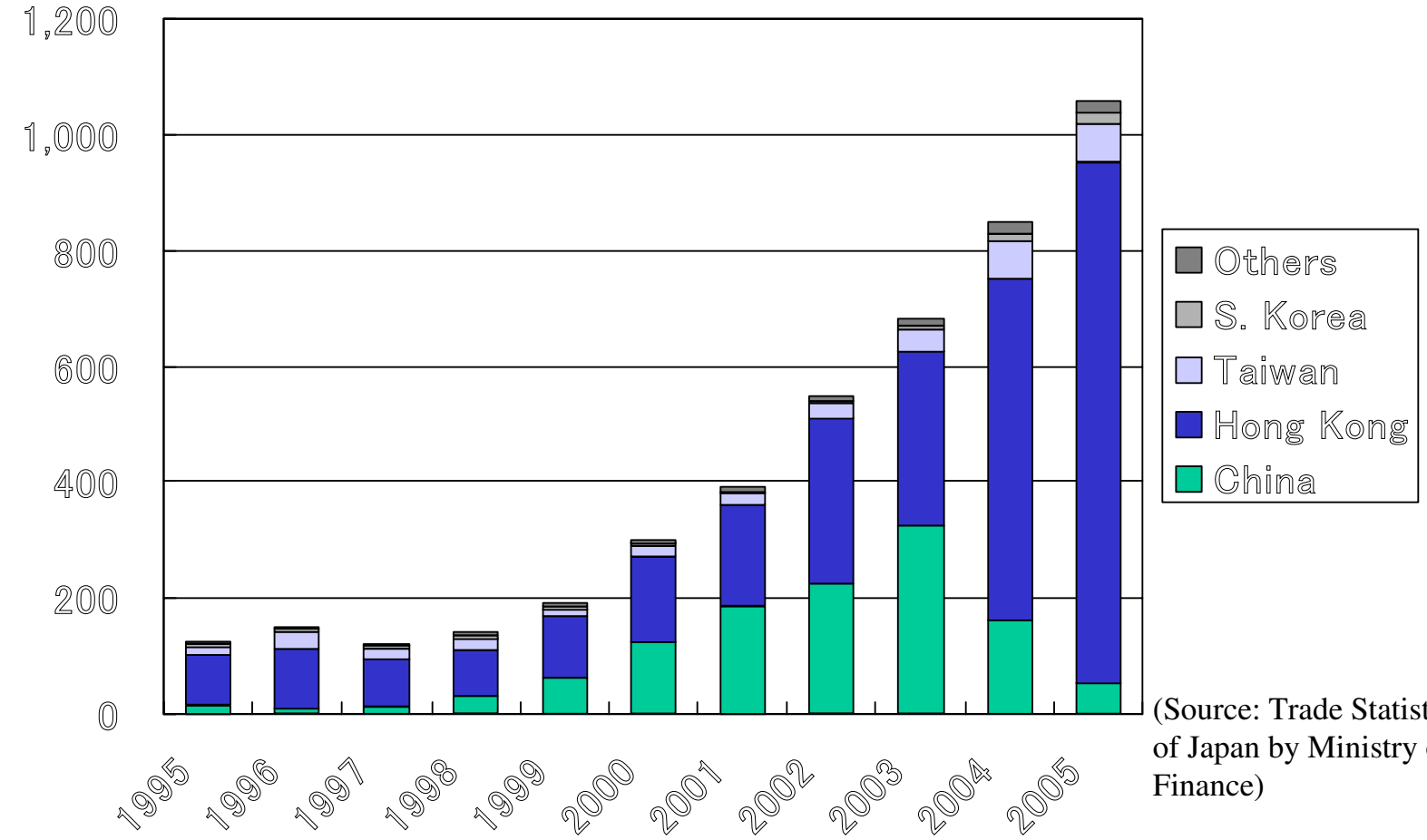
[K tons] [%]



(Plan)

(Source: The council for PET bottle recycling)

Export of Waste Plastic to Asian Countries



(Source: Trade Statistics of Japan by Ministry of Finance)

Conclusion

1. Plastics are resource efficient materials in the phases of production and use, and still versatile as resources in the phase of end of life. End of life plastics after use should be collected and utilized by appropriate methods including energy recovery without land filling to avoid visual pollution such as litter.
2. The most suitable method should be selected for collection and utilization of waste plastics by taking into account LCA, economics evaluation, local conditions and voluntary approaches. The increase of social understanding on energy recovery is particularly important.
3. It is vital to involve Asian developing countries in discussion in future, as their influences on environment and resource consumption are rapidly growing and getting crucial.

Thank you for your attention

Plastic Waste Management Institute

Sumitomorokko Bldg.,1-4-1 Shinkawa,Chuo-ku,Tokyo

104-0033,Japan

Tel;81-3-3297-7511　Fax;81-3-3297-7501

Web site http://www.pwmi.or.jp