

Aiming to create a recycling-oriented society
Waste Plastic Oiling Technology & Business Summary

~ Road to the future ~

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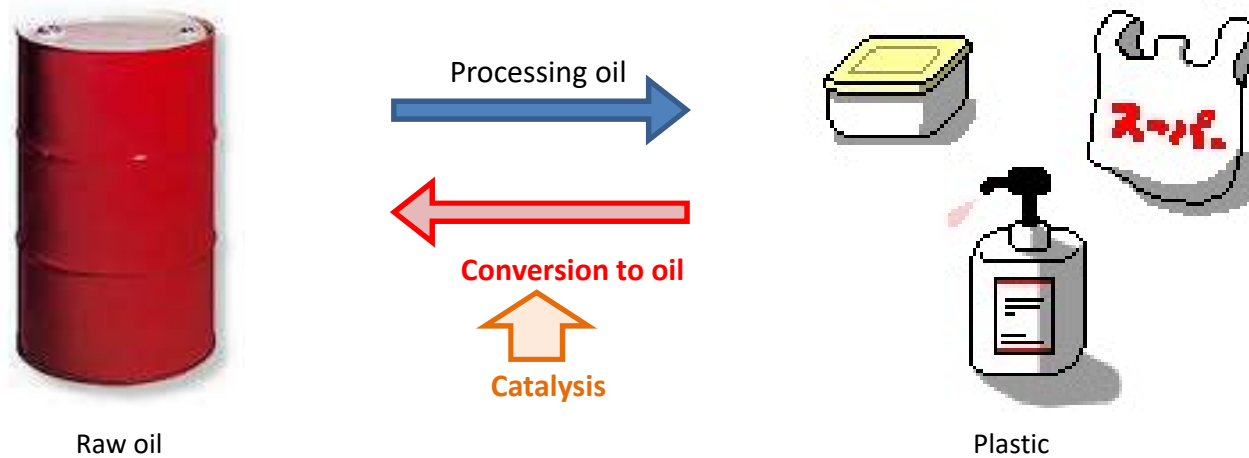
	Environment Energy CO.,LTD.
Trade name	(Head Office) 〒721-0952 Akebonocho, Fukuyama City, Hiroshima Prefecture 6-9-24
Location	TEL 084-920-2830 FAX 084-920-2855 (Tokyo Office) 〒136-0082 Shinkiba, Koto-ku, Tokyo 3-6-7 (Kitakyushu Research Institute) 〒808-0135 Fukuoka Prefecture Kitakyushu City Wakamatsu-ku Hibiki 1-8 Kitakyushu Science and Research Park Business Development Support Center Room 02
Establishment	May 2013
Capital	80 million yen
Business description	Waste plastic oiling business-Waste plastic oiling equipment (HiCOP method)- New biodiesel business-Biodiesel oil conversion equipment (HiBD method)- Environment-related plant business RE:OIL activities
Joint research	The University of Tokyo / Professor Emeritus, Kitakyushu City University Director, HiCOP / HiBD Research Institute Kaoru Fujimoto Kitakyushu City University Professor Kenji Asami Chubu University Professor Masao Yukimoto Nissan Motor Co., Ltd Aisin Seiki Co., Ltd.
Cooperation	Nissan Kogyo Co., Ltd. Jtec Holdings Inc. Enomoto Patent and Trademark Office

Turning waste plastic back to oil, the raw material

Plastic is made from petroleum.
Oiling is the process of returning the plastic to its original oil state.

Previously, pyrolysis was the mainstream, in which waste plastics were heated to become oil again, but now a new oiling technology using a catalyst (*) was developed.

We aim to use this new technology to recycle more advanced waste plastics and create a recycling-oriented society.



※ What is a **catalysis** : A substance that speeds up the reaction of certain chemicals. It refers to something that does not change before and after the reaction, even if consumed by the reaction, it regenerates at the completion of the reaction, and does not seem to change.

Technology to produce high quality hydrocarbon oils from waste plastics at low cost

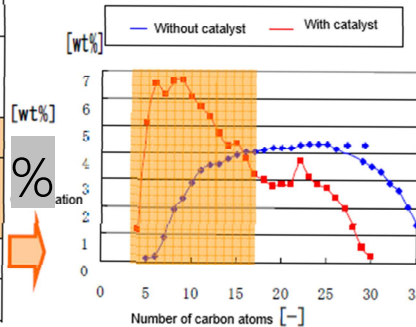
The HiCOP method is a technology that uses a catalyst to convert waste plastic into oil of high quality and at low cost. Compared to the conventional pyrolysis method that does not use a catalyst, the use of a catalyst results in better oil quality, and there is no coking problem in the furnace, so the maintenance and production costs can be significantly reduced.

- « Features »
1. The product oil is of high quality (high fluidity) due to processing with a catalyst.
 2. Since there is no coking inside the furnace, operating costs are greatly reduced.
 3. Since no pressure is required in the process, the safety of the plant is high.
 4. There is no problem even if there are some foreign substances such as deposits and metals.
 5. Use of a discarded catalyst results in the effective utilization of resources.

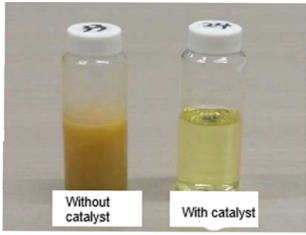


Example of material balance of generated oil

	PE		RPF
	Without catalyst (%)	With catalyst (%)	With catalyst (%)
Dry gas (C1~C2)	1.5	2.9	18
LPG (C3~C4)	2.3	5.2	
Naphtha (C5~C8)	2.7	21.5	36
Lamp oil (C9~C12)	13.1	20.8	28
Light oil (C13~C24)	37.8	36.6	
Heavy oil (C25~)	29.9	12.1	6
Residual products	12.6	0.9	12



Clean oil without wax

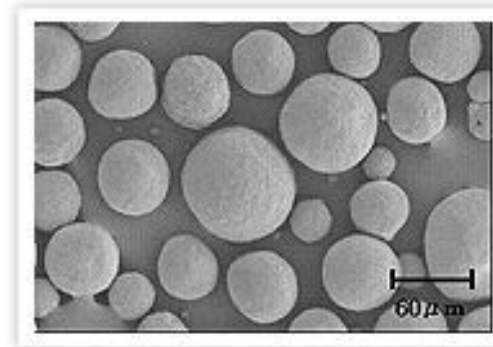


《What is HiCOP method》

It is a technology for producing high-quality hydrocarbon oils from waste plastic with the catalytic cracking method using the catalyst.

High-quality catalytic cracking
oil from plastics = HiCOP

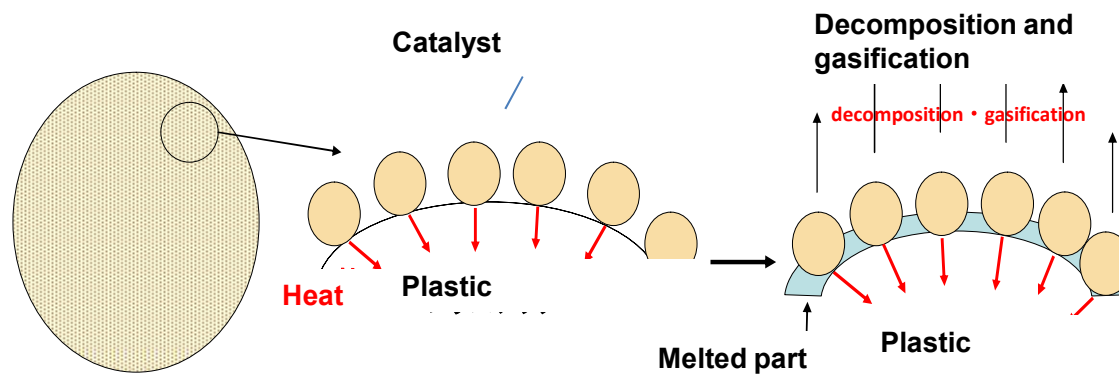
《What is the catalyst》



It is a spherical particle with a diameter of about 10 μm (1 μm is one hundred thousandth of a meter) to about 100 μm, and is composed of substances such as natural clay minerals.

《Reaction》

The waste plastic is put into the heated catalyst, the catalyst adheres evenly to the surface and becomes like Kinako mochi.



When the plastic comes into contact with the heated catalyst, the plastic melts and decomposes into hydrocarbon gas.

When this gas is cooled and condensed, it will be a good quality oil.

Inventor Kaoru Fujimoto

(Inventor) **Kaoru Fujimoto**

Professor Emeritus, The University of Tokyo
Professor Emeritus, Kitakyushu City University
Former Chairman of the Energy Society of Japan, Honorary Member
Japan DME Forum Chairman
Former Chairman of the Plastic Recycling Chemistry Study Group
Councilor, Japan Petroleum Institute
(Corporation) Director of HiCOP Research Laboratory, (Corporation) Director of HiBD Research Laboratory

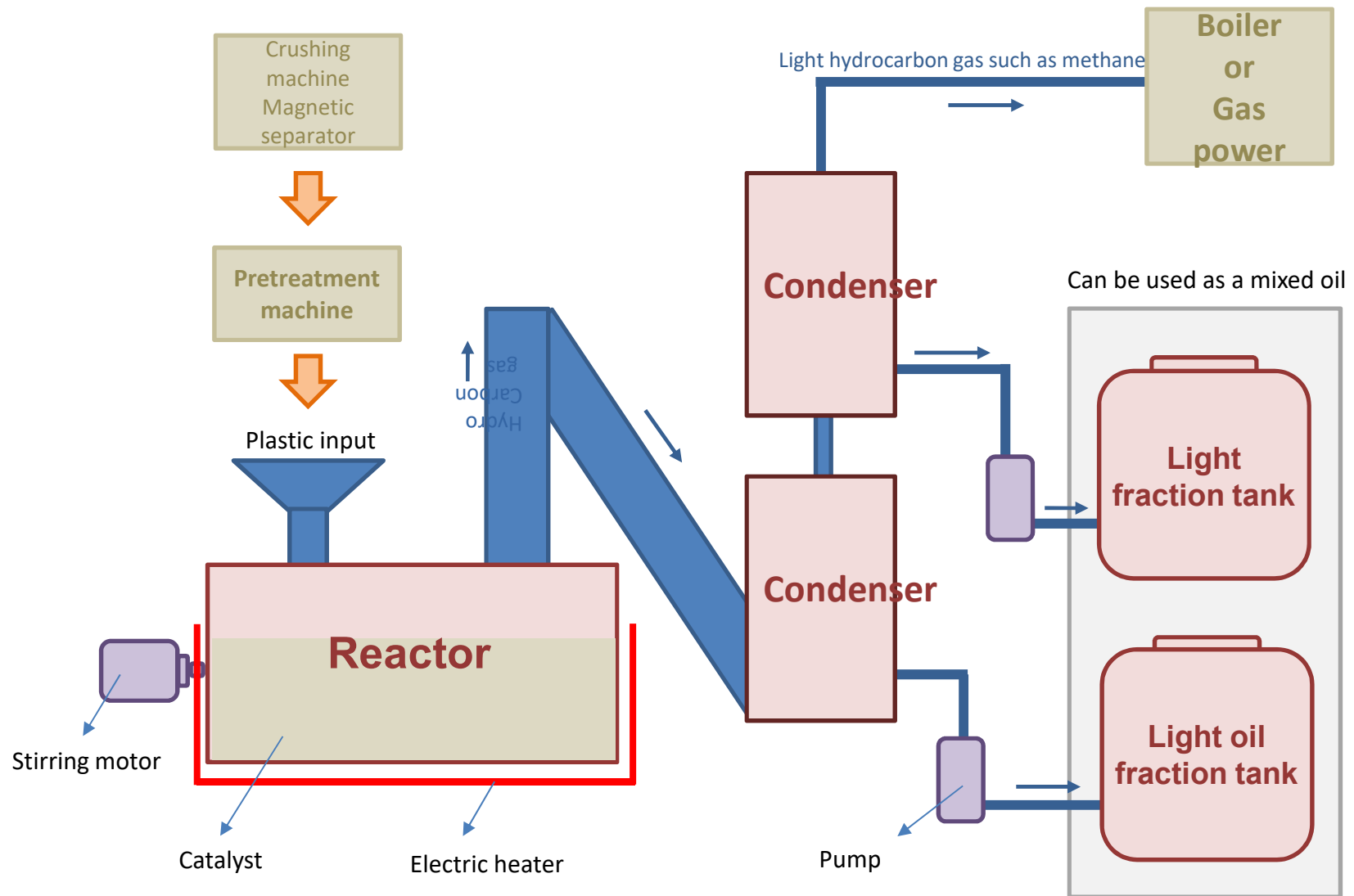


Professor Emeritus of the University of Tokyo and Kitakyushu, a specialist in energy science, process engineering, catalyst and resource chemistry processes.

His research achievements have been highly evaluated both in Japan and abroad, and he has received many awards. He is also a member of the Review Committee on various national projects, and is currently the director of the HiCOP and HiBD Research Institute.

Awards

- September 2010 Contribution Award, IDA (The International DME Association)
- June 2008 Technical Development Award, Research Association For Feedstock Recycling of Plastics Japan
“Development of a continuous catalytic cracking process for waste plastics using ECG catalyst”
- 2008 Technical Development Award, Research Association For Feedstock Recycling of Plastics Japan
- 2007 Contribution Award of 2006, The Japan Institute of Energy
- 2001 Visiting Professor, Tsinghua University, China
- 1999 Catalysis Society of Japan Award
- 1998 Honorary member of the Russian Academy of Sciences
- 1998 Japan Petroleum Institute Award
- 1998 Japan Institute of Energy Award



HiCOP

Comparison table between pyrolysis method (conventional technology) and HiCOP method (new technology)

Comparison table of the conventional cracking technology, the thermal cracking method, and the HiCOP method. The HiCOP method, which can solve many of the problems faced by the pyrolysis method, greatly expands the potential of the waste plastic oil business.

	Conventional technology	HiCOP method
Method	Thermal decomposition	Catalytic cracking
Catalyst	No	Yes
Applicable plastic	Mainly PP, PS, unsuitable for PVC and PET	3P mix (PP,PS,PE) Some PVC and PET can be mixed
Processing method	Mainly batch type	Continuous type
Product oil yield	~ 70%	~ 80%
Refined oil main component	Heavy Quality oil (Light oil, Heavy oil)	Naphtha, kerosene, light oil
Generated oil quality	Low (more WAX, lower fluidity)	High (less WAX, high fluidity)
Residual chlorine	Several 100ppm (without desalination)	100 ppm or less
Safety	Concerns of sudden pressure rise and gas ejection (Simple batch type)	No sudden gas generation due to continuous charging Gas pressure is stable
Equipment stability (maintenance)	Degradation of processing capacity due to coking, Pipes are easily blocked, Requires frequent maintenance	There is no coking in the furnace, Dramatically reduced maintenance costs Less pipe clogging and corrosion problems

Oil generated from waste plastic

Oil produced by a project funded by the Ministry of the Environment.
Light fractions and light oil fractions can be separated according to the cooling temperature.

Light oil fraction



Light fraction



Business summary

Item	Cost
Primary sorting of waste plastic Waste plastic oil conversion business	Annual throughput: 1,200t

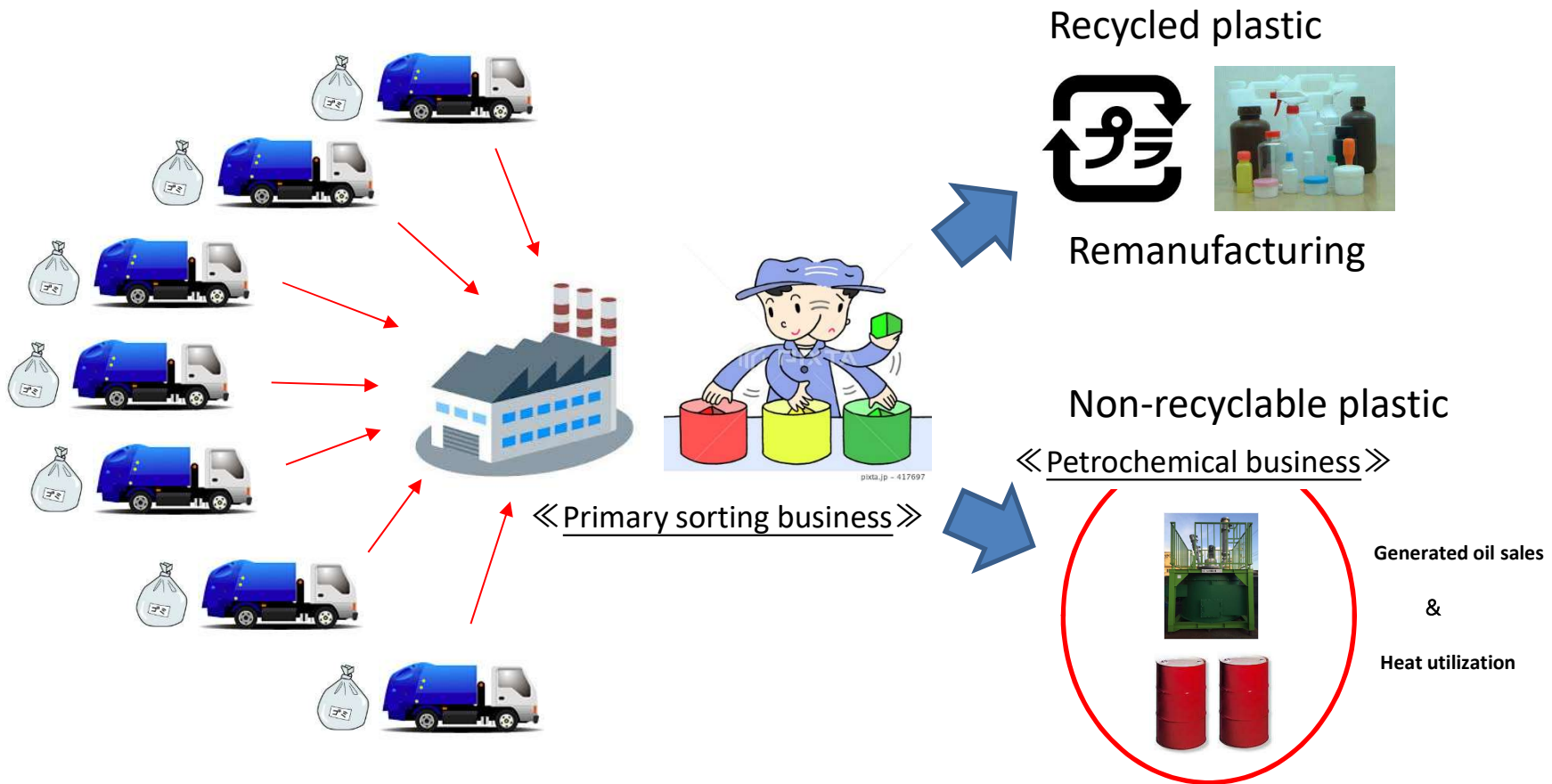
Company Profile

Name	YK Clean (Yanagawa Shoji Ltd., Kamishigen Co., Ltd., Environmental Energy Co., Ltd.)
Location	2734-2 Yokomizo, Oki-machi, Mizuma-gun, Fukuoka
Type of industry	Waste treatment industry
Capital stock	10 million yen
Establishment	June 30, 2016
Employers	3 full-time employees, 8 part-time employees

Waste plastic primary sorting & oiling business

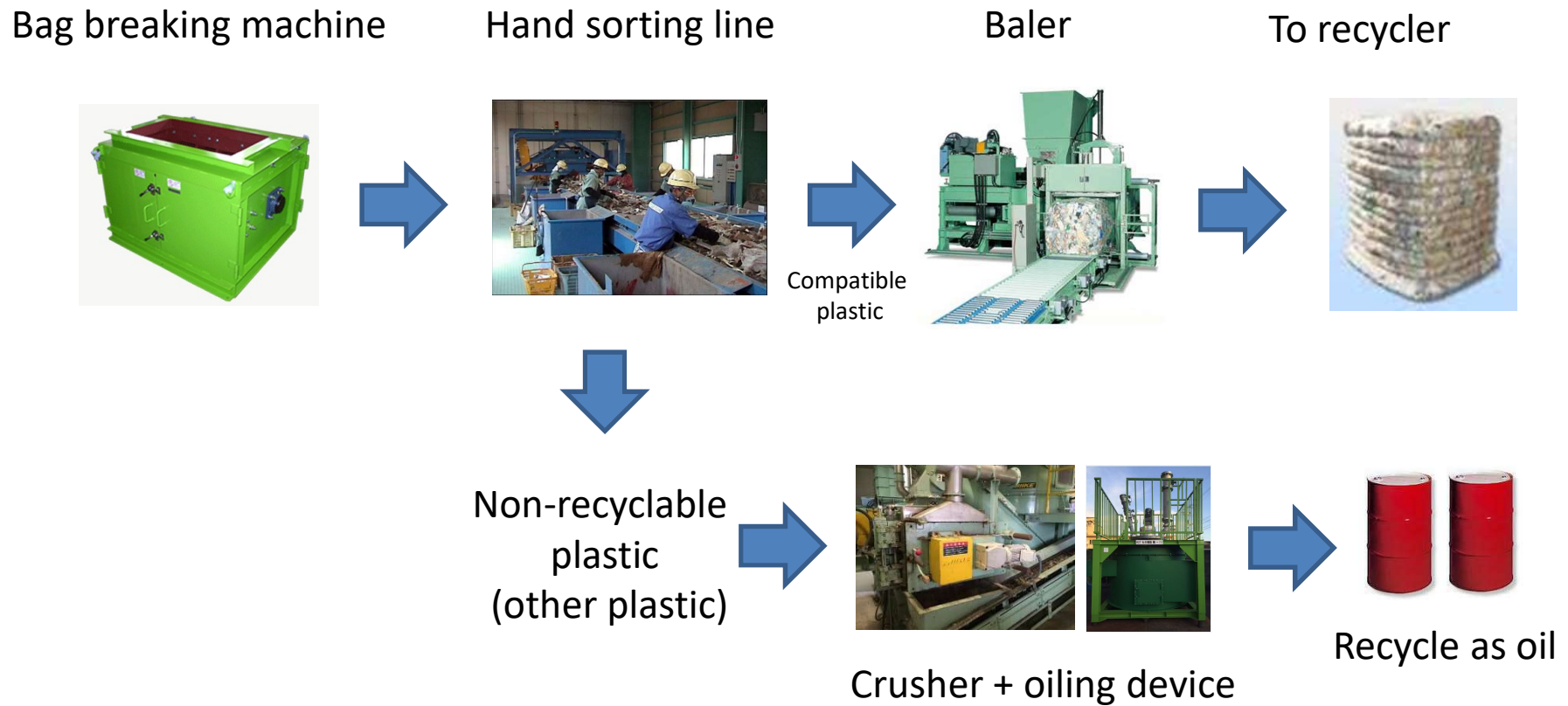


Chikugo 7 municipalities (Oki-machi, Yanagawa-shi, Miyama-shi, Chikugo-shi, Okawa-shi, Hirokawa-cho, Yame-shi) conduct business to jointly enhance the recycling of waste plastic

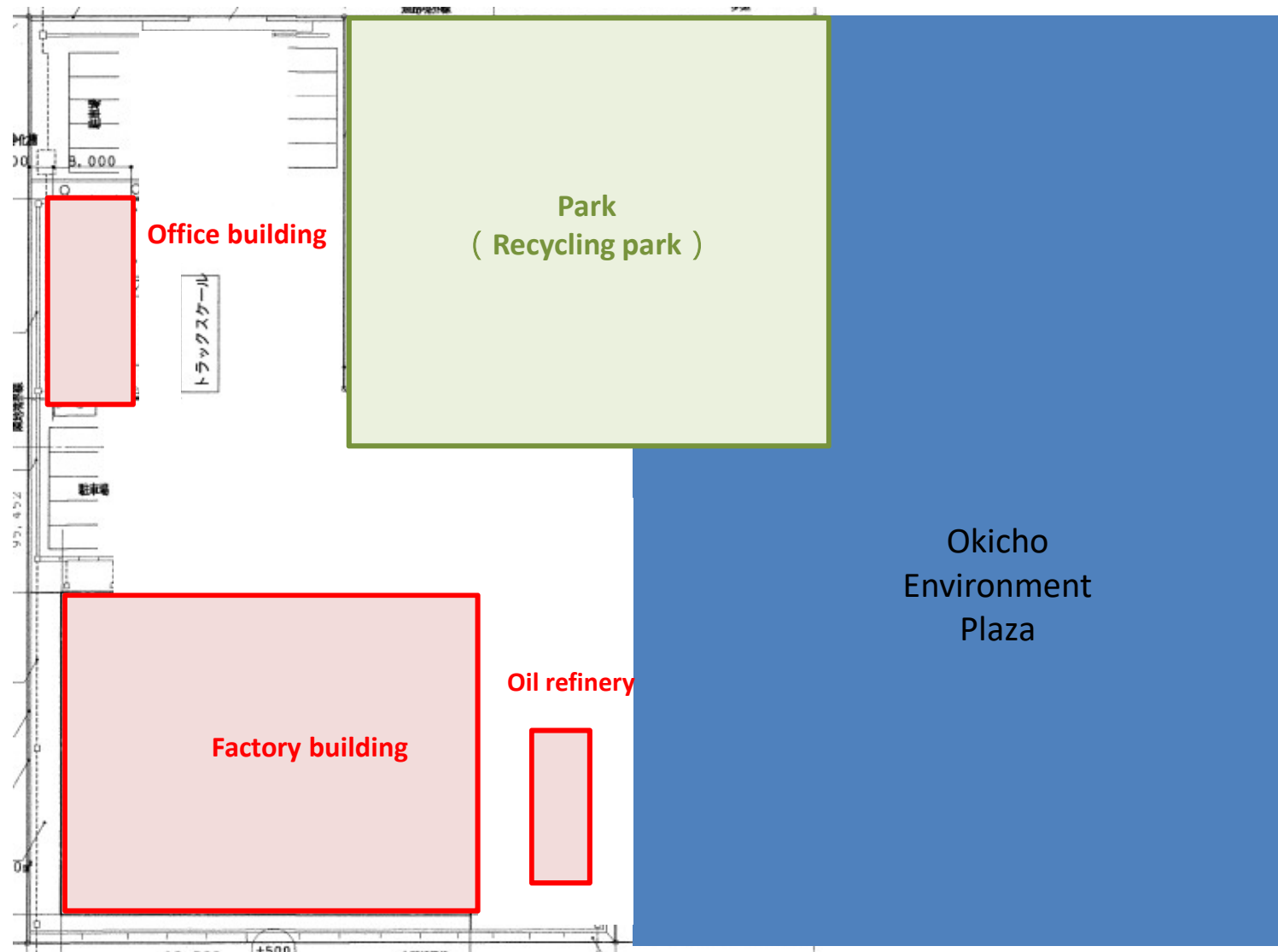


Business flow chart

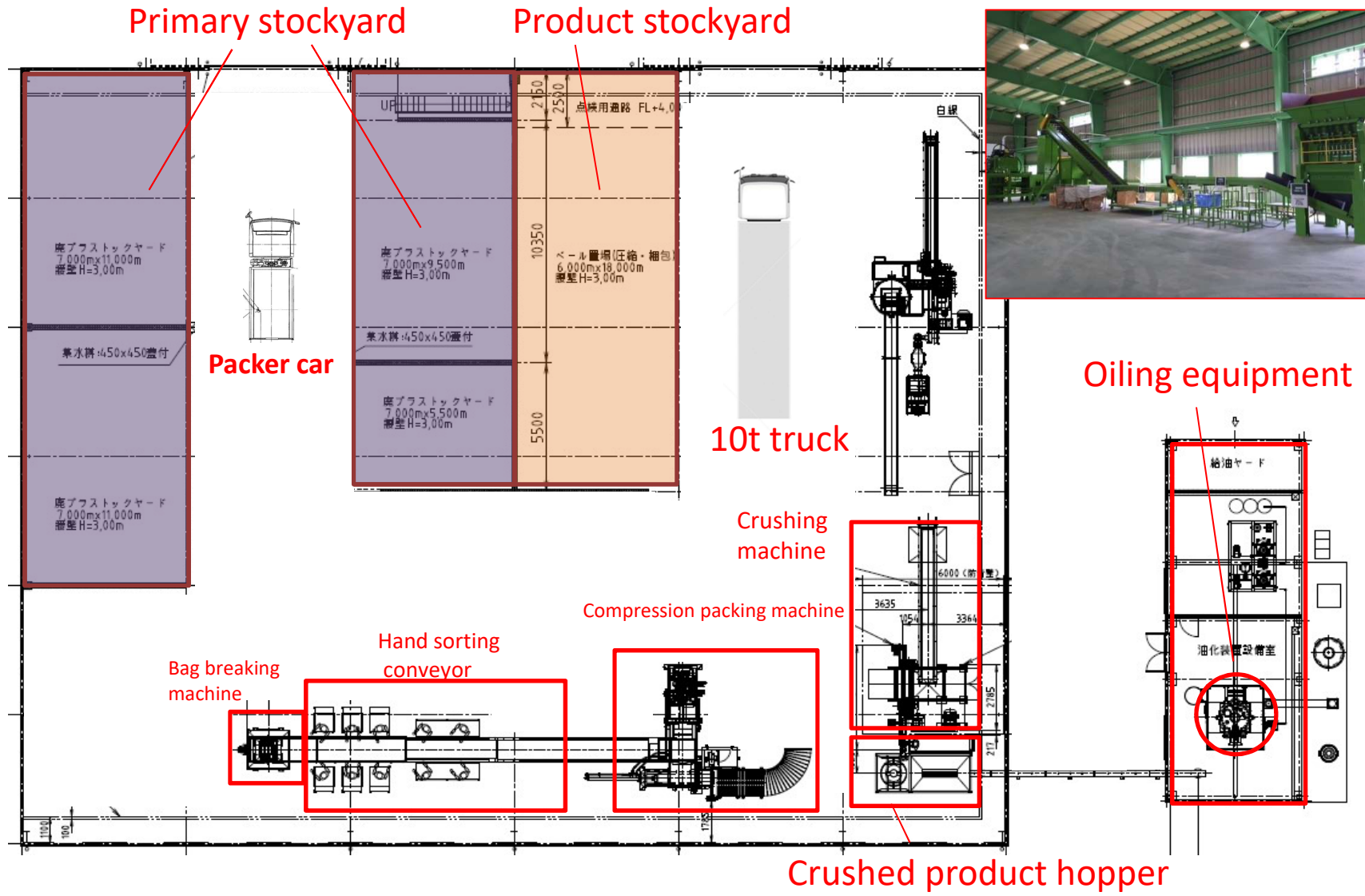
Waste plastic collected from each municipality is assembled into the following lines and recyclable plastic is packaged in the form of pressed piles for recyclers (recycling companies).



Scheme of business buildings



Factory building details



Types of recyclable waste plastic

《Plastic containers and packaging》



Packages



Packs



Bottles



Styrene foam



Other waste



《Other waste plastic products = Suitable for oiling》

Boxes



Packagings



Containers



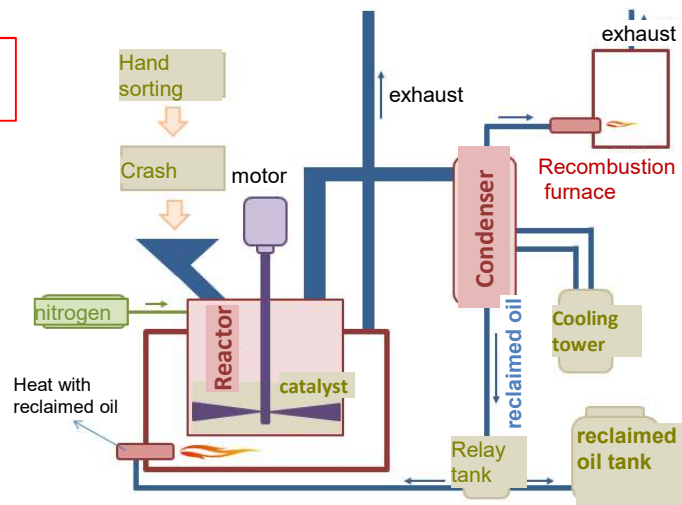
Other waste plastic

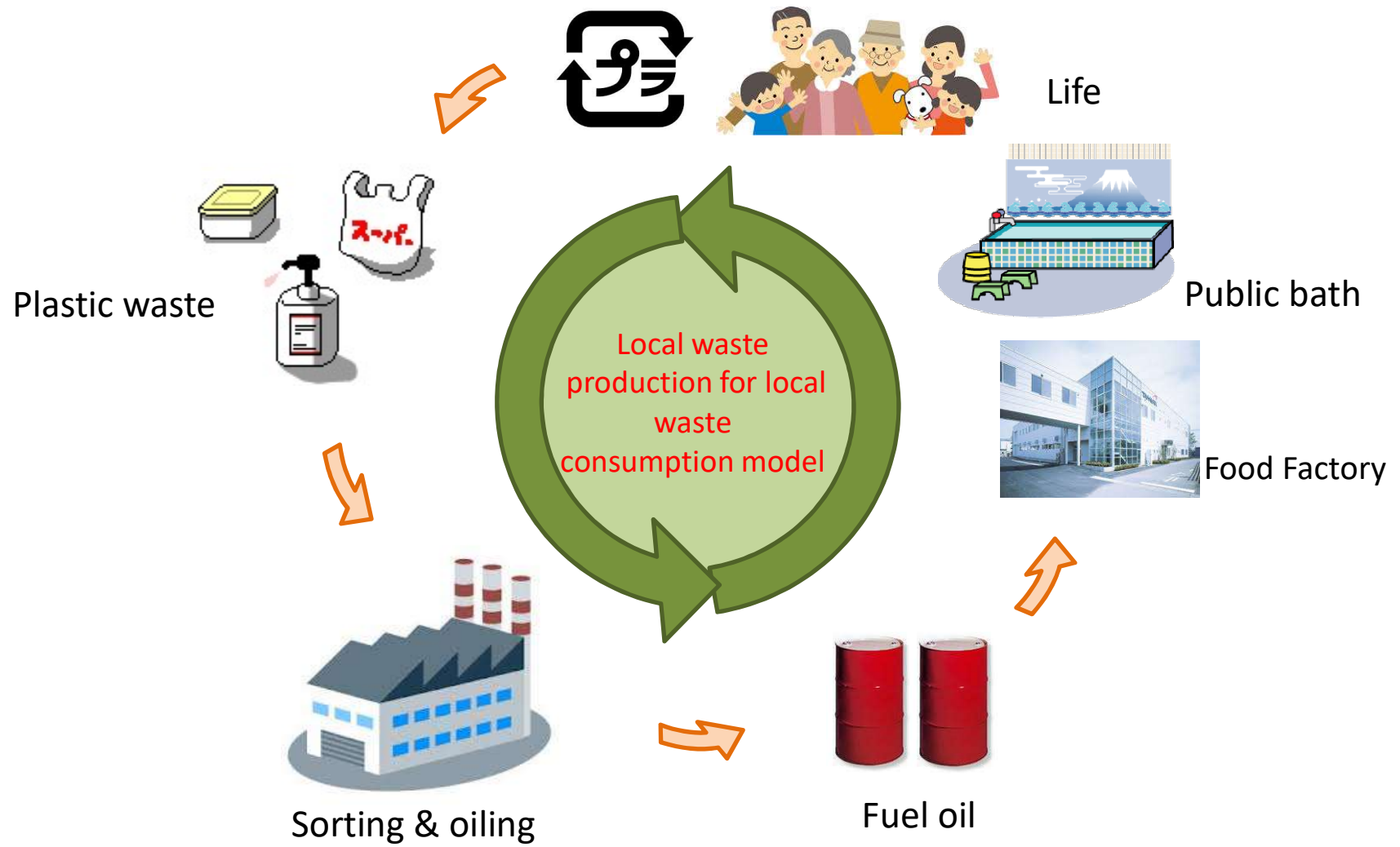


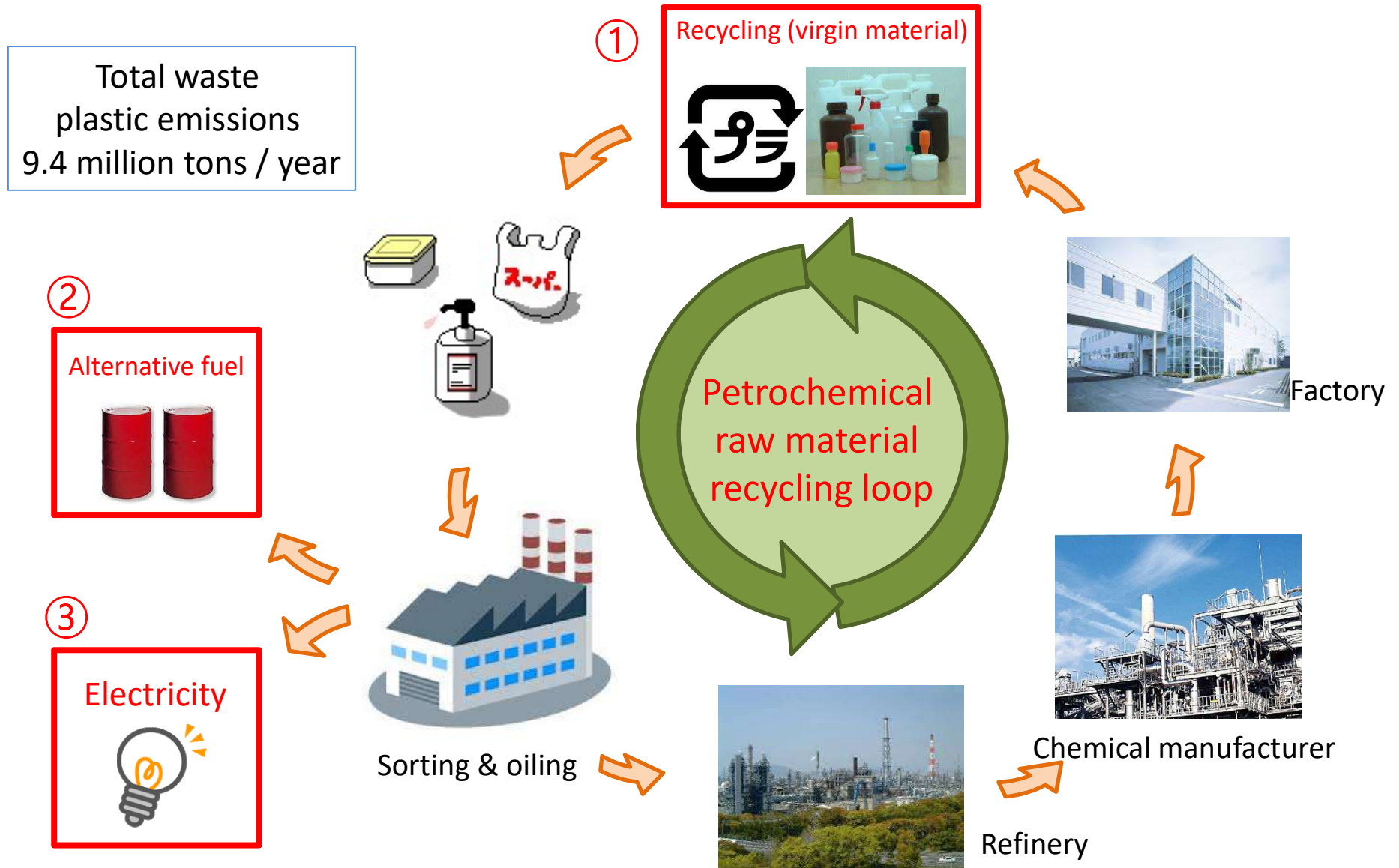
Petrochemical plant (B-100)



Maximum processing capacity 100kg/h









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Contribute to people's happiness
through working in the environment
and energy fields