The future drawn by chemical recycling that makes oil from waste plastic

Future image of waste plastic oil conversion system

- ●Company Name - Environmental Energy Co., Ltd.
- ●CEO - Shuji Noda
- ●Founded - May,2013
- ●Capital - JPY 350Million
- ●Number of employee - 30 (May, 2023)
- ●Major business

◆ Development of waste plastic oiling technology
◆ Development of bio-naphtha / bio-diesel / bio-jet fuel manufacturing technology
◆ Development of environment-related equipment
* Design, manufacture, and installation

Location

Head Quarter and Plant

6-9-24 Akebono-cho, Fukuyama-city, Hiroshima-Pref ,
721-0952 Japan

Tokyo Office

3-6-7 Shinkiba, Koto-ku, Tokyo, 136-0082 Japan

Kita-Kyushu Lab,

Room 501, 1-8 Hibikino, Wakamatsu-ku, Kitakyushu-city,
Fukuoka-pref, 808-0135 Japan

History

2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023





More than 10 years
Waste Plastic Oil
Conversion
Technology
development

Selected as a national project for the 7th consecutive year




Bio-jet Fuel
Production
Technology
development

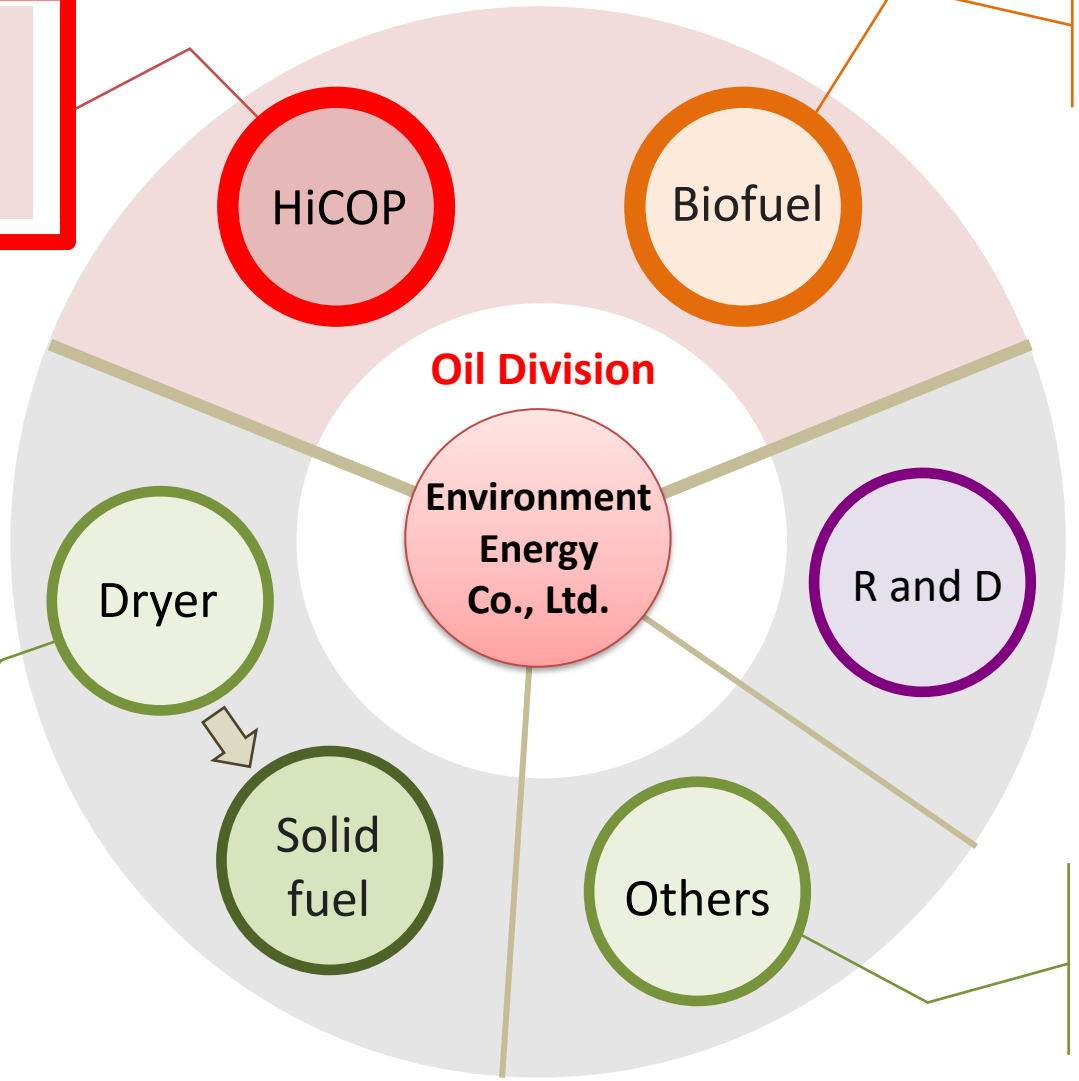







Manufacture and sale
of environmental
equipment

Waste plastic oiling equipment (HiCOP)



Bio-jet fuel / Bio-Diesel Bio-Naphtha

Airflow dryer

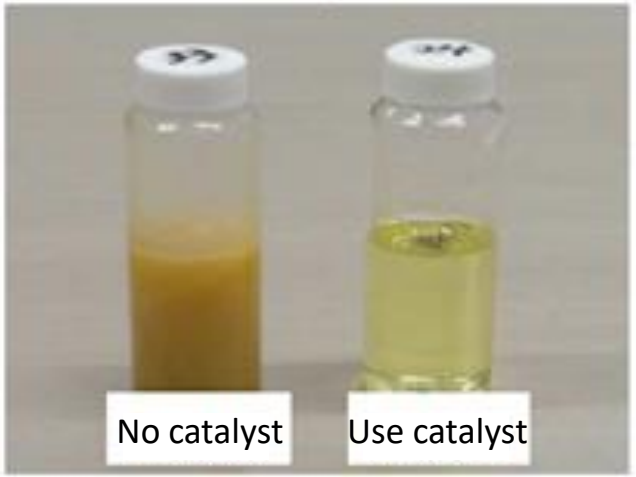
Chip dryer
Oil mist collector

How to make oil from waste plastic ?

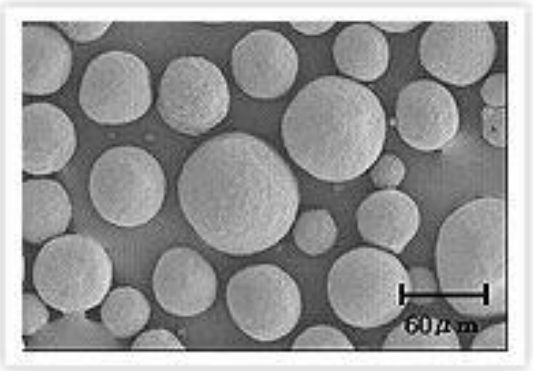
Waste plastic

Catalytic Pyrolysis

Oil



High quality oil can be produced at low cost



Use Catalyst

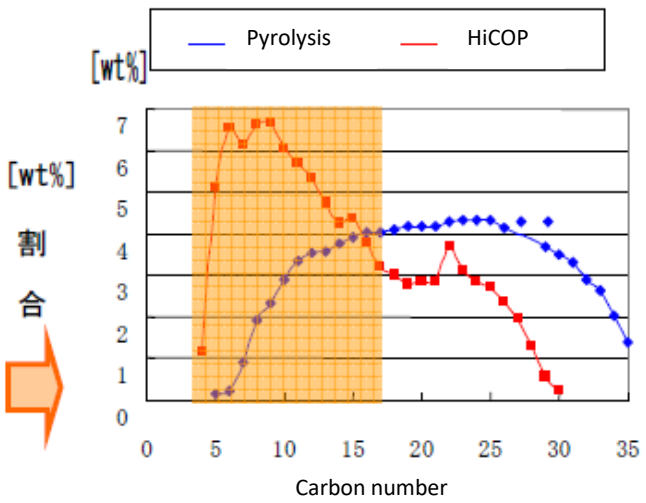
Technical strengths not found in other companies

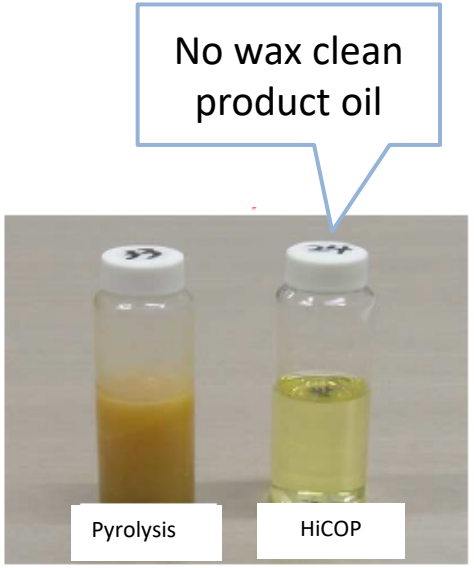
HiCOP System = (High quality Catalytic cracking Oil from Plastics)

- Allows continuous operation for a long time.
- Mixed Plastics (Polyethylene, Polypropylene and Polystyrene) can be applicable.
- It is possible to remove chlorine in waste plastic during operation.

Examples of the material balance of the product oil

	PE		RPF
	Pyrolysis	HiCOP	HiCOP
GAS (C1-C2)	1.5	2.9	18
LPG (C3-C4)	2.3	5.2	
Naphtha (C5-C8)	2.7	21.5	36
Kerosene (C9-C12)	13.1	20.8	28
Light oil (C13-C24)	37.8	36.6	
Heavy oil (C25-)	29.9	12.1	6
Residue	12.6	0.9	12





Inventor : Ph.D. Kaoru FUJIMOTO

The inventor, Kaoru Fujimoto, is a professor emeritus of the University of Tokyo and the University of Kitakyushu, and a specialist in energy science, process engineering and catalytic and resources chemical process.
His research achievements have been highly recognized both domestically and internationally. He has been appointed as various committee members and awarded various prizes. He is now a member of the project of Kyoto city for practical use of “bio gas oil(diesel)”.

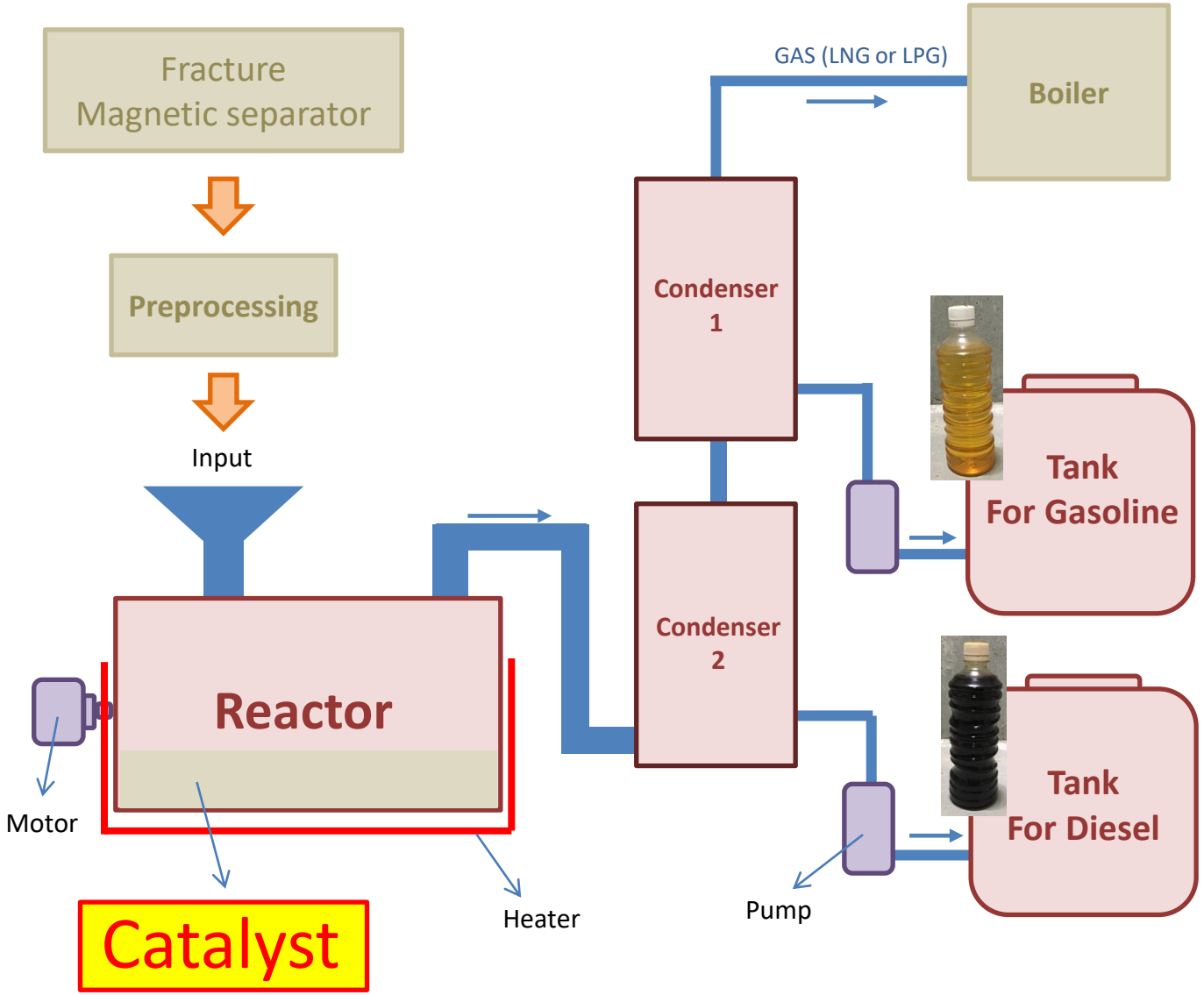
Kaoru FUJIMOTO

Professor emeritus of the University of Tokyo
Professor emeritus of the University of Kitakyushu
Former chairman and honorary member of the Japan Institute of Energy
Chairman of Japan DME Forum
Former chairman of Research Association for Feedstock Recycling of Plastics Japan
Councilor of the Japan Petroleum Institute
Director of HiCOP Laboratory Association and HiBD Laboratory Association

Awards

2010, Sep. IDA (The International DME Association) Award for Contribution
2008, Jun. Research Association for Feedstock Recycling of Plastics Japan, Advanced Technology Prize
“Continuous catalytic cracking process for waste plastics using waste FCC catalyst”
2008 Research Association for Feedstock Recycling of Plastics Japan, Advanced Technology Prize
2007 The Japan Institute of Energy Award for Distinguished Paper for 2006
2001 Guest professor at Tsinghua University, China
1999 Catalysis Society of Japan Award
1998 Honorary member of Russian Academy of Science
1998 The Japan Petroleum Institute Award
1998 The Japan Institute of Energy Award

Reference document : Flow outline diagram and our plant series



our plant series

Max: : 200kg/h

Max: : 100kg/h

Max: : 50kg/h

Max: : 100kg/h

Currently developing a large 1.2t/h device

Products / Distillation temperature

Temperature Number of carbon	Distillation temperature Distribution	Yield	
35℃ (C_1 - C_4)	COGAS Fraction (LP Gas)	GAS	About 10 - 15wt%
35℃ - 180℃ (C_5 - C_{10})	NAPHTHA Fraction (Automobile・Low material)	NAPHTHA	About 35 - 40wt%
170℃ - 300℃ (C_{10} - C_{15})	KEROSENE Fraction (Kerosene・Jet Fuel)	DIESEL	About 35 - 40wt%
200℃ - 350℃ (C_{15} - C_{20})	DIESEL OIL Fraction (Light Oil)		
over 350℃ (over C_{20})	Residual Oil Fraction (Heavy oil・Asphalt)	HEAVY OIL	0wt%
		CARBIDE	About 2 - 5wt%

A waste plastic is solid crude oil.

Overall image

Waste Plastic

1000kg

Oil production device

*Reference photograph

Gas & Carbide

About 200kg

Naphtha equivalency product

About 530L (400kg)

(specific gravity : 0.75)

Diesel equivalency product

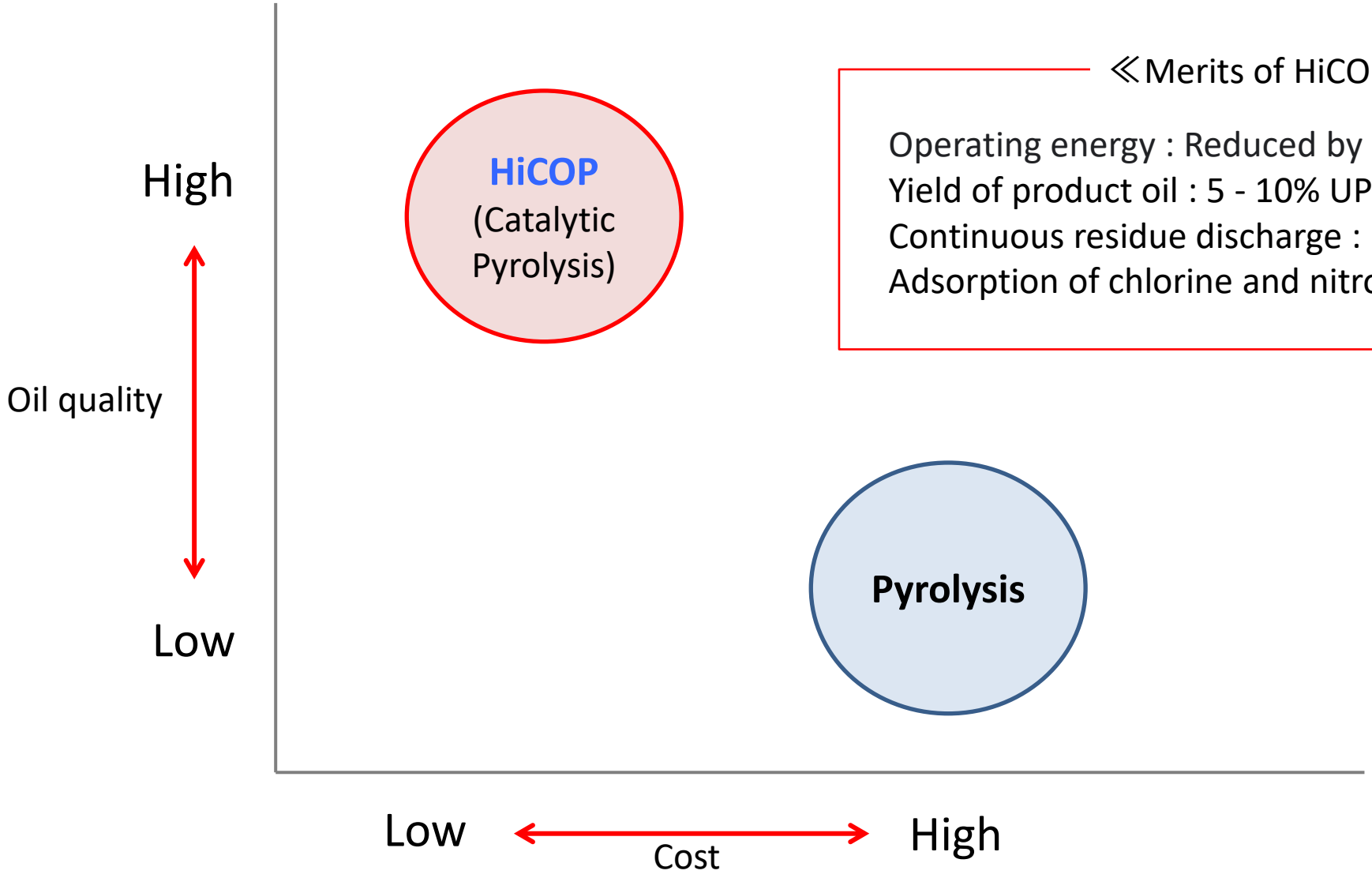
About 480L (400kg)

(specific gravity : 0.83)

Comparison table

	Catalytic Pyrolysis	Pyrolysis	Gasification	Monomerization
Catalytic	Use	No use	Use	Use
Temperature	420℃	450 - 500℃	1300 - 1500℃	200 - 500℃
Pressure	Normal pressure	Normal pressure	High pressure	High pressure
Processing method	Continuous	Mainly batch/Continuous	Continuous	Continuous
Yield	Max 90wt%	Max 80wt%	Not suitable	Not suitable
Product	Naphtha, kerosene, diesel	Mainly diesel and heavy oil	CO,CO2,H2,NH3	Monomer(PS,PET,PMMA)
Oil quality	High(Low wax)	Low(High wax)	-	-
Dechlorination	Prospective	Difficult	-	-
Continuous residue discharge	Possible	Difficult	-	Difficult
Operation	Stable pressure	Unstable pressure	-	-
Maintainability	Less trouble	More trouble	-	-

Merits of HiCOP



≪Merits of HiCOP≫

Operating energy : Reduced by 10 – 15%
Yield of product oil : 5 - 10% UP
Continuous residue discharge : Possible
Adsorption of chlorine and nitrogen : possible

Waste plastic recycling rate in Japan (2020)

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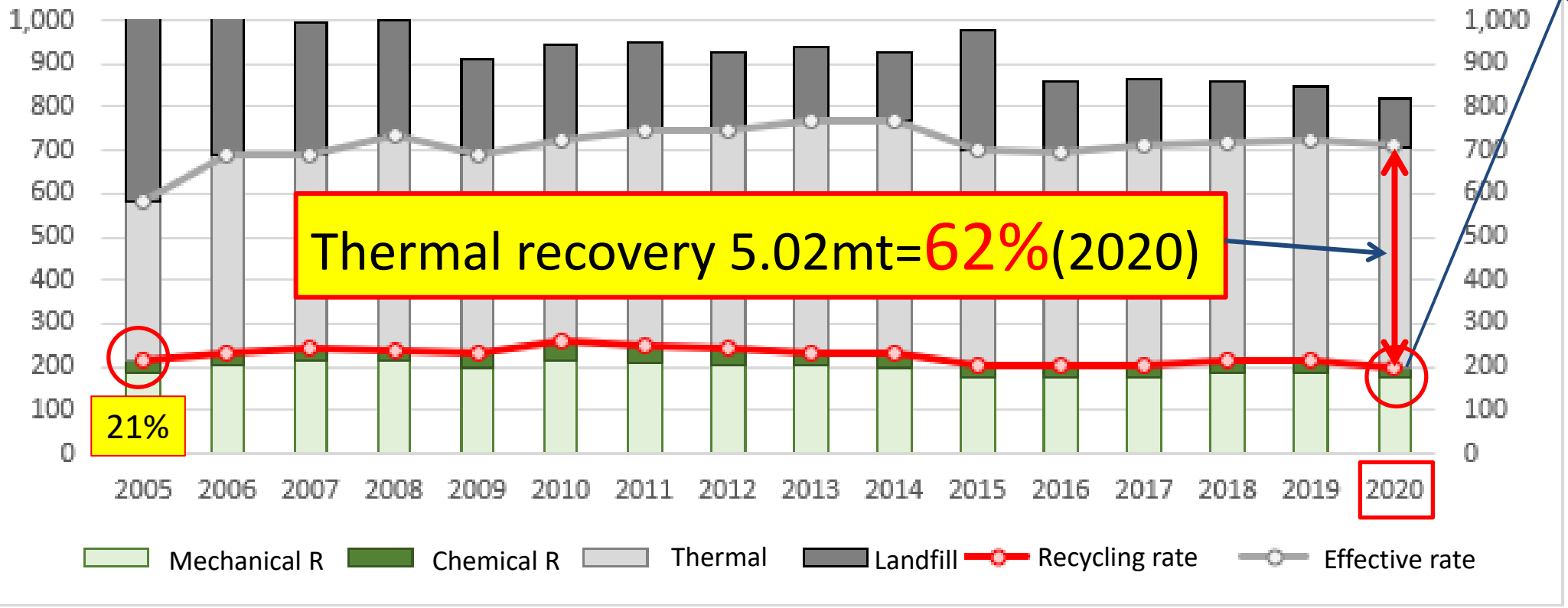
More than half of waste plastic is incinerated in Japan

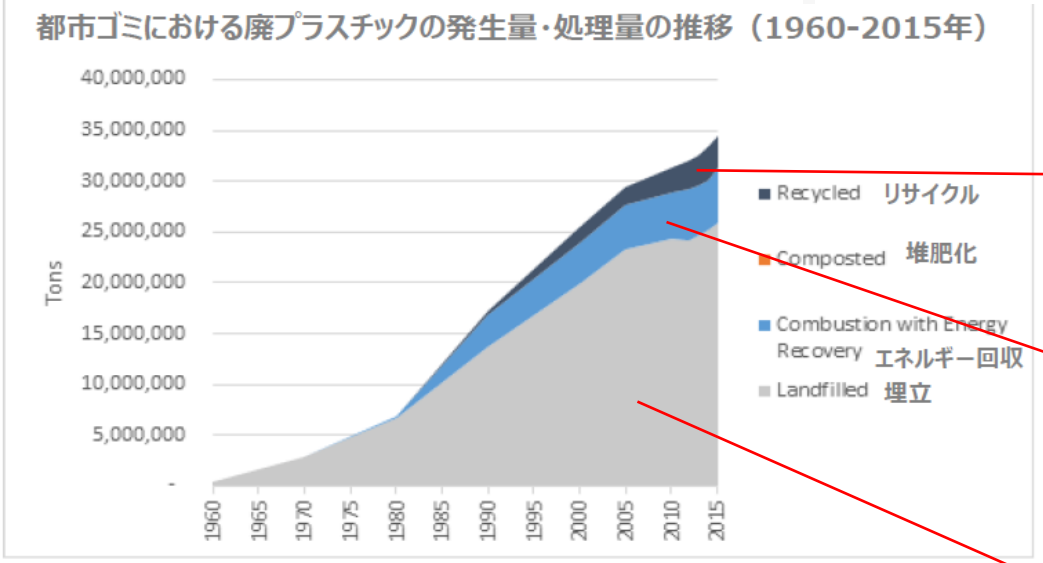


Recycling rate*
24%

*Mechanical R + Chemical R

Waste plastic recycling rate in the United States (2015)

Plastics Smart



Recycling rate = 9%(2015)

Thermal recovery = 16%(2015)

Landfill = 75%(2015)

（単位：1000ﾄﾝ）

Management Pathway	1960	1970	1980	1990	2000	2005	2010	2014	2015	
Generation	390	2,900	6,830	17,130	25,550	29,380	31,400	33,390	34,500	
Recycled	-	-	20	370	1,480	1,780	2,500	3,190	3,140	⇒（9%）
Composted	-	-	-	-	-	-	-	-	-	
Combustion with Energy Recovery	-	-	140	2,980	4,120	4,330	4,530	5,010	5,350	⇒（16%）
Landfilled	390	2,900	6,670	13,780	19,950	23,270	24,370	25,190	26,010	⇒（75%）

（三菱総合研究所作成）

出所） EPA https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/plastics-material-specific-data （閲覧日：2018年9月6日）

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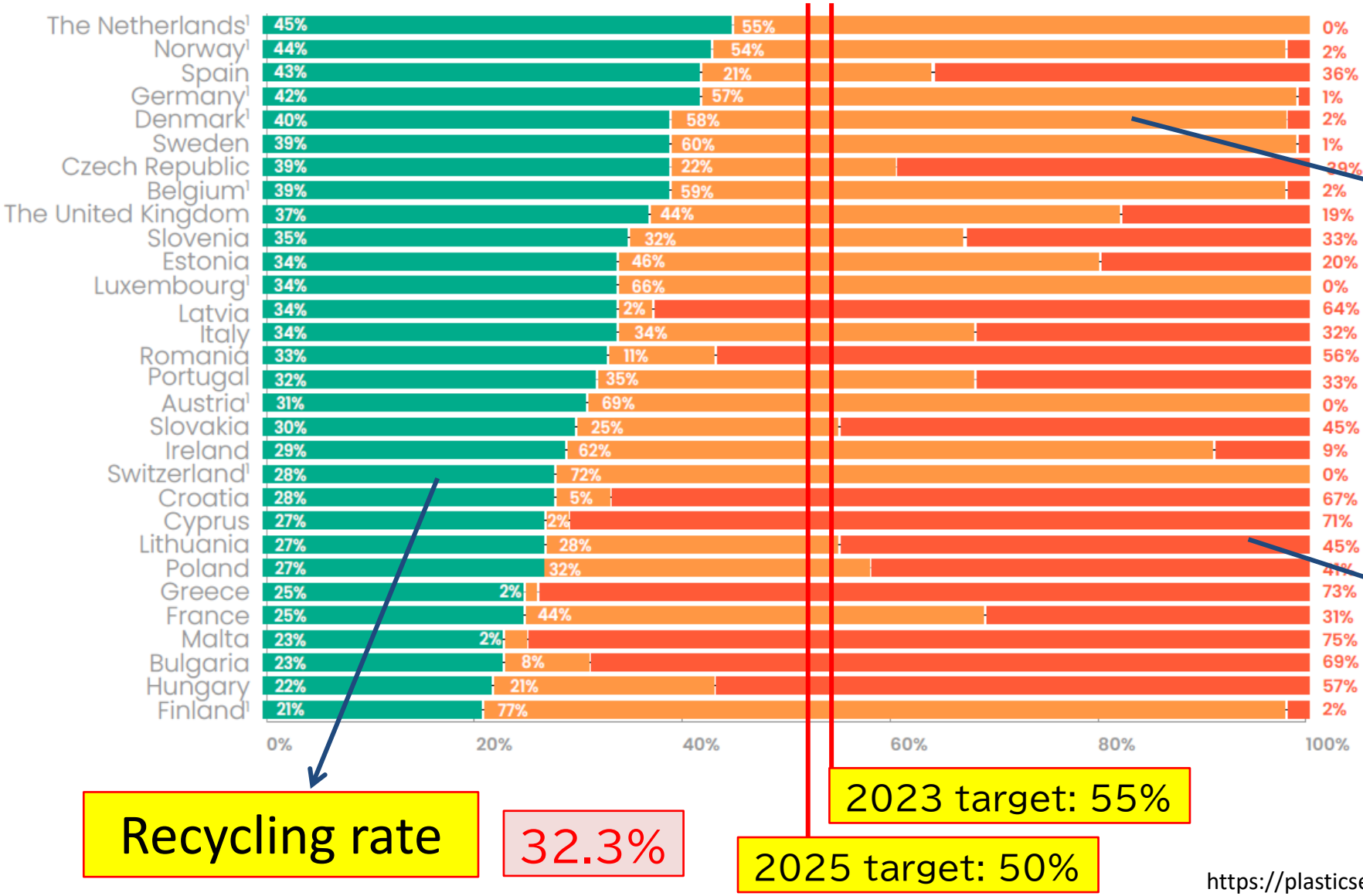
Waste plastic recycling rate in Europe (2022)



Thermal recovery

36.8%

Landfill

30.8%

Recycling rate

32.3%

2023 target: 55%

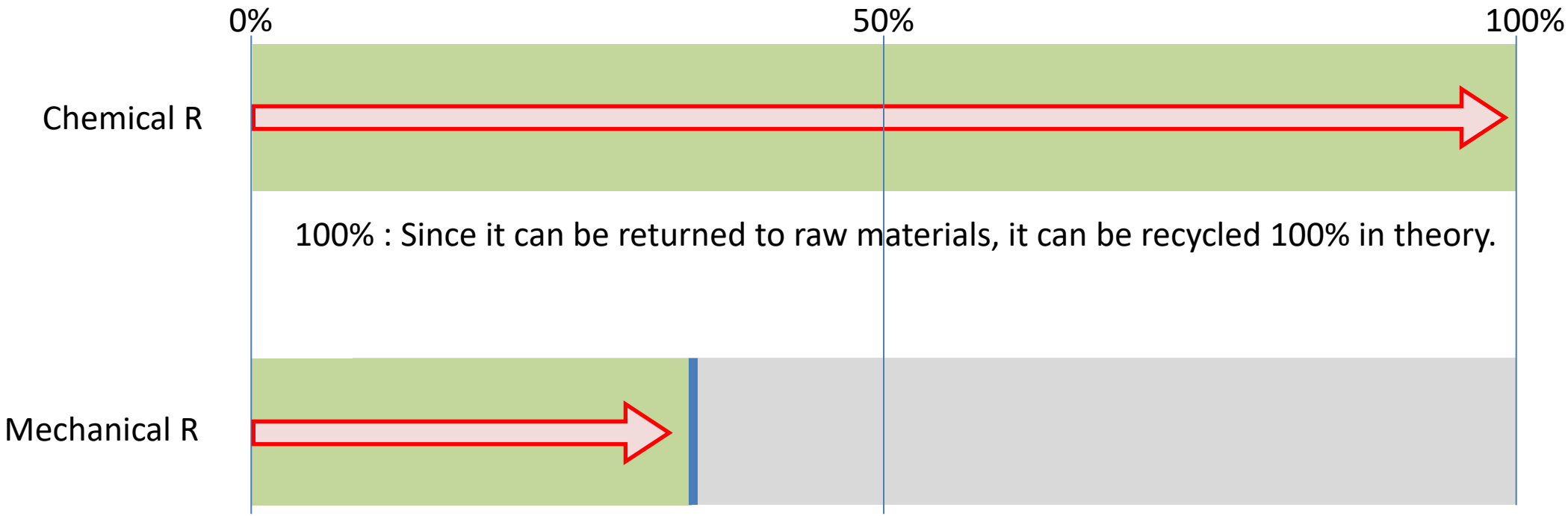
2025 target: 50%

PLASTICS EUROPE
Enabling a sustainable future

https://plasticseurope.org/knowledge-hub/plastics-the-facts-2022/

Hope of chemical recycling

	Chemical R	Mechanical R
Recyclable rate	**100%**	30-40%



100% : Since it can be returned to raw materials, it can be recycled 100% in theory.

30 - 40% : Limited markets available due to color, odor, strength and hygiene issues

- Possibilities and Social Significance of Chemical Recycling

- The Global Problem of Waste Plastic
- The World's Wealth Disparity Problem

Chemical recycling can solve both problems simultaneously and permanently

e-plastic certification model where resources and money circulate

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Public Benefit Activities Fund

Marine waste plastic

Developing countries Landfill

Child labor ban

Employment support

Resource and money circulation model

（International redistribution of wealth）

consumer

Traceability

REDcert

ISCC

ISO ＋ e-plastic certification

Chemical recycling loop

Sorting & oiling

ISO certification

Petroleum Refining / Petrochemistry

For overseas support

For recycling costs

Resin/Molding

Brand owner

Carbon Neutral Products

Added value to the environment

e-Plastic certification organization

International certification & Mass balance method

Product certification

Platinum
Three Stars

Gold
Three Stars

Silver
Three Stars

Bronze
Three Stars

Reduction of CO2 emissions in waste plastic chemical recycling

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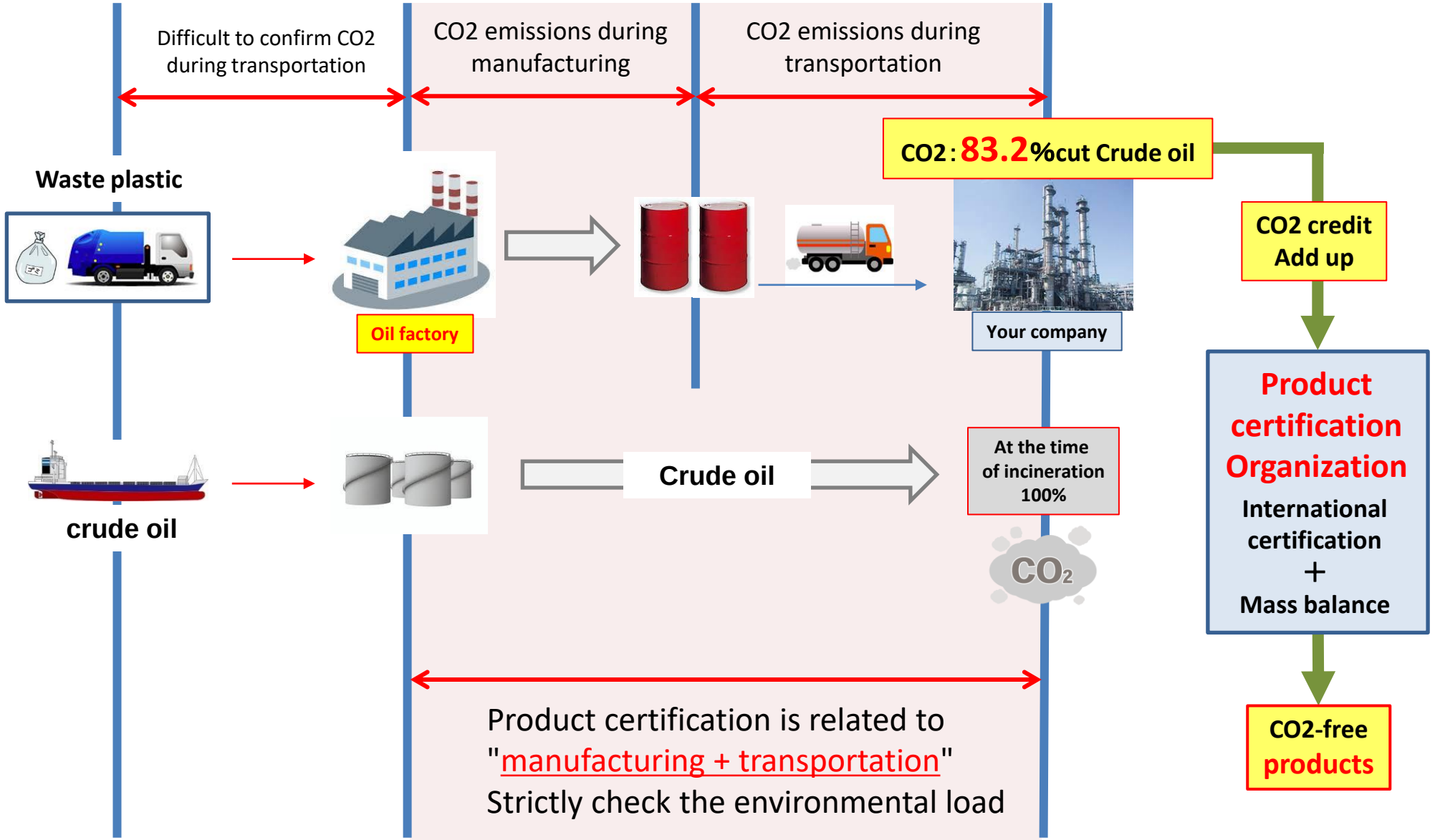


Example of how to calculate CO2 reduction

Recycled carbon

e-plastic = Reduced use of new fossil fuels

■ In the case of chemical recycling by an oil refinery company

Amount of recycled oil × Crude oil CO2 (2.619kg-CO2/Crude oil *L) − CO2 during oil production + transportation

* Energy origin

= 1kg × 2.24 kg-CO2 − 0.441kg-CO2

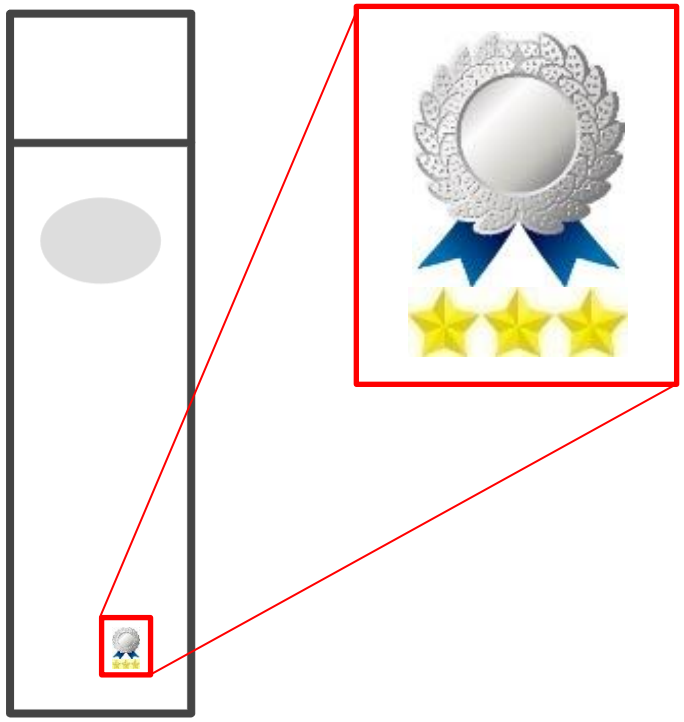
* Electric power required for production & transportation: 1kw / crude oil L

* In Tokyo 0.441kg-CO_2/kWh

= 2.178 kg-CO2/L = 2.178 / 2.619 = 83.2% CO2 reduction crude oil

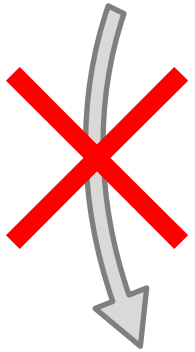
* CO2 reduction effect when 1 kg of crude oil is recycled from waste plastic

Aiming for a simple and clear certification system



Products that contribute to
the environment
= Naturally high price

Cheap
products



Environmental
Contribution

High-end
products

Correcting the disparity

The world's plastic waste problem

Purpose = My dreams = Public interest capitalism

Conventional capitalism

Investor

Investment

Dividend

Make an oil company

Public interest capitalism

Investor

Investment

Dividend

Make an oil company

* Dividend below bank rate

Educational support

Environmental protection

Through the field of environment and energy technology,
We make contributions to the solutions in promotion of
the happiness of mankind.

～ The road to Recycling Society ～