Initiatives to Achieve Carbon Neutrality in the Waste Management Sector in Japan

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- Current Status of Solid Waste
- Toward Carbon Neutrality in Waste Sector
- Future Scenarios and Estimation
- Plastic Waste Recycling
- Challenges of WtE with CCU
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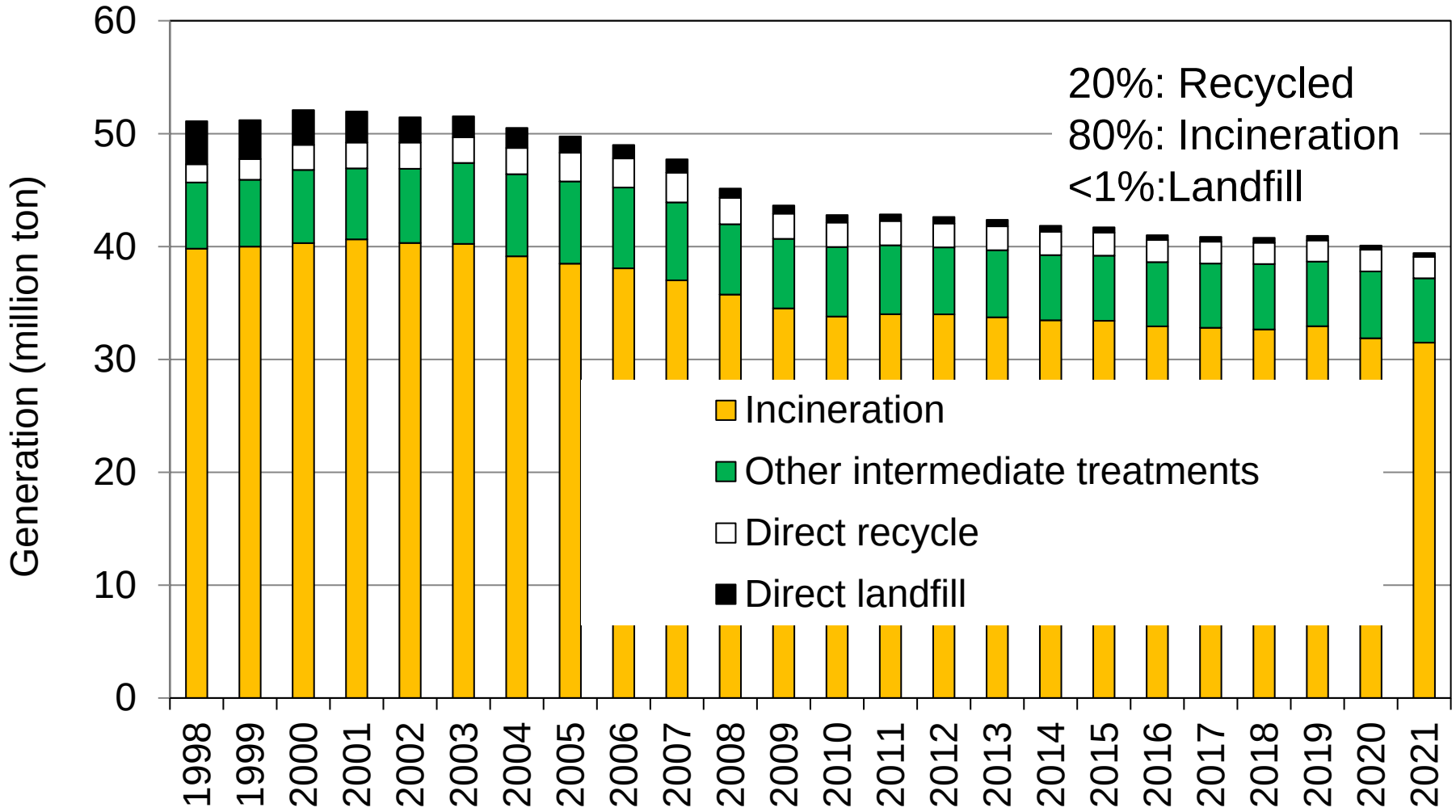
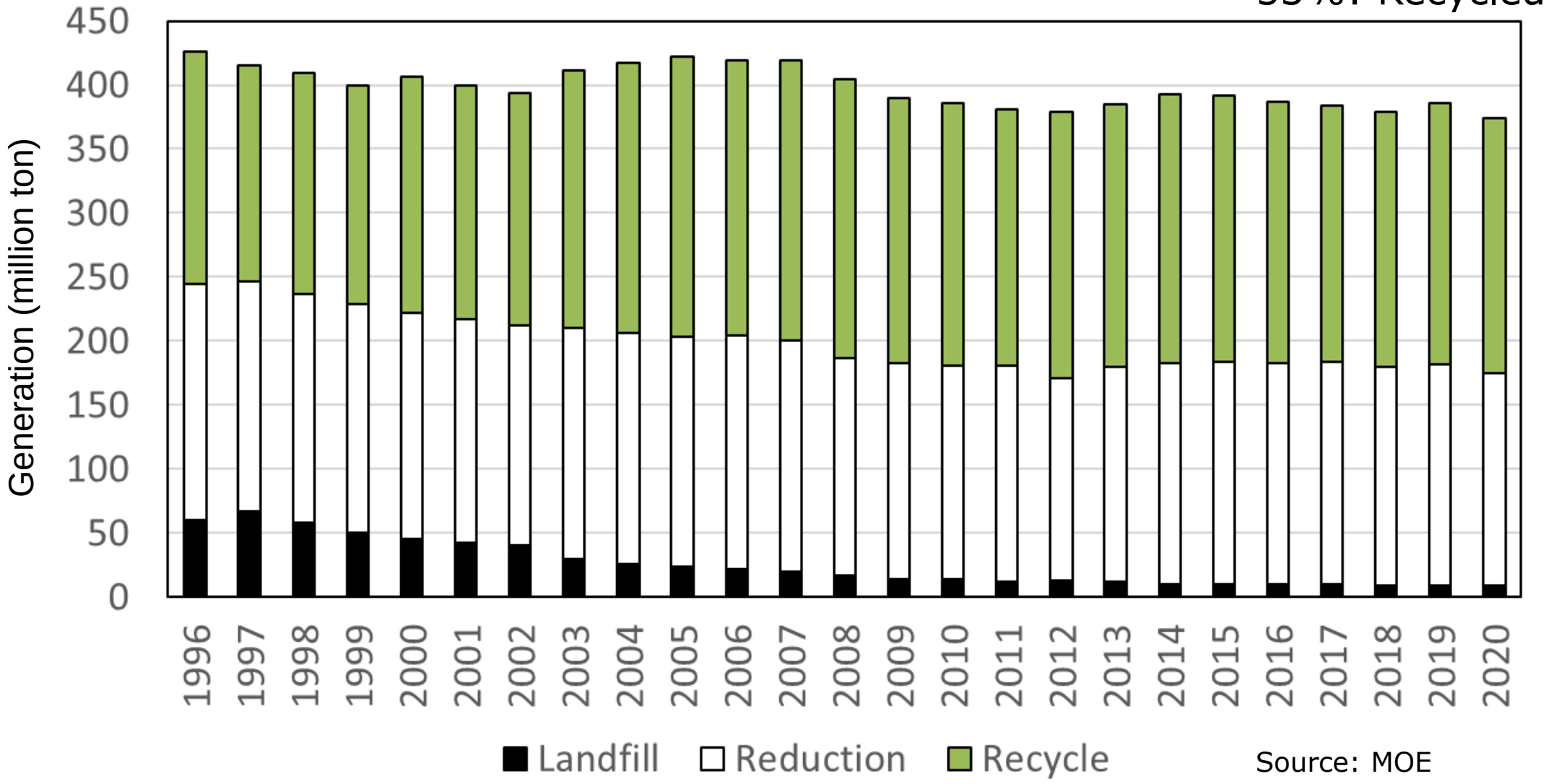
Treatment of Municipal Solid Waste



Source: MOE

Treatment of Industrial Waste

53%: Recycled



Source: MOE

Towards Carbon Neutrality by 2050

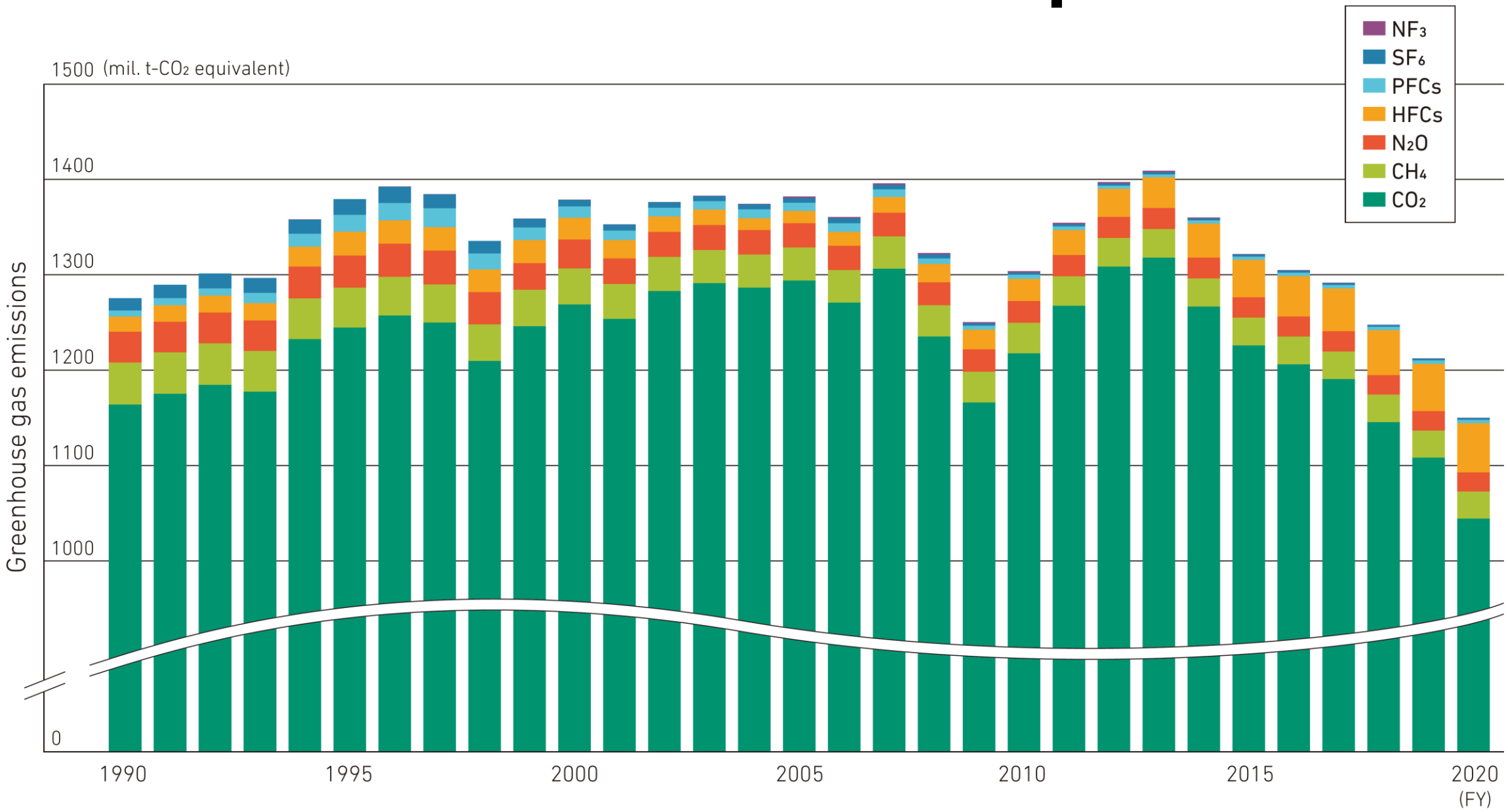
- Ex Prime minister Suga
- a cut in greenhouse gas emissions in Japan to net zero by 2050 in his first policy speech on 26th October 2020.

- Original plan (compared to 2013)
- 26% reduction by 2030 and 80% reduction by 2050

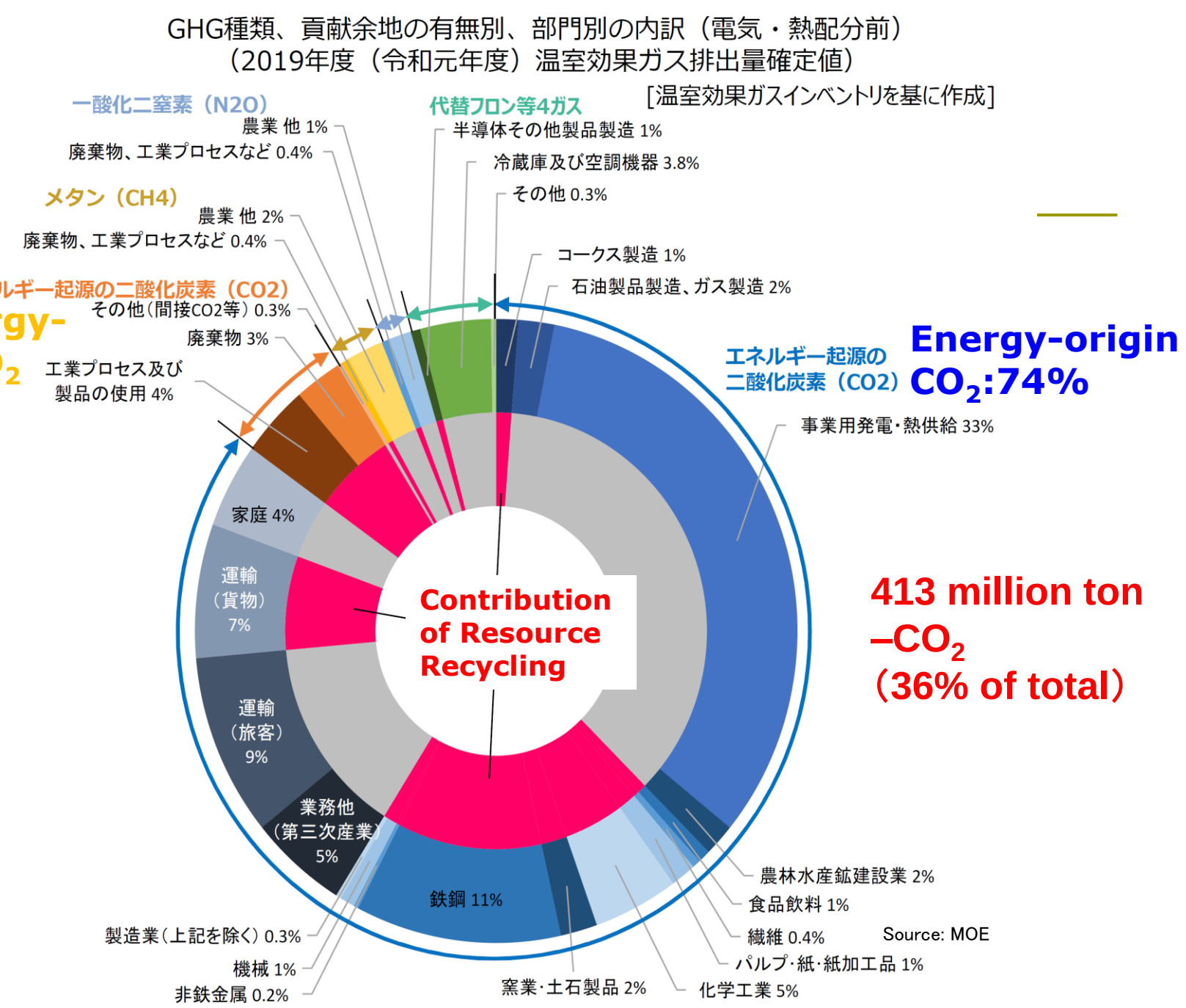
- 46% reduction by 2030 and Net zero by 2050

Ministry of the Environment, Japan proposed **the mid and long-term scenarios towards carbon neutrality in waste sector** in Aug 2021.

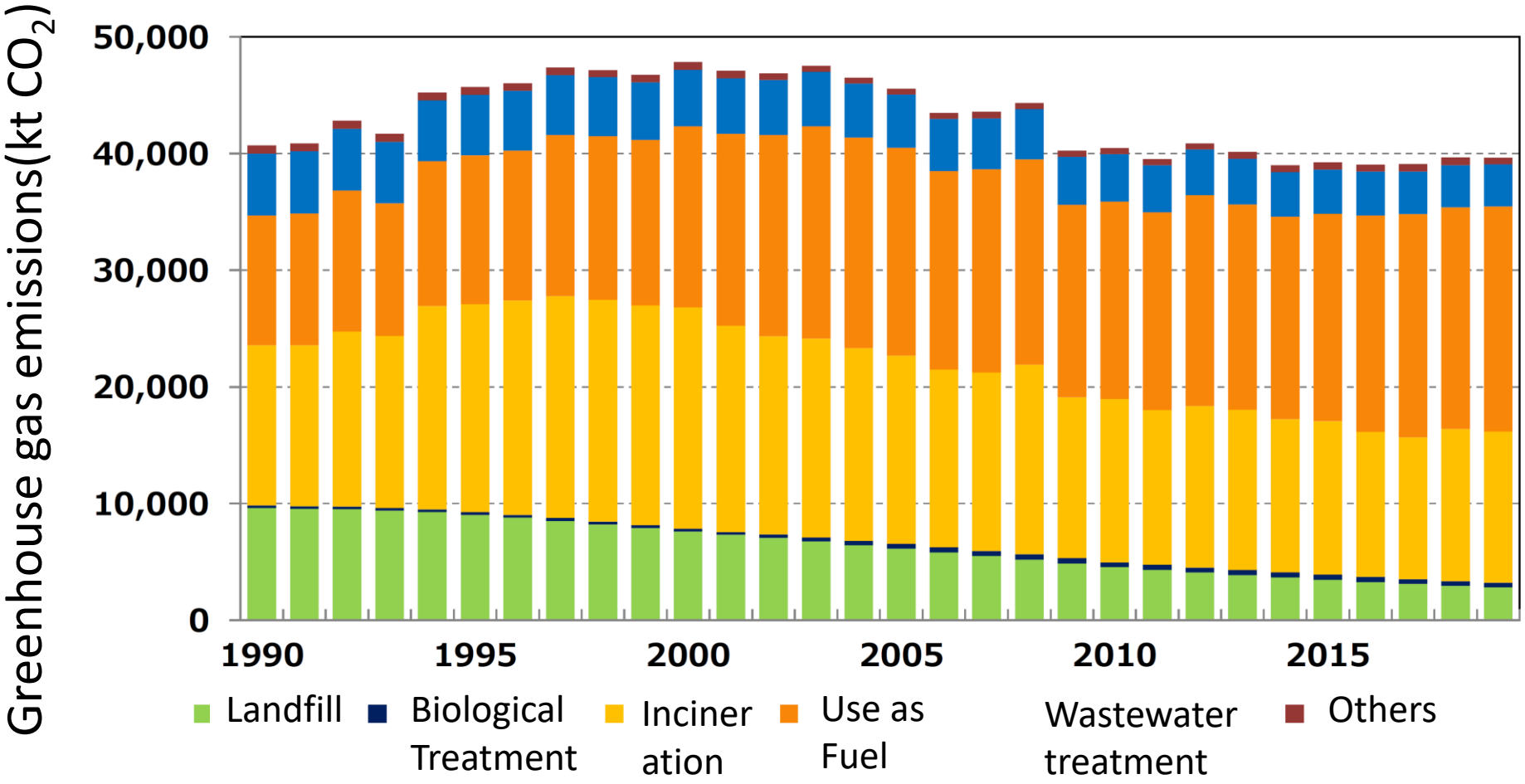
GHG Emissions in Japan



Percentage of sectors with scope for resource recycling to contribute to total GHG emissions in Japan.

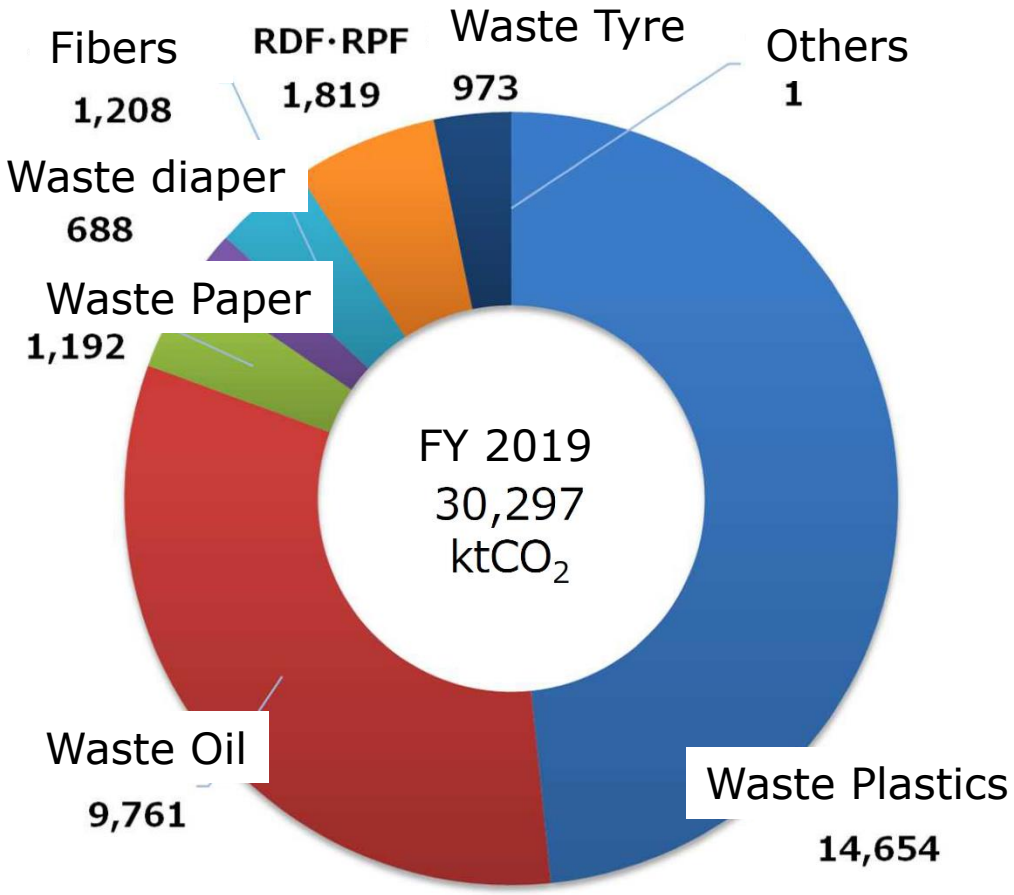


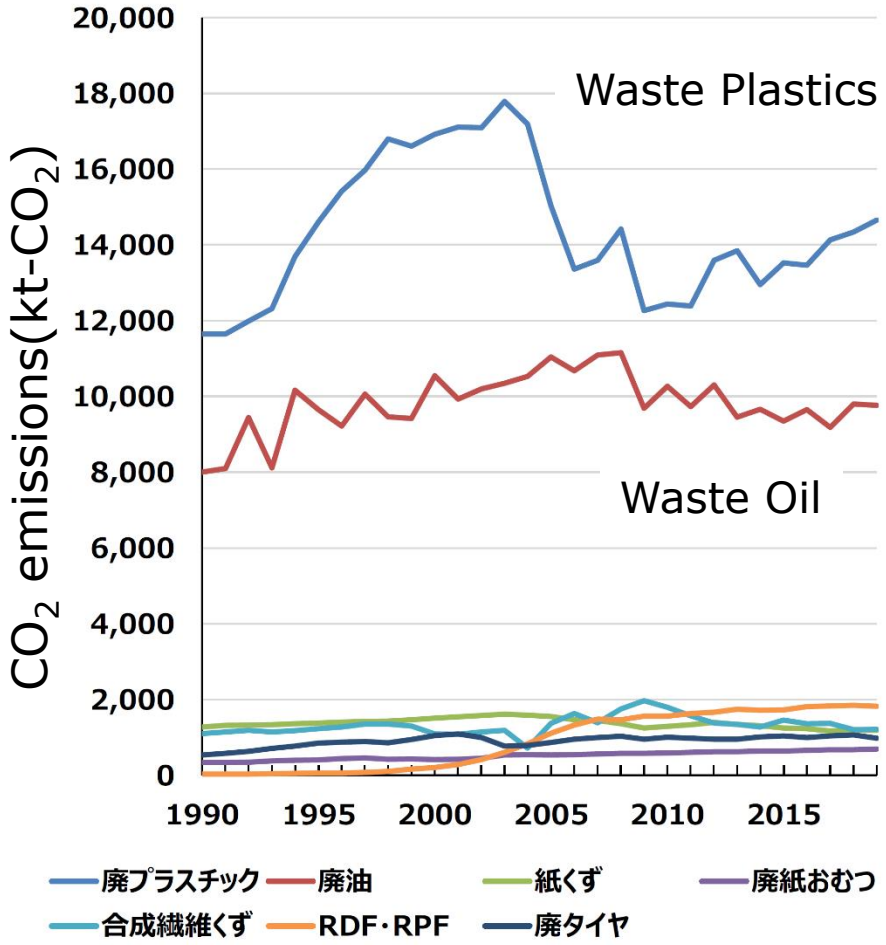
GHG Emissions in Waste Sector



Source: MOE

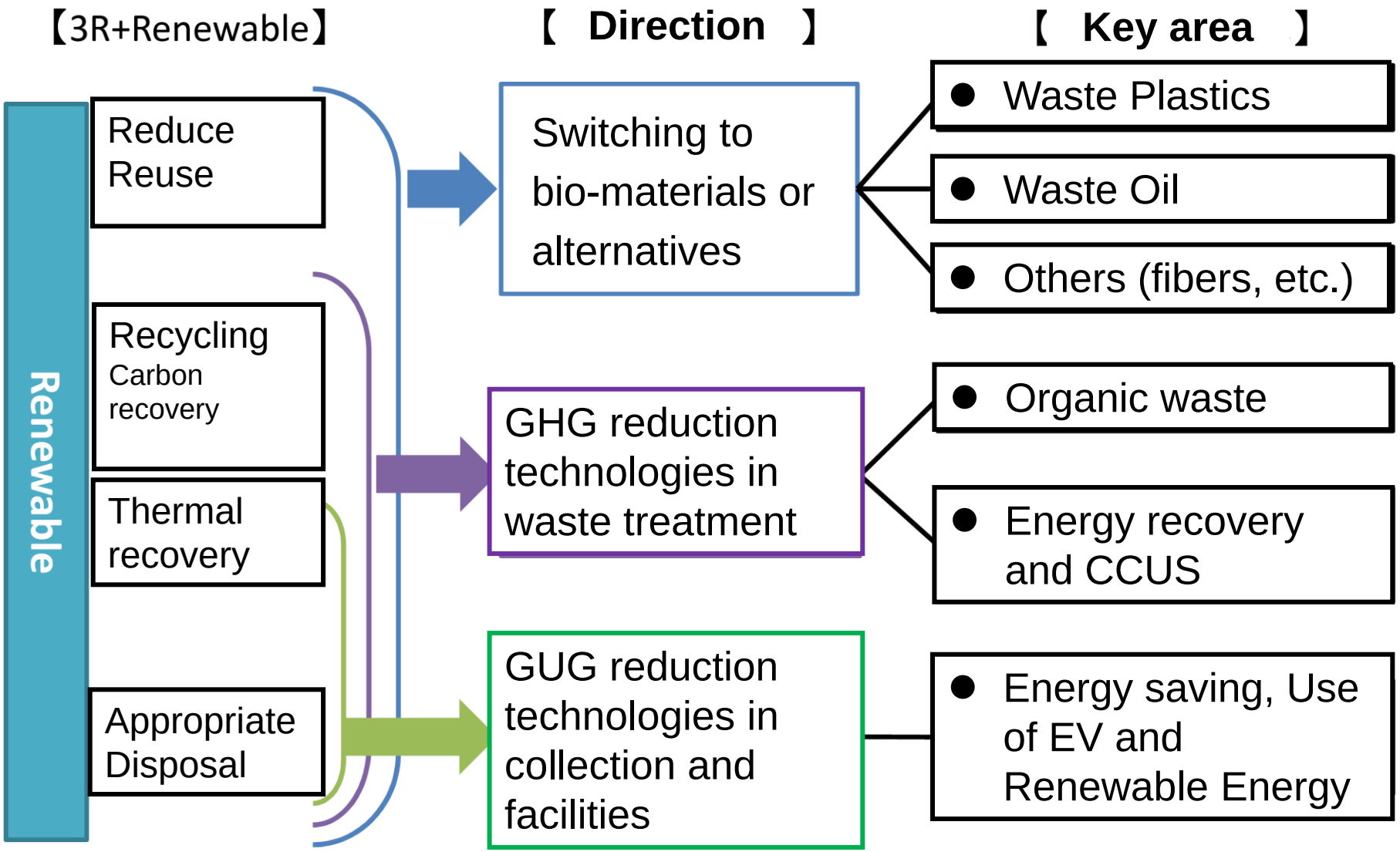
CO_2 Emissions in Waste Incineration and Use as Fuel





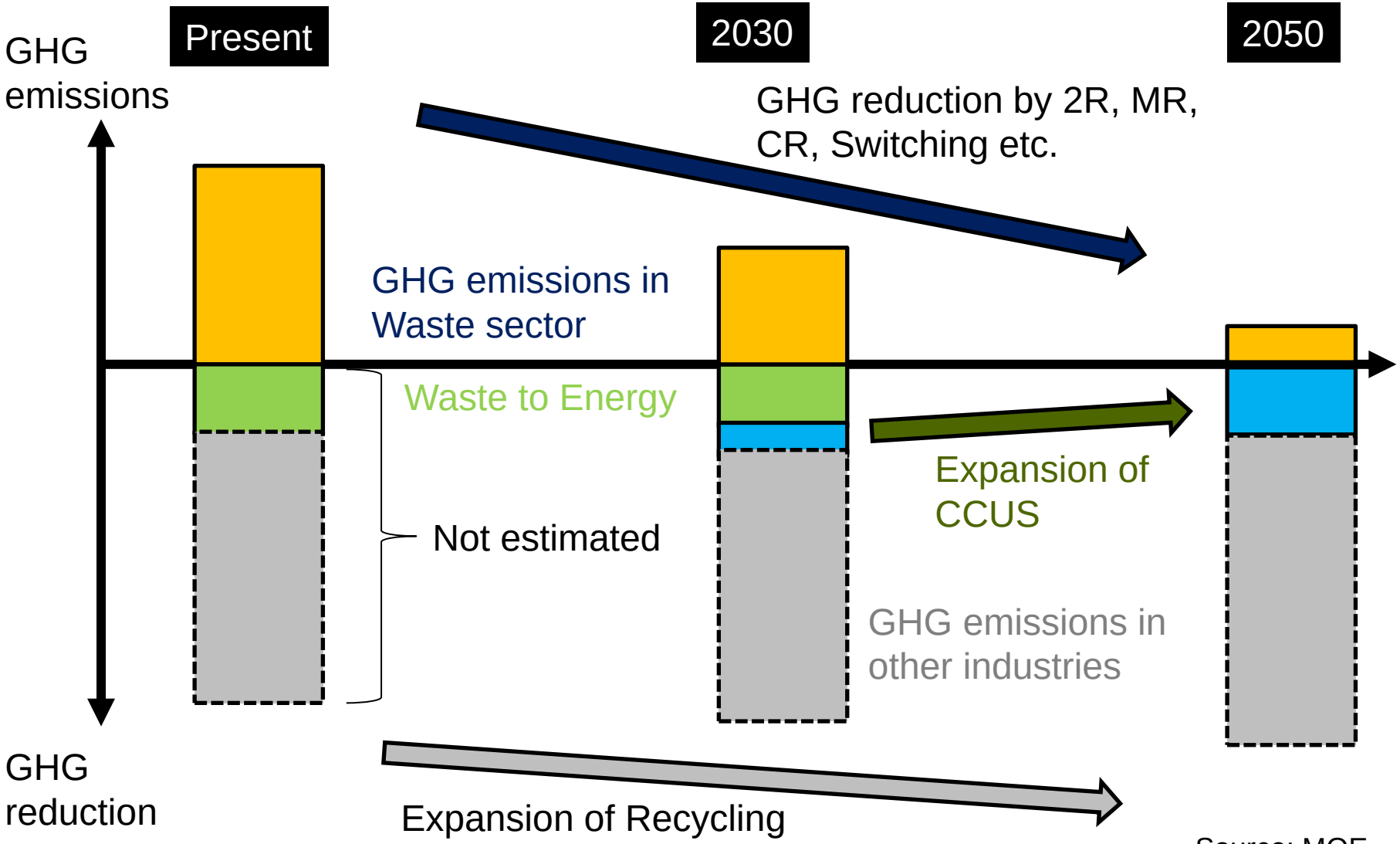
Source: MOE

Countermeasures to Net Zero



Source: MOE

Basic Concept of Net Zero in Waste Sector



Source: MOE

GHG Reduction Scenarios in Waste Sector

Source: MOE

GHG reduction scenarios	GHG emissions in 2050 (thousands t-CO_2)			
	Non energy – originated CO_2	Energy originated CO_2	CCUS	Total
1) BAU	29,602	4,367		33,968
2) Planned scenario based on existing goals, strategies and plans	20,270	1,933	-	22,203
3) Extended planned scenario (introducing countermeasures for energy orientated CO_2 emission)	20,270	1,911	-	22,180
4) Innovation scenario (GHG reduction technologies in key area)	9,031	1,468	-	10,499
5) Extended innovation scenario (Future GHG reduction technologies in key area)	6,164	0	-	6,164
6) Net zero scenario	6,164	0	-6,164	0
7) Maximum CCUS scenario	6,164	0	-16,138	-9,975

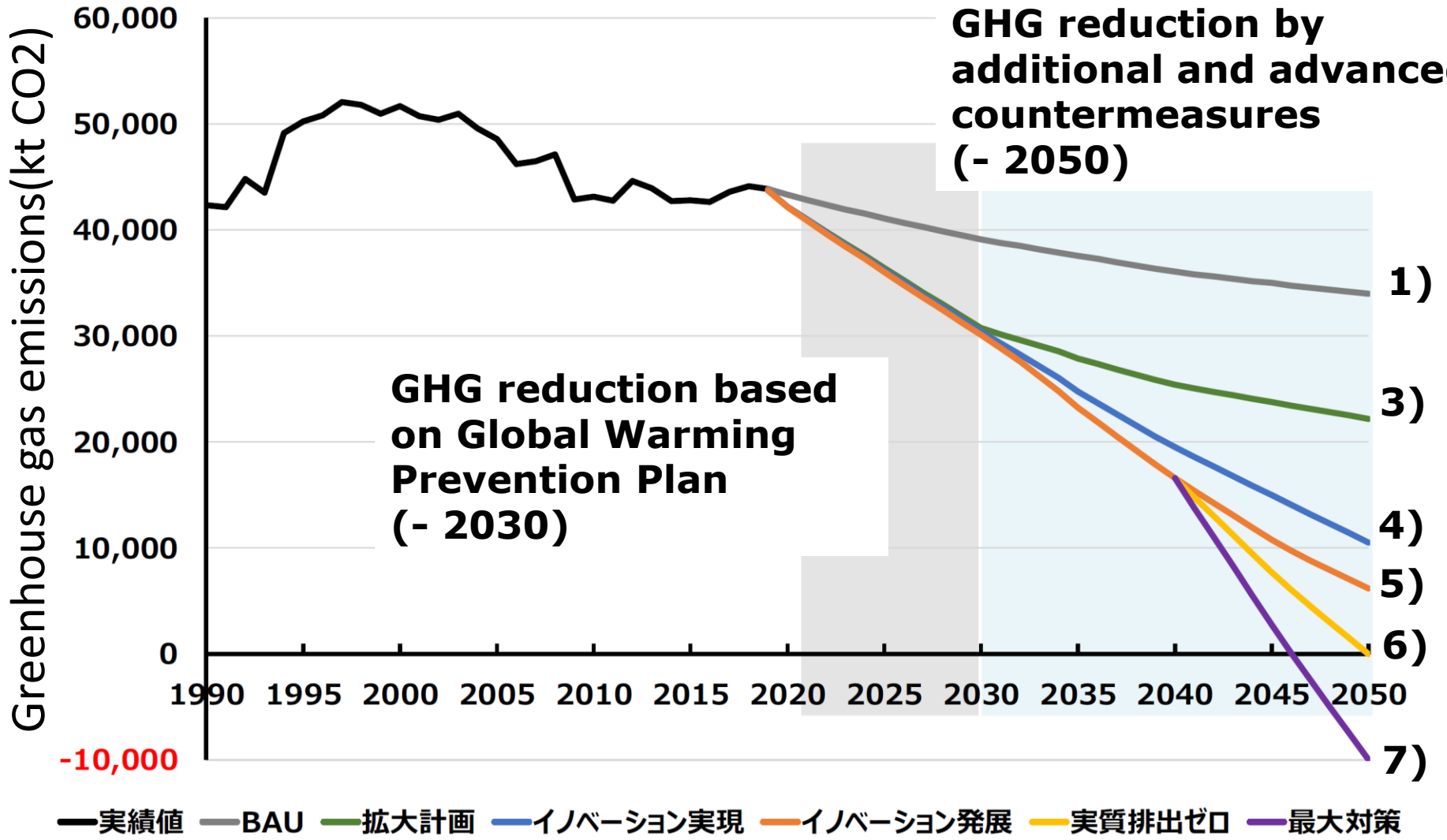
Main Measures in Scenarios

Source: MOE

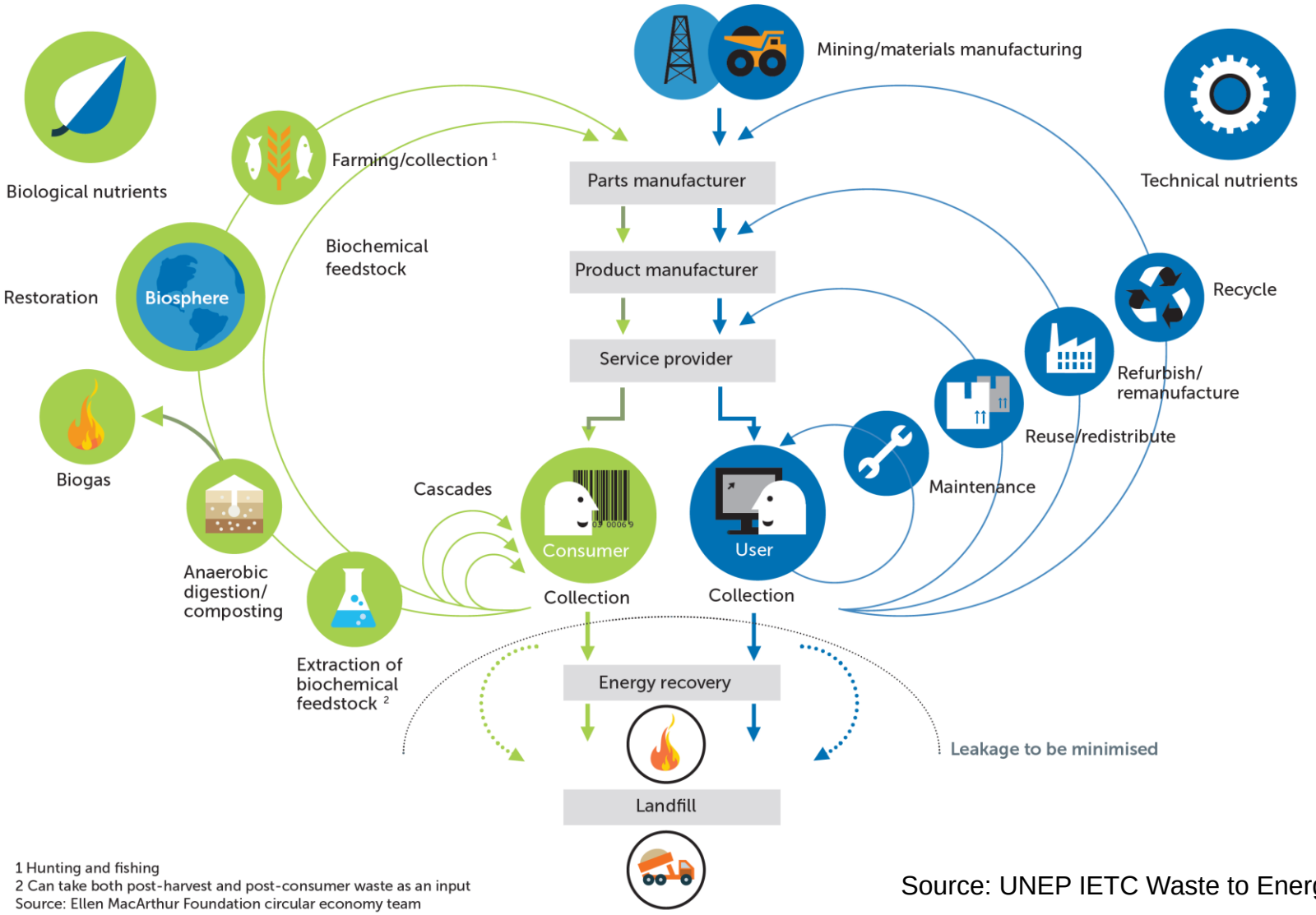
<table>
<tr><th></th><th>Plastic Waste</th><th>Biogas plant</th><th>Incineration＋CCUS</th></tr>
<tr><td>1) BAU</td><td></td><td></td><td></td></tr>
<tr><td>2) Planned S</td><td rowspan="2">・Charging of plastic bag
・Waste reduction based on 3R voluntary action plan for Container and Packaging Recycling
・Bio-plastic(0.6-0.8 million ton @2030)
・Mechanical recycle in ideal chemical industry
・Sustainable feed stock recycling(FSR) (Yield of FSR: 70% @2050）</td><td></td><td></td></tr>
<tr><td>3）Extended Planned S.</td><td colspan="2">After 2030, the construction of only incineration plants with >100 t/day will be permitted.
If the capacity is lower, a bio gas plant will be constructed, and the remaining will be transferred to a larger concentrated incineration plant.</td></tr>
<tr><td>4）Innovation S.</td><td>・Sustainable feed stock recycling (FSR)（Yield of FSR:80%@2050）
・Bio-plastic(2.5 million ton@2050)</td><td colspan="2" rowspan="2">After 2030, the construction of only incineration plants with >300 t/day will be permitted.
At the same time, a bio gas plant will be constructed, A facility during newly constructed facilities will supply the steam to industry.</td></tr>
<tr><td>5）Extended Innovation S.</td><td rowspan="3">・Sustainable feed stock recycling(FSR) (Yield of FSR:90%@2050）
・Bio-plastic（2.5 million ton@2050)
・25% waste reduction</td></tr>
<tr><td>6）Net zero S.</td><td colspan="2">To achieve net zero, the necessary amount of CO_2 was captured by CCUS devices. The plant will start to operate from 2040. CO_2 recovery ratio is 90%.</td></tr>
<tr><td>7）Maximum S.</td><td colspan="2">To achieve maximum reduction of CO_2, the CCUS devices will be installed in all plants from 2040.. CO_2 recovery ratio is 90%.</td></tr>
</table>

Timeline of Introduction of Countermeasures

Source: MOE



Circular Economy: Plastic Waste



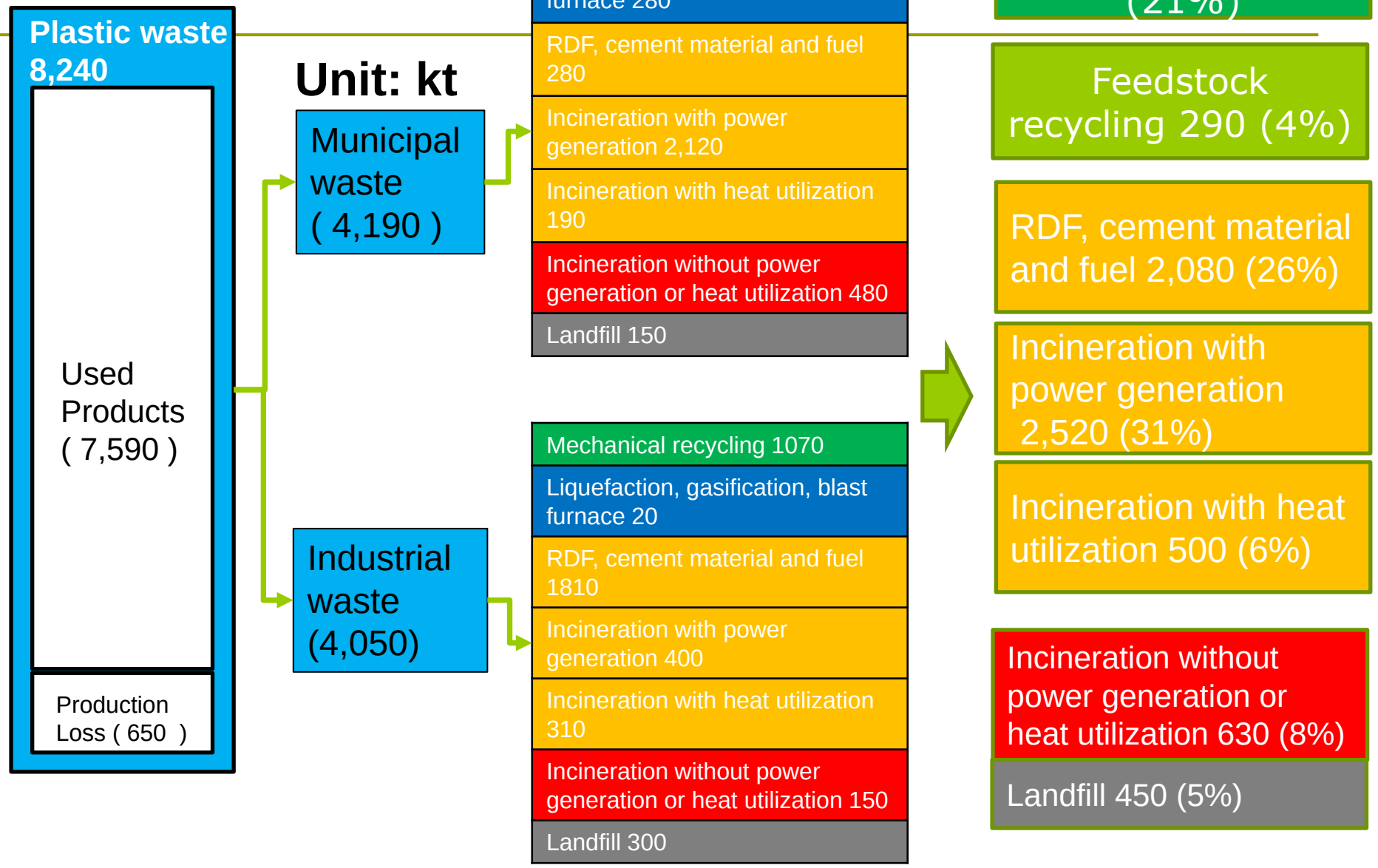
1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input
Source: Ellen MacArthur Foundation circular economy team

Source: UNEP IETC Waste to Energy, 2019

The Plastic Resource Circulation Act (2020)

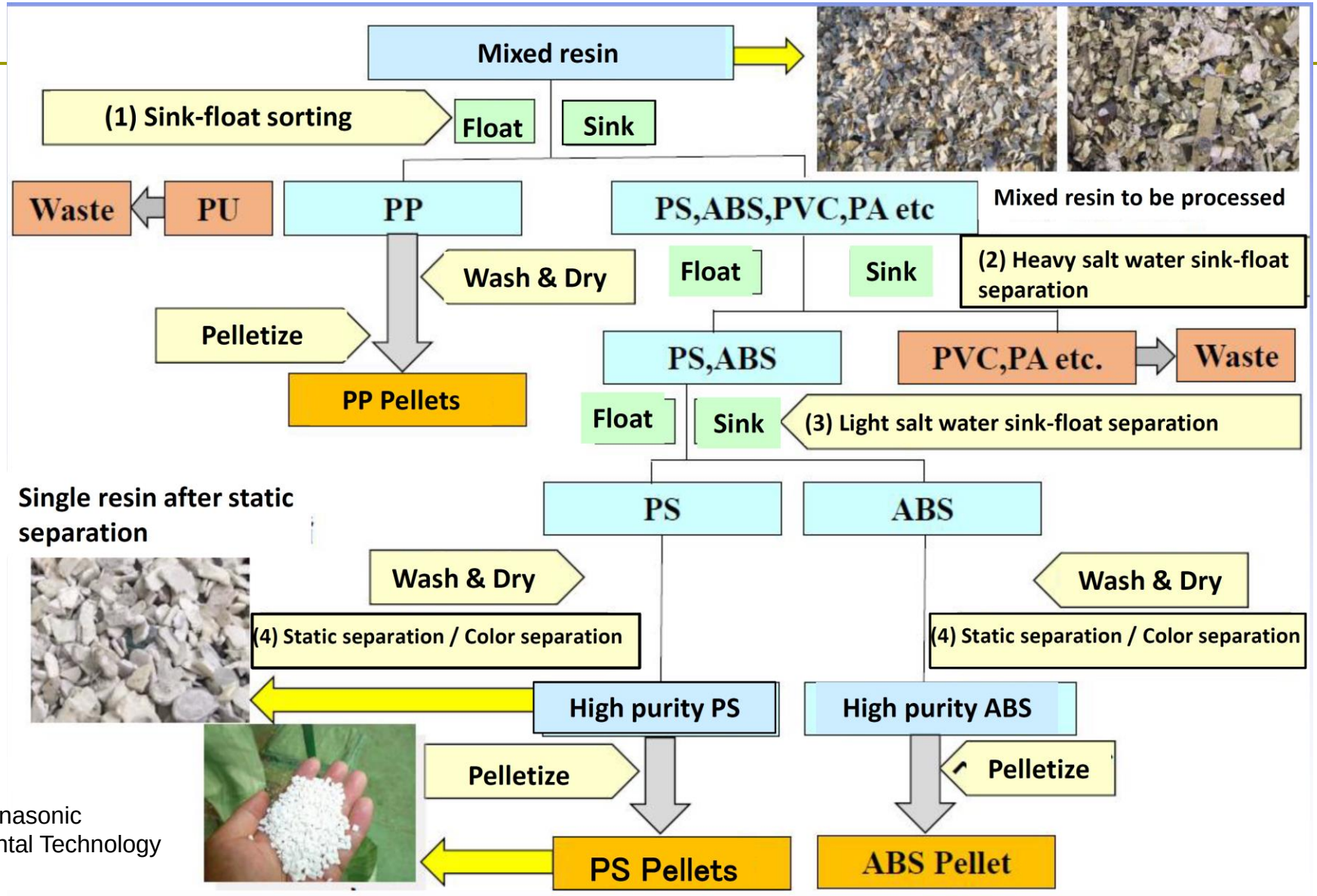
- To promote circulation of plastics in a comprehensive and planned way, basic policy includes:
  - ✓ Design for the Environment by manufacturers
  - ✓ Reduction of single-use plastics by retailers and service providers
  - ✓ Separation, collection and recycling of plastic waste by municipalities and private sectors

Plastic Waste Flow in 2019



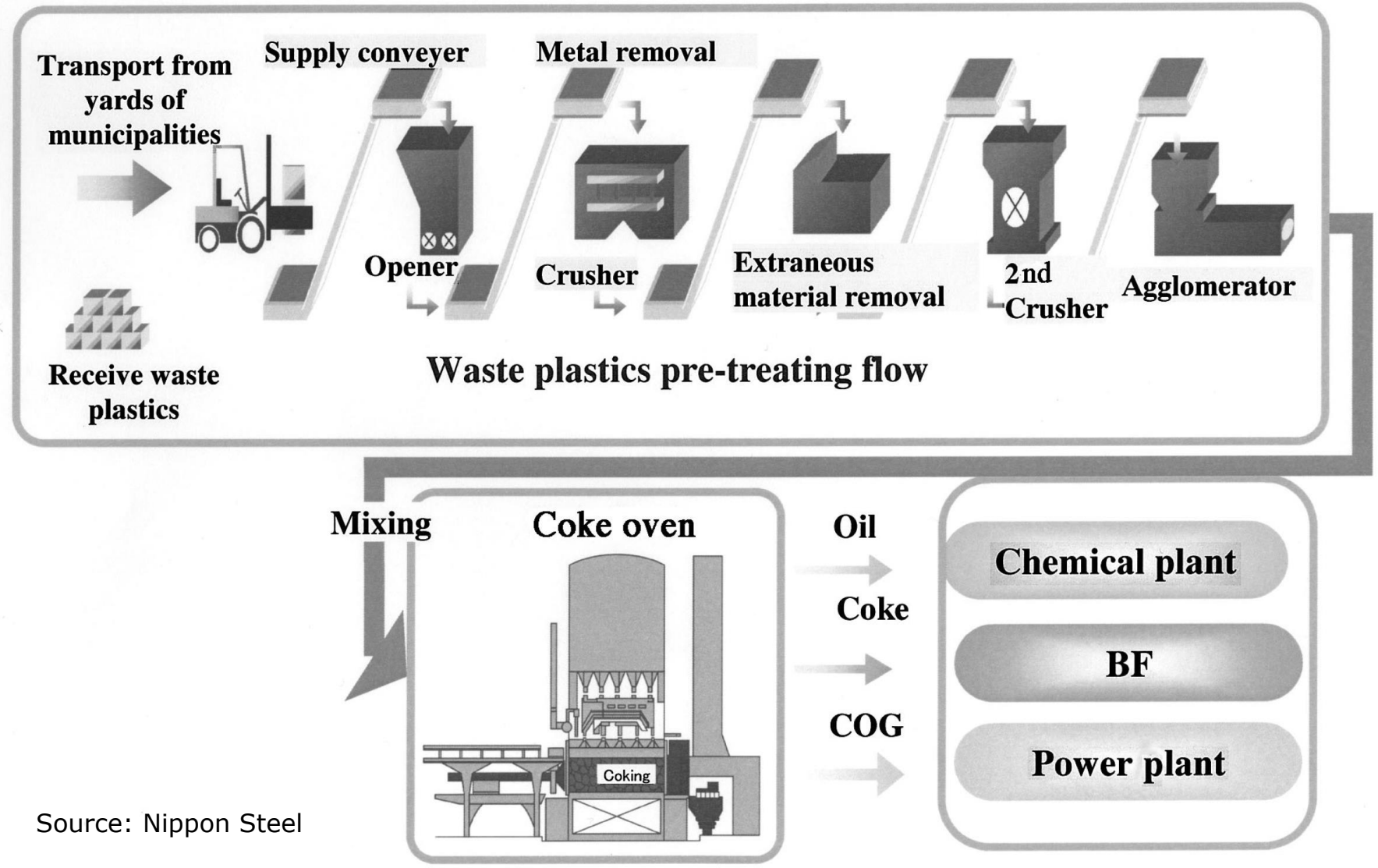
Source: PWMI

Mechanical Recycling: High precision Sorting



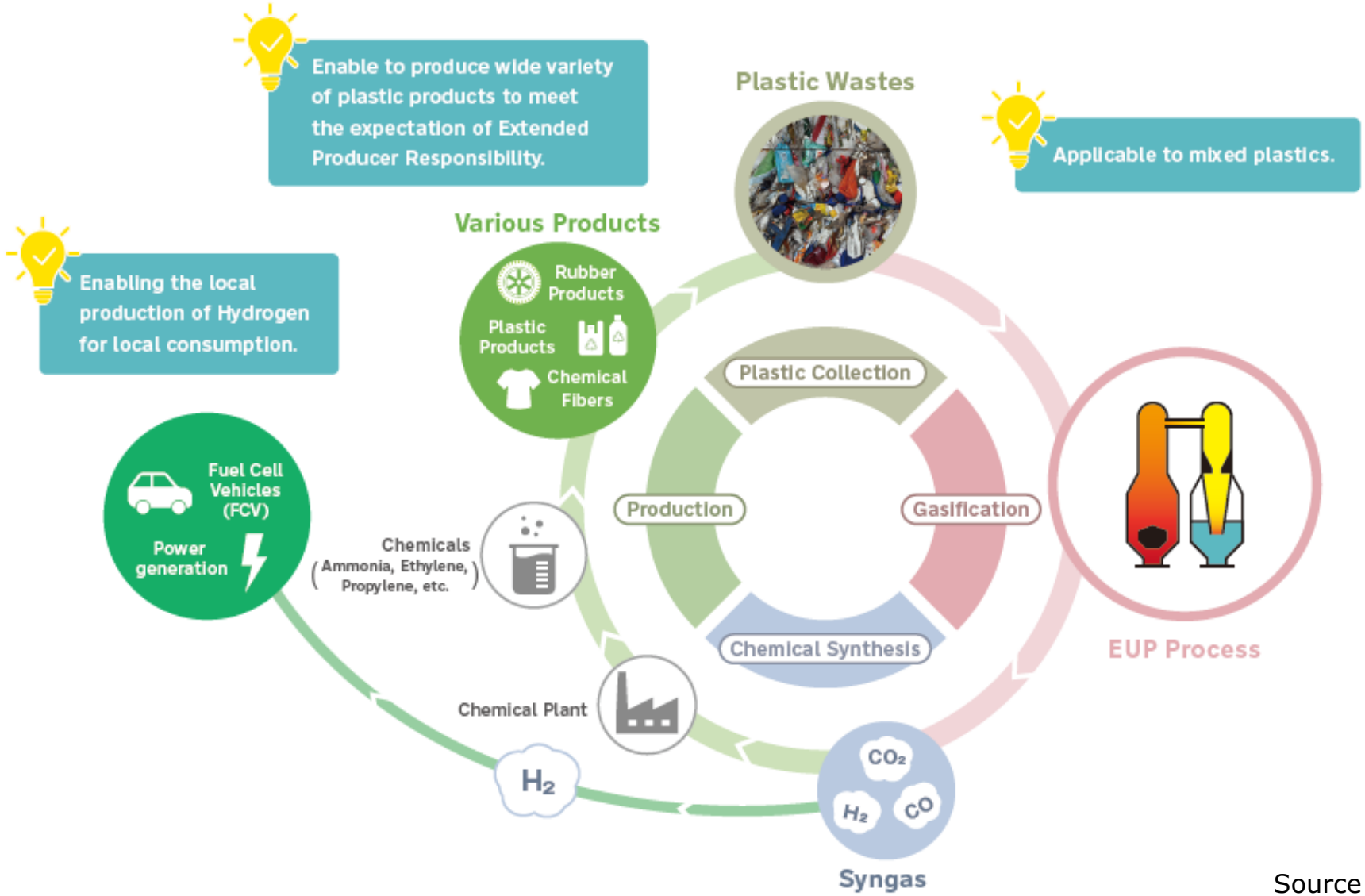
Source: Panasonic Environmental Technology Solution

Feedstock Recycling: Coke Oven



Source: Nippon Steel

Feedstock Recycling: Gasification

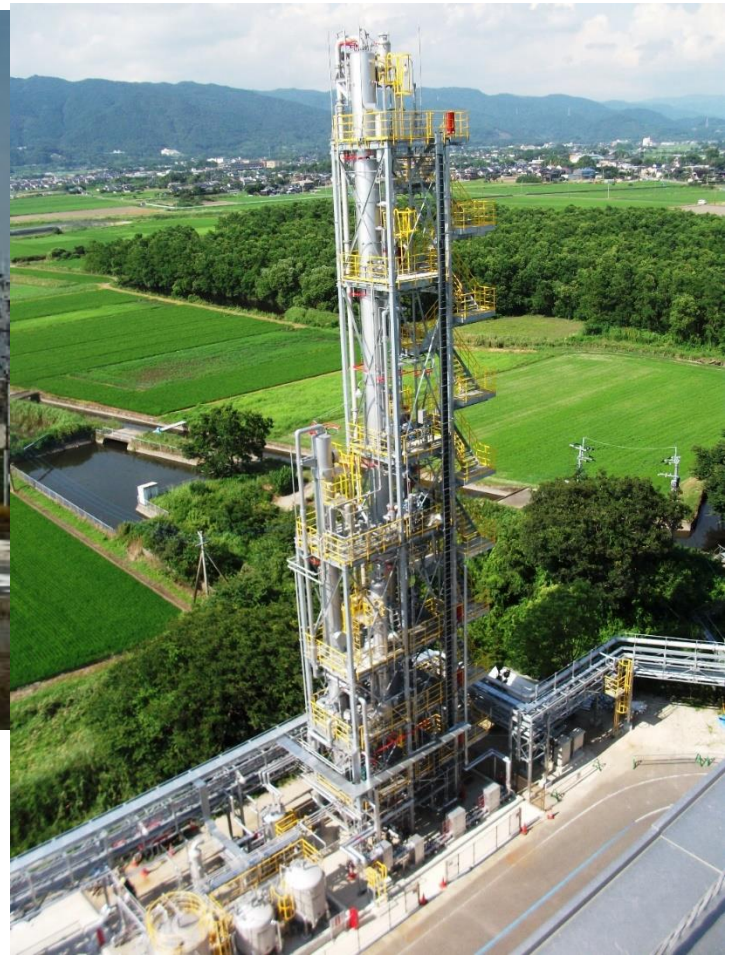


Source: JGC

Biogas + WtE Combined System

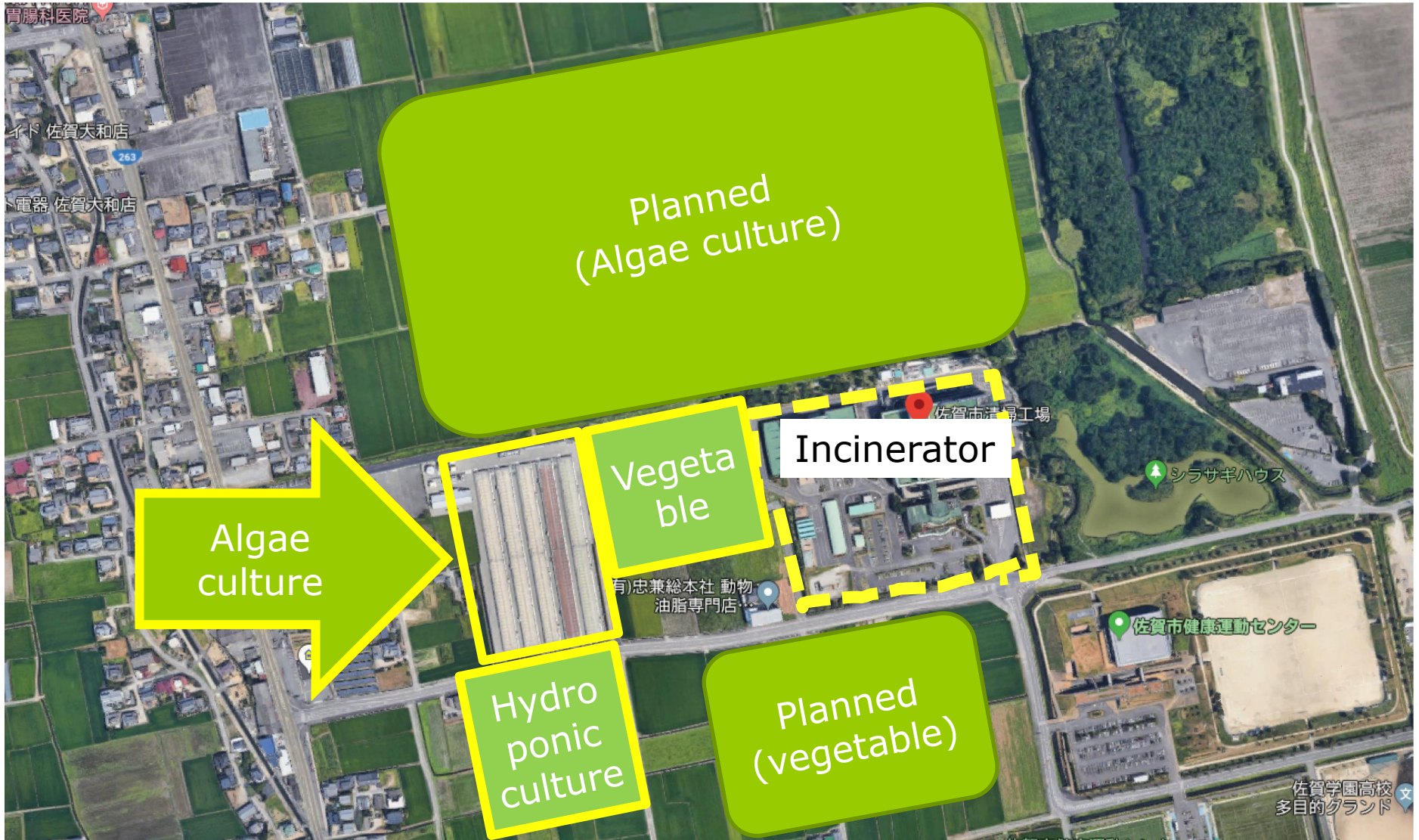
- ✓ Nantan town (2013-), Hohu City (2014-)
- ✓ Kyoto City (Oct., 2019 -)：MSWI 500 t/d+ Biogas 60 t/d
- ✓ Machida City (Jan., 2022-)：MSWI 258 t/d+ Biogas 50 t/d
- ✓ Kagoshima City(Jan., 2022-)：MSWI 220 t/d+ Biogas 60 t/d

Waste to Energy + CCU (Saga)



- Saga City in 2016
- 300t/day stoker type
- 10t/day CO_2 recovery
- Amine based chemical absorption method

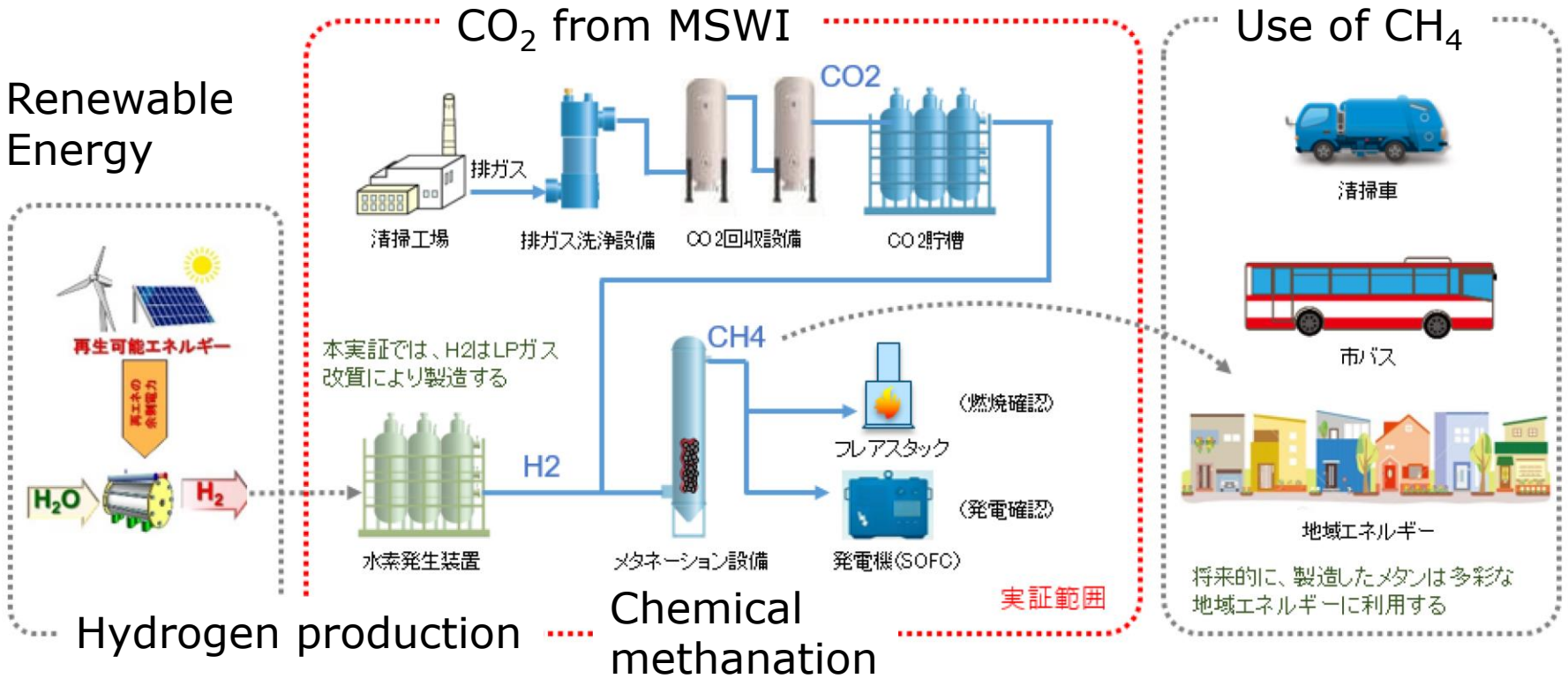
Agricultural Use
= No Longer NIMBY



Methanation from CO_2 from MSWI Flue Gas

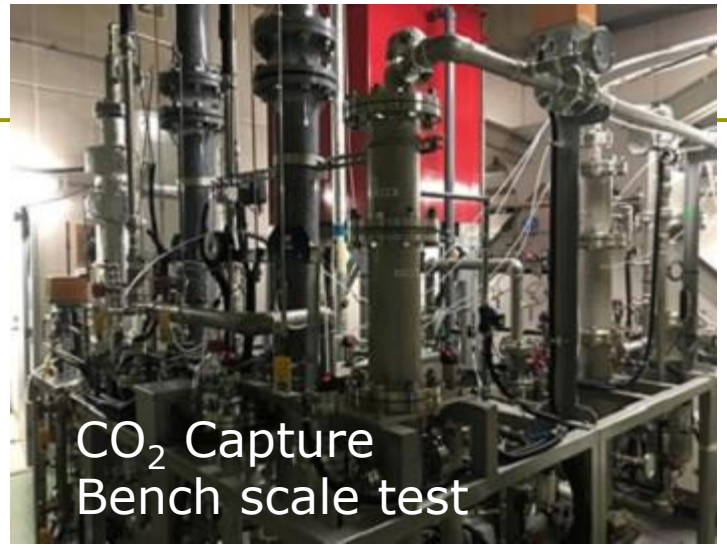
https://www.hitachizosen.co.jp/newsroom/news/assets/pdf/20220616.pdf

The project demonstrates the production of methane on a commercial scale by reacting carbon dioxide emitted from municipal solid waste incinerator with hydrogen. Through the demonstration, challenges for the diffusion of the methanation technology will be clarified. The effectiveness of this technology in reducing carbon dioxide emissions will also be examined.

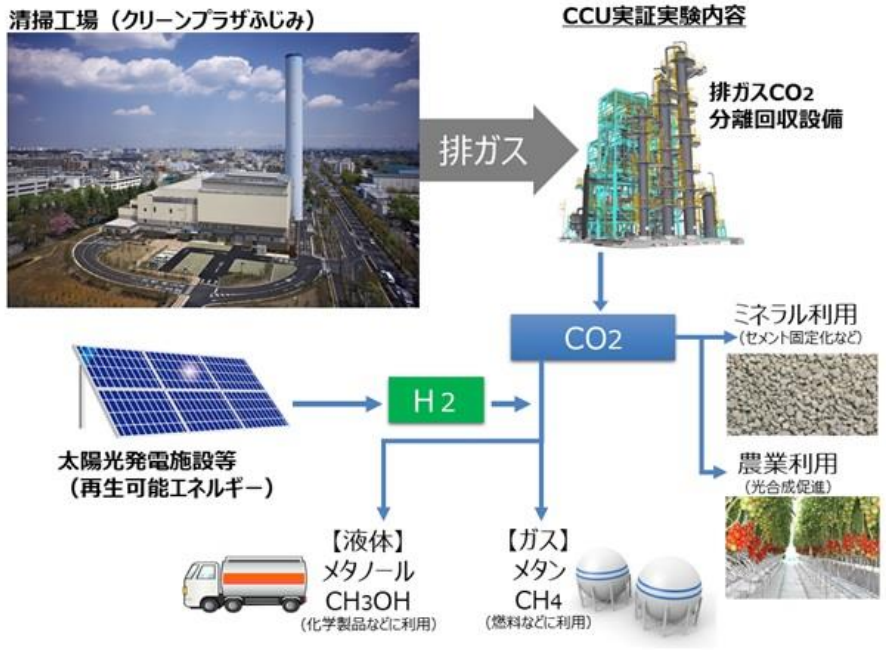


Methanol Synthesis from CO_2 from MSWI Flue Gas

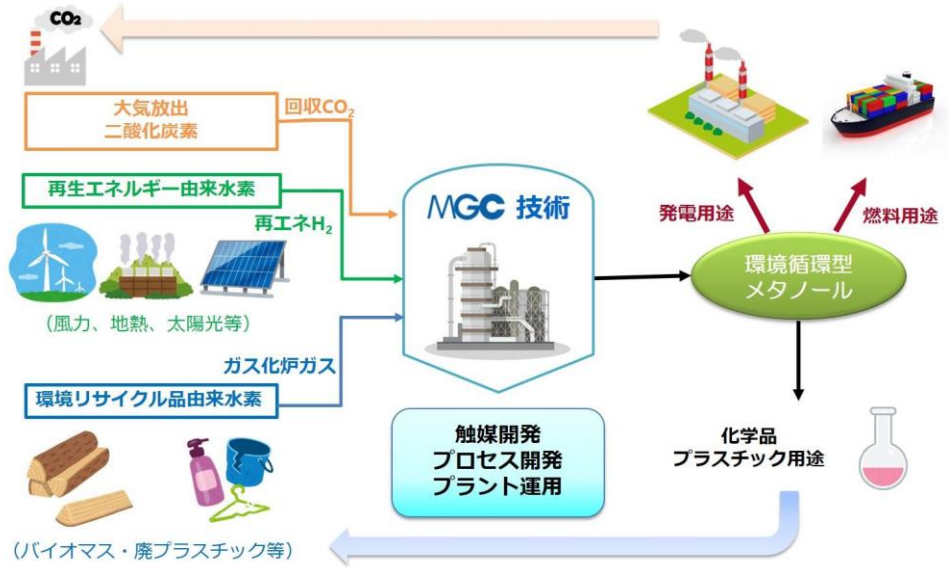
Methanol was produced from captured CO_2 in municipal solid waste incinerator flue gas. The methanol conversion test conducted at a Laboratory of Mitsubishi Gas Chemical Company.



https://www.jfe-eng.co.jp/news/2022/20220331.html



https://www.jfe-eng.co.jp/news/2021/20210120.html



https://www.mgc.co.jp/corporate/news/2021/210330.html

Conclusions & Future challenges

- Ministry of the Environment, Japan proposed the mid and long-term scenarios towards carbon neutrality in waste sector in Aug 2021.
- The CO_2 emission from incineration of plastic waste is the largest source of GHG emissions in the waste sector.
- The Plastic Resource Circulation Act was enacted in 2020, and Mechanical and Feedstock recycling of plastic waste was promoted under the circular economy concept.
- Even if all countermeasures are applied, the capture of CO_2 will be required to achieve net zero in 2050. Technologies are being developed to utilize the captured CO_2.
- The future challenges are the development of advanced GHG reduction technologies and cost allocation.

Thank you for your kind attention!

If you have any questions, please contact me.

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