12th Regional 3R and Circular Economy Forum in Asia and the Pacific,
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Advancing Circular Society in Asia-Pacific

- Key to Achieve SDGs and Carbon Neutrality

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Material Cycles &
Waste Management

Targets of 2025 3R&CE Forum Plenary by Shinichi Sakai

- A vision for sustainable material circulation and further advanced effort required for waste management are discussed in this plenary.
- The focus is "3R Plus", thinking mainly about prevention and recycling of plastic materials and de-carbonization strategies.
- First, I would like to start on an example of waste management with a reverse hierarchy that is opposite to the 3R concept.

Advancing Circular Society in Asia-Pacific - Key to Achieve SDGs and Carbon Neutrality

1. Challenges for Material Cycles Society Development
    1. Food Loss Reduction Challenges
    2. Plastic Materials as a target of 3R & Renewable Measures
    3. Decarbonized Society and Material Life Cycles
2. Principles of Circular Society & Circular Economy
    1. “Planetary Boundaries” & “Safe and just Earth system boundaries”
    2. Hierarchy and Integration as “3R Plus” Concept
    3. 5th Fundamental Plan for a Sound Material-Cycle Society and National Circular Economy Plan
3. Essential Roles of Waste Management
    1. Disaster Waste Management and Final Sink Concept
    2. Chemical Control for Cleaner Material Cycles
    3. COVID-19 and Essential Waste Management Works

Survey on Edible Food Waste by Kyoto City & Kyoto Univ.

- Analyzed 250-300 bags of waste and Classified them into 300- some categories
- Started in 1980 by Prof. Takatsuki and Kyoto City
- Sometimes untouched food reached 17%, and more than 50% of them were within expiry date

- The ratio of food waste in domestic waste is 40% (174 g/person/d)
- Redundant kitchen food loss that could be avoided amounts to 39%: left-over food: 22%; untouched edible food: 17%

GHG Emissions by Food Waste Management

- GHG emission vary according to treatment & recycling method of wet food waste
- More GHG emissions at anaerobic/semi-aerobic landfills
- GHG emissions will decrease by utilizing electricity from incineration of waste, utilizing residual excess heat, and utilizing anaerobic biogas electricity.

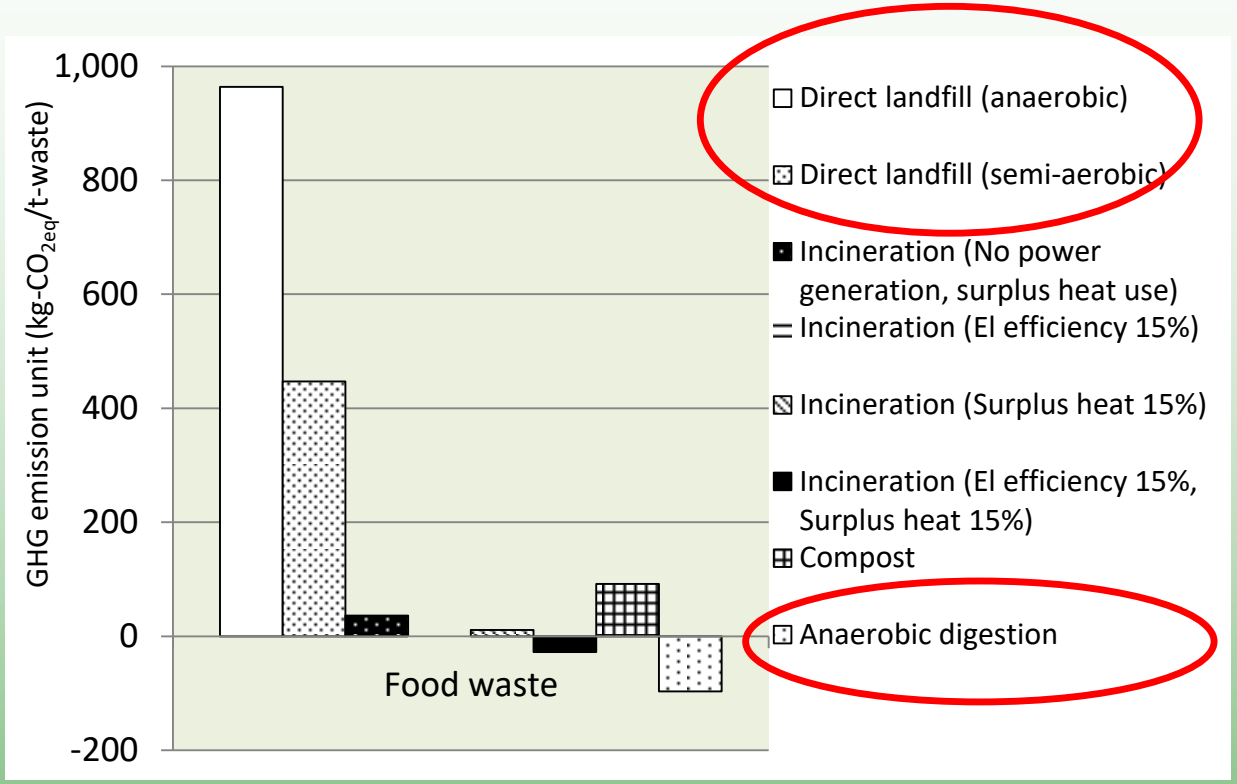


Fig. GHG emission per 1 t-wet food waste with each treatment

Yano J., Hirai Y., Sakai S.: Life cycle analysis of waste management focused on waste categories and treatment methods, Proceedings of Sardinia 2011, Cagliari, Italy; 3-7 October 2011

Concerns from marine plastic pollution

Beach litter along the coastline

Tobishima, Sakata, Yamagata

Tsushima, Nagasaki

*Samples of drifted wastes

Fishing gear

Plastic container

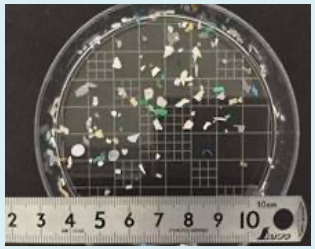
Detergent container

Negative impacts

- Concerns regarding marine life
- Obstruction for ship sailing
- Impacts on tourism and fishery
- Impacts on the residential environment along the coast

Turtle & Plastic, Source: UN World Oceans Day

A whale has died after swallowing more than 80 plastic bags Source: Ministry of Natural Resources and Environment, Thailand



Small plastic fragments Source: Isobe lab, Kyusyu university

Plastic Resource Circulation Strategy

Basic Principal : “3R+Renewable”

Issued in June 2019 by Japan Government

Reduce	➢Reduce the amount of the one way plastic by mandatory charging of one way plastic bags ➢Development and utilization of alternatives for petroleum resource derived plastics
Reuse Recycle	➢Easy and efficient plastic collection and recycle system ➢Promote innovative recycling technologies
Recycled and Biomass Plastics	➢Promote technical innovations and support to build infrastructures ➢Stimulate demands for recycled plastics and biomass plastics by government green procurement

Milestones

<Reduce>

① Reduce 25% of the accumulated volume of one way plastics by 2030

<Reuse / Recycle>

② Reuse / recyclable designs by 2025

③ 60% of packages / containers to be recycled or reused by 2030

④ 100% utilization of used plastics by 2035

<Recycled Plastics / Biomass Plastics>

⑤ Utilization volume of recycled plastics to be doubled by 2030

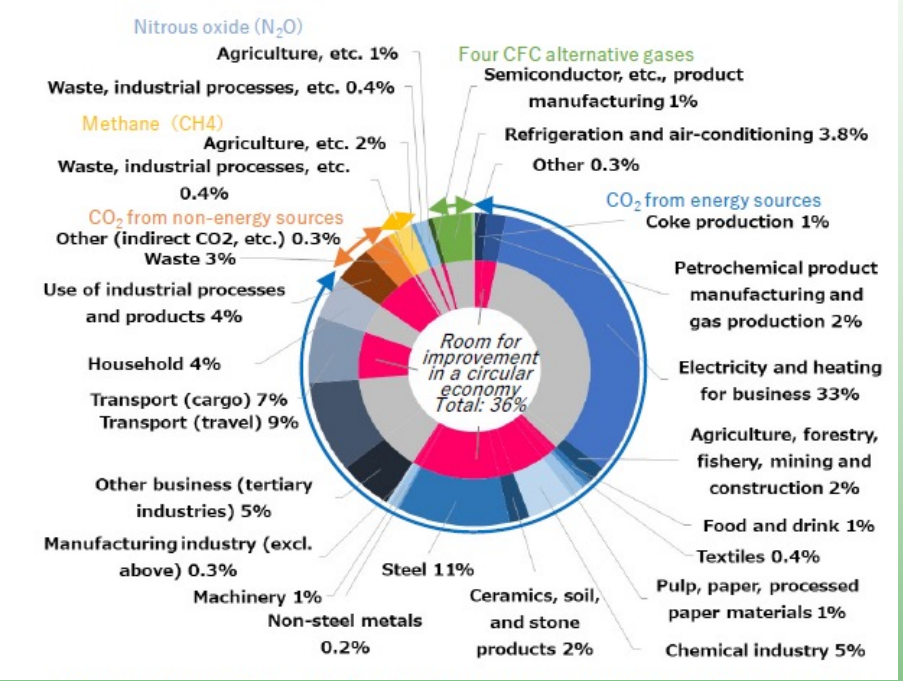
⑥ Introduce 2 million tons of biomass plastics by 2030

Recycling sector that contribute to the total GHGs emissions

- Resource circulation can contribute to reductions that accounts for about 36% of Japan's GHG emissions. It also contributes to solving social issues such as economic security by ensuring a stable supply of resources and regional revitalization.
- It is important to enhance industrial competitiveness in recycling businesses to ensure the quality and quantity of recycled materials.

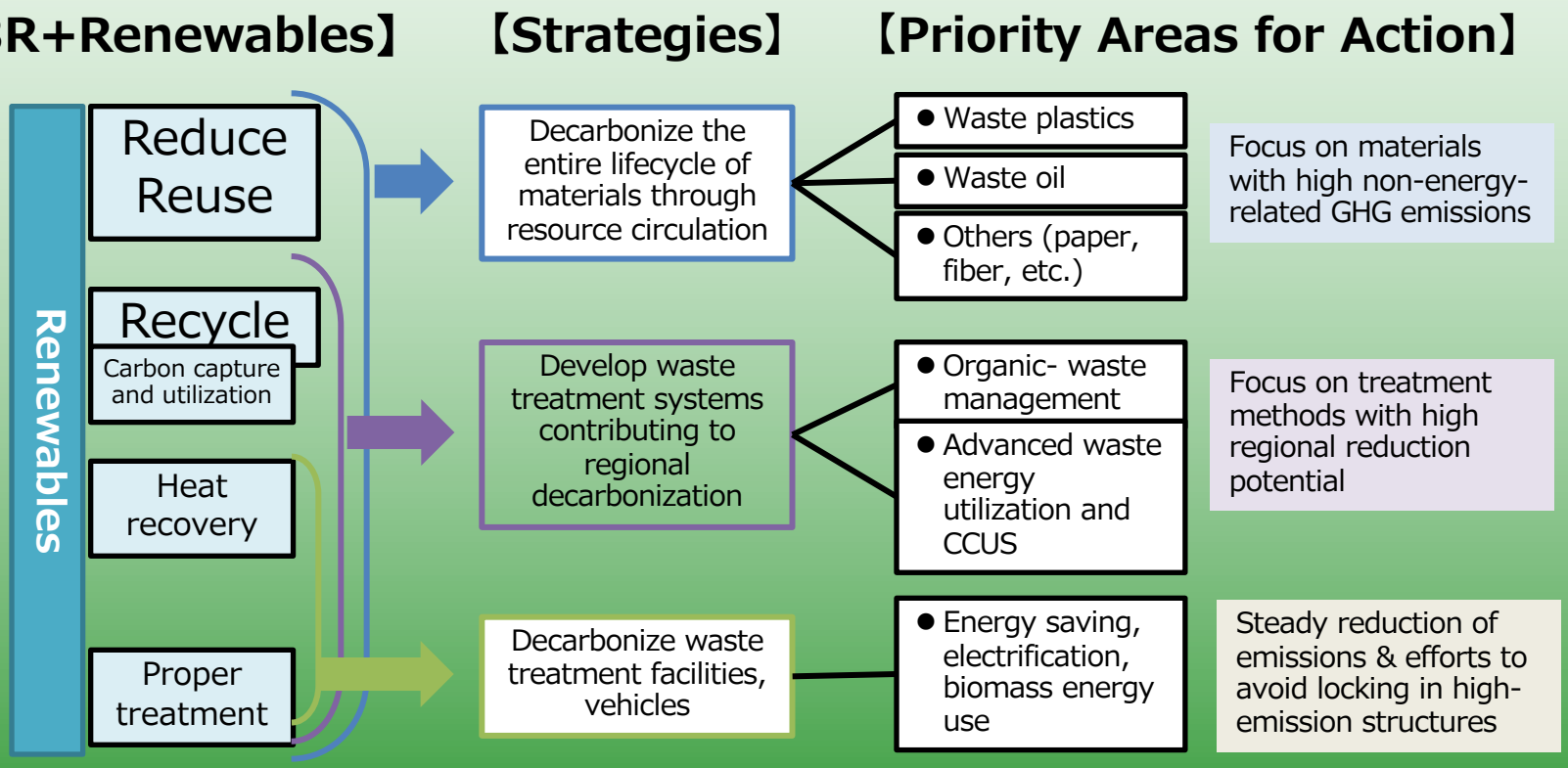
- Japan aims to enhance the recycling industry by upgrading recycling businesses to ensure the supply of recycled materials of the quality and quantity required by manufacturers.

Proportion of the recycling sector that has room to contribute to the Japan's total GHGs emissions

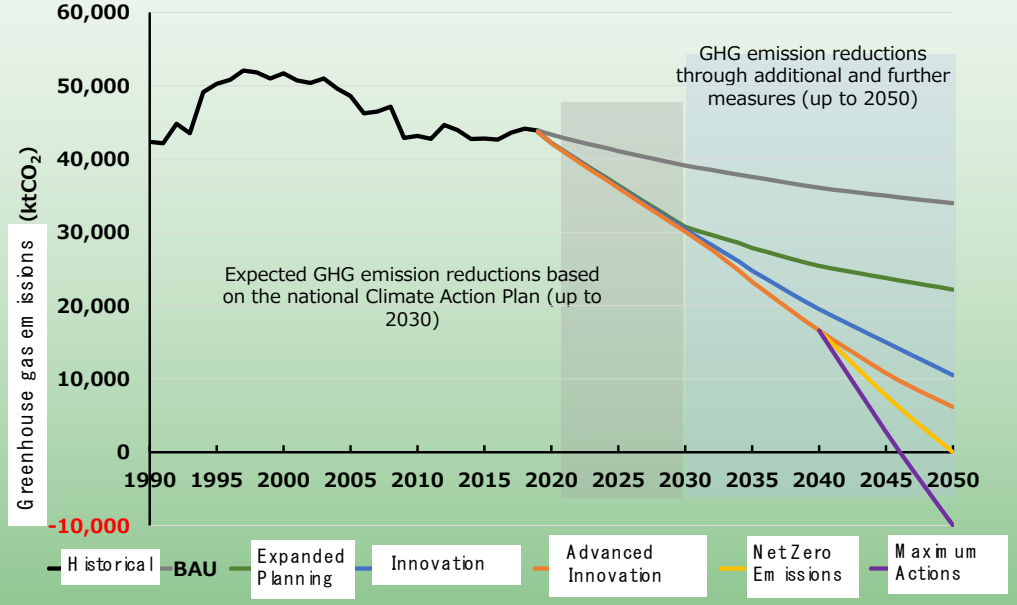


Note: Percentages given for categories where there is room for improvement do not necessarily mean that the entire reduction amount is achievable.
Source: FY2019 Confirmed Greenhouse Gas Emissions, pre-electricity and heating distribution

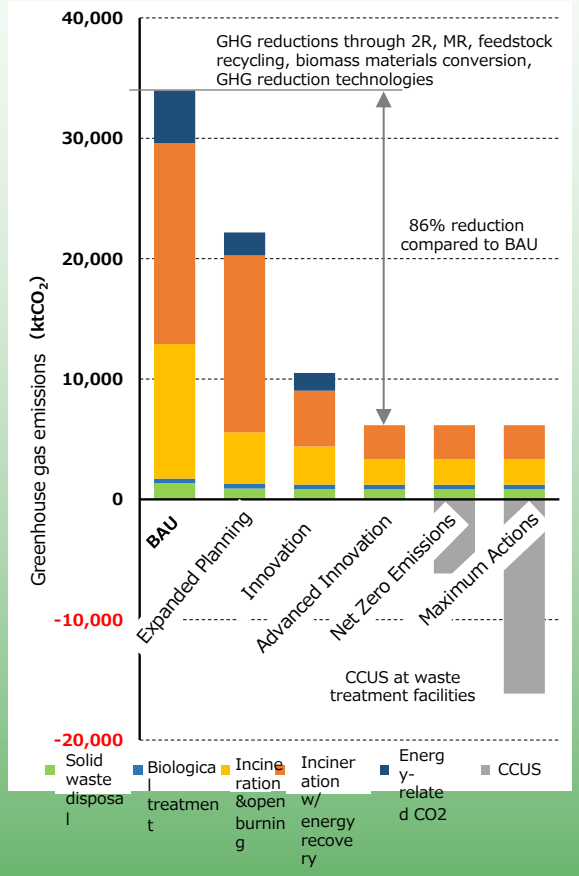
Priority Areas for Action Japan's greenhouse gas reduction scenarios toward net zero by 2050 in the material cycles and waste management sector management



Simulated GHG Emissions for 2050



Projected paths toward net zero emissions by scenario



Estimated GHG emissions by scenario in 2050

Koji Yamada, Ryota Ii, Madoka Yamamoto, Hiroyuki Ueda, Shinichi Sakai: Japan's greenhouse gas reduction scenarios toward net zero by 2050 in the material cycles and waste management sector management in Japan, Mater Cycles Waste Manag, 25, 1807–1823, https://doi.org/10.1007/s10163-023-01650-7 (2023)

K. Yamada et al., J Mater Cycles Waste Manag (2023) 25:1807-1823

Journal of Material Cycles and Waste Management
https://doi.org/10.1007/s10163-023-01650-7

SPECIAL FEATURE: ORIGINAL ARTICLE

Material Cycles toward Carbon Neutral Society

Japan's greenhouse gas reduction scenarios toward net zero by 2050 in the material cycles and waste management sector

Koji Yamada[1] · Ryota Ii[2] · Madoka Yamamoto[2] · Hiroyuki Ueda[3] · Shinichi Sakai[4]

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Abstract
The first draft scenario toward net zero greenhouse gas (GHG) emissions by 2050 for the material cycles and waste management sector was presented by the Ministry of the Environment, Japan in August 2021. The details of the future GHG emission estimation used to create the draft scenario are described in this document. For multiple scenarios where more aggressive measures, such as carbon capture, utilization, and storage (CCUS), were included in addition to business-as-usual and the current policy continuity scenario, future GHG emissions were estimated as the sum of the products of activities and emission factors indicating changes in measures between scenarios. The estimation outcomes demonstrated that future GHG emissions from the solid waste management sector could be anticipated to be zero or even negative when material conversion to biomass, primarily for plastics, recycling to raw materials, and installation of CCUS at incineration facilities are assumed. Extensions of prior plans are not enough to reach the goal of net zero emissions, according to the measures necessary and the volume and pace of their implementation suggested in this study. Stakeholders should collaborate with great ambition.

Keywords GHG reduction · Material cycles · Waste management · 3R plus · Plastic management · CCUS

2. Principles of Circular Society & Circular Economy

1. “Planetary Boundaries” & “Safe and just Earth system boundaries”
2. Hierarchy and Integration as “3R Plus” Concept
3. 5th Fundamental Plan for a Sound Material-Cycle Society and National Circular Economy Plan

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Material Cycles &
Waste Management

Planetary Boundaries (PB)

- The planetary boundaries (PB) framework defines nine environmental limits for a safe operating space that regulates the stability of the Earth system. Exceeding these limits poses a global environmental risk.
- In addition to the previously identified rates of species extinction and the nitrogen and phosphorus cycles in 2015, the latest findings from 2022 reveal that climate change, land use changes, and new chemicals are now in a high-risk zone, moving beyond uncertainty.

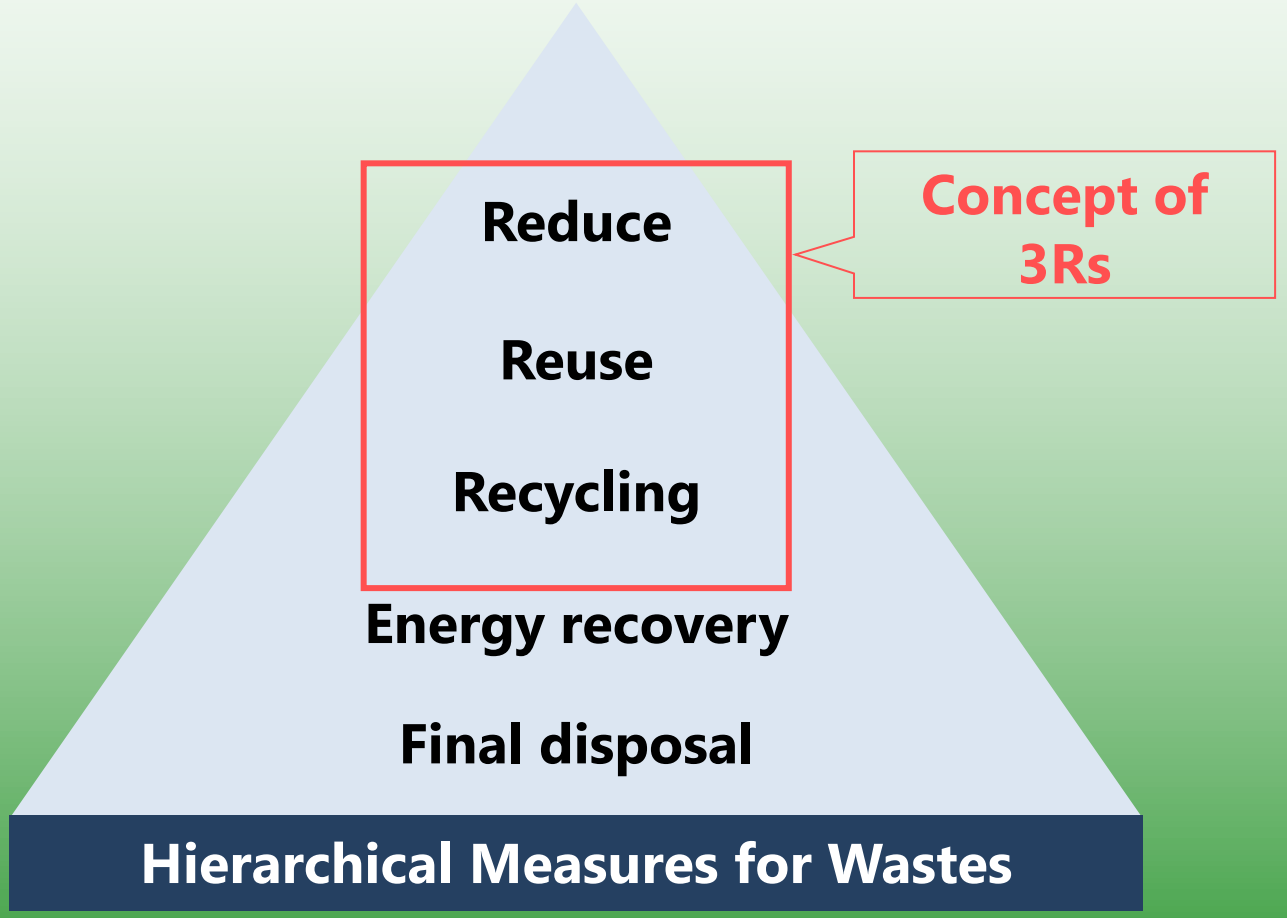
Steffen, W. et al. Planetary boundaries: guiding human development on a changing planet. Science 347, 1259855 (2015).

Safe and just Earth system boundaries

- Holistic Framework: Integrates Earth's environmental limits with equitable standards, ensuring everyone can meet their basic social needs, contributing to sustainable development.
- Modeling Eight Domains: Focuses on critical factors including climate, biosphere, water cycles, nutrient cycles, and aerosols.
- Just Transition: Emphasizes the importance of supporting citizens and communities affected by social changes, such as climate change initiatives and energy conversion, ensuring a fair transition for all.

Johan Rockström et al. (2023), Safe and just Earth system boundaries, Nature, Volume 619, pp. 102-111

3R Concept as Countermeasures for Waste Issues



Hierarchy of Waste Management: 3R, "Reduce, Reuse, and Recycling"

- With the development and spread of the waste management policy,

  Hierarchical priority is given to "reduce, reuse, recycling, treatment and final disposal" in this order. We call the first three measures of 3R, "Reduce, Reuse, and Recycling".

- The idea of hierarchy is regarded as the basis on regulations, policy discussions and voluntary plans.

Principles Expansion of Resource Use based on 3R Concept

1. Find the best way for the top priority of waste prevention/ avoidance to reduce waste flow amount in society to a fixed certain level.
2. Utilize and recycle renewable resources as a basic principle. Consider accumulation of exhaustible resources before recycling.
3. Waste unavoidably generated should be treated by energy recovery and managed as natural capital at final sinks as much as possible.

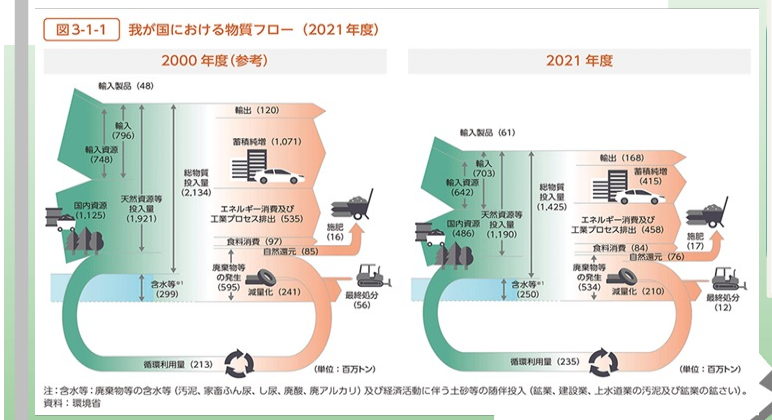
3R plus Renewable & Recovery

The 5th Fundamental Plan for Establishing a Sound Material-Cycle Society

What's the Fundamental Plan for Establishing a Sound Material-Cycle Society?

- The Fundamental Plan, formulated based on the Basic Act for Establishing a Sound Material-Cycle Society (established in 2000), aims to **promote comprehensive and structured measures and policies for the formation of a recycling-oriented society**. The plan is formulated every five years based on the Basic Environmental Plan.
- The Cabinet approved the Fifth Fundamental Plan on **** 2025.

Development of policies focusing on economic and social aspects



1st Fundamental Plan(2003)

Set numerical targets for recycling rate, resource productivity, and final disposal amount.
Introduce the concept of material flow.

2nd Fundamental Plan(2003)

(1) Integrated efforts to create a low-carbon society and a society in harmony with nature
(2) Creation of a Regional Circular and Ecological Sphere
(3) Creation of a global recycling-oriented society

3rd Fundamental Plan(2013)

(1) Strengthening measures that focus on reduce, reuse, in addition to recycling
(2) Response to the Great East Japan Earthquake

4th Fundamental Plan(2018)

Holistic enhancement of environmental, economic, and social aspects.

5th Fundamental Plan

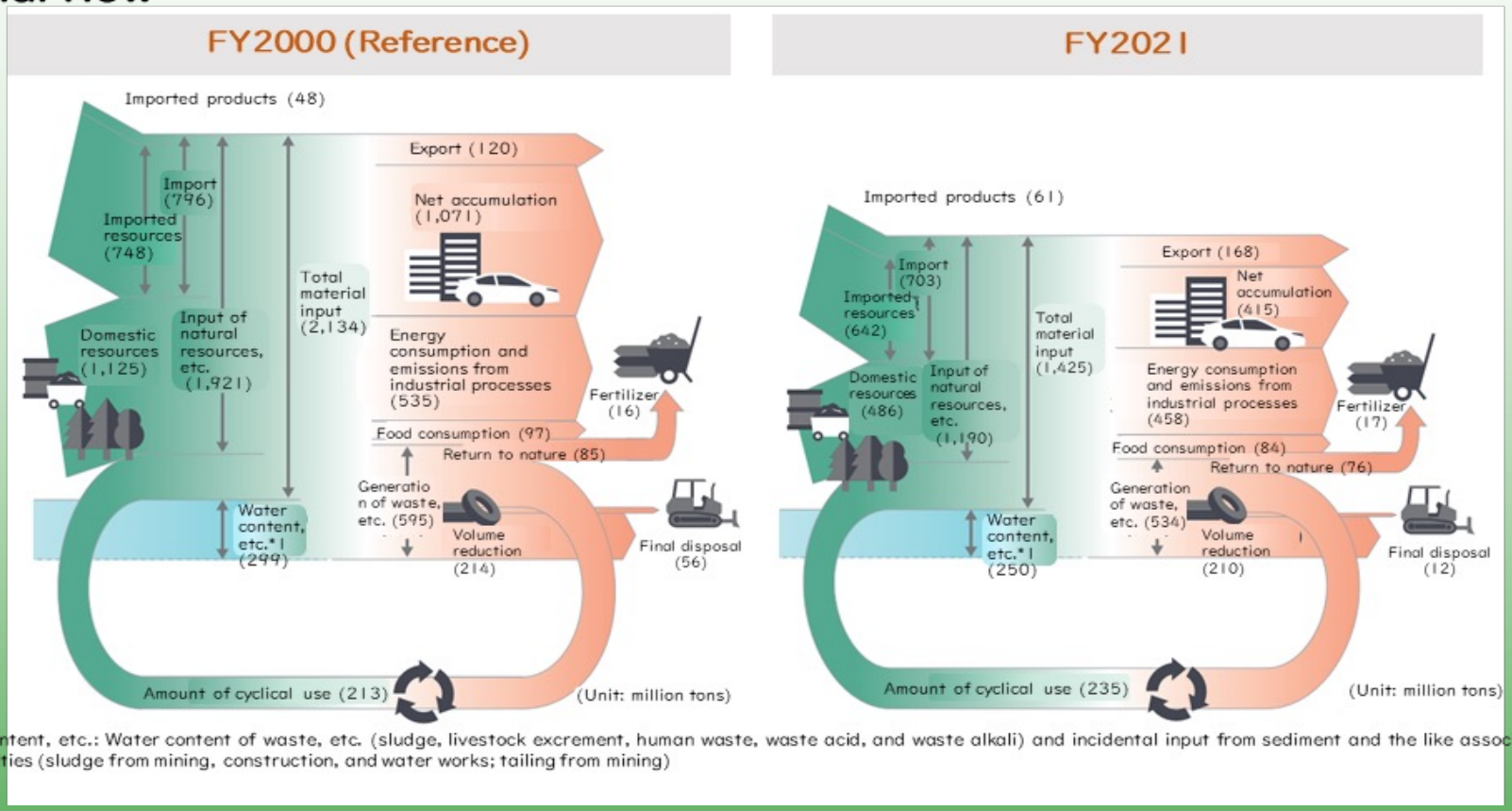
■ Highlighting the shift to a circular economy
■ In addition to environmental aspects such as climate change and biodiversity conservation, it strengthens industrial competitiveness, economic security, regional revitalization, and the realization of a high-quality lifestyle.

Developing the plan as a national strategy to ensure a better future for the next generation.

Development of policies focusing on environmental aspects

Regular assessment of the plan

*Material flow



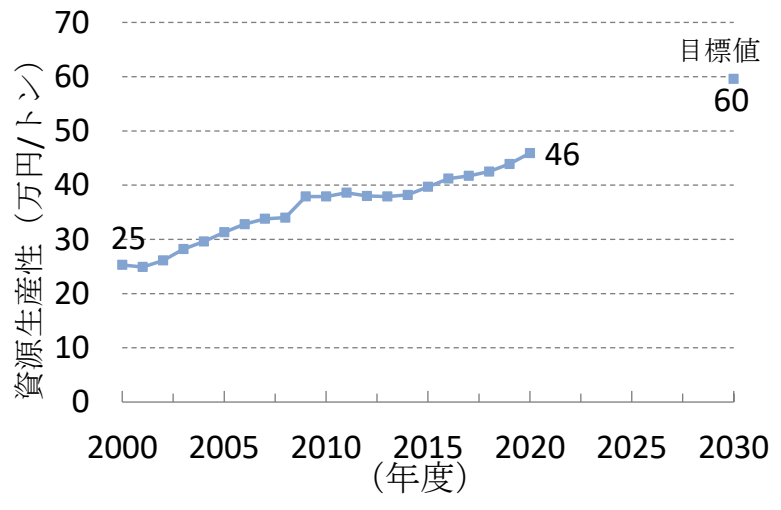
Note: Water content, etc.: Water content of waste, etc. (sludge, livestock excrement, human waste, waste acid, and waste alkali) and incidental input from sediment and the like associated with economic activities (sludge from mining, construction, and water works; tailing from mining)
Source : MOEJ

Material Flow Indicators for Assessing the Overall Status of a Material Cycles-Oriented Society

① Resource productivity

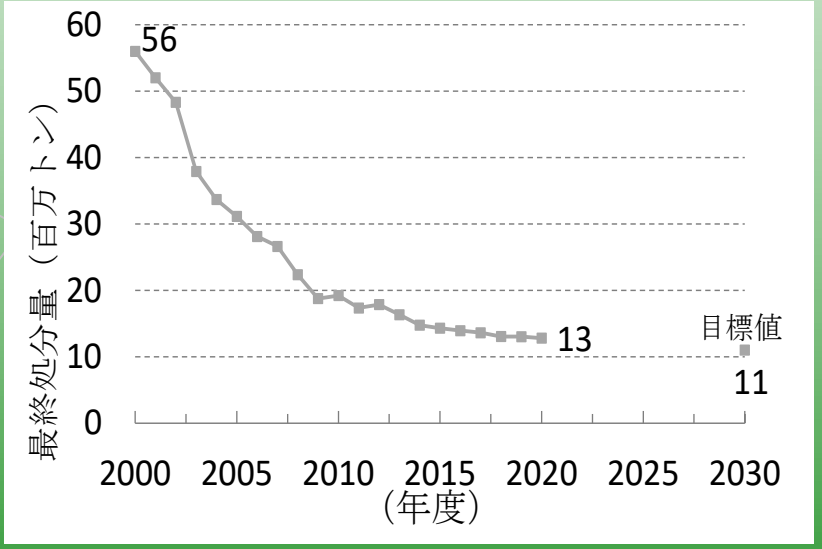
=GDP/Direct Material Input

An indicator that shows whether production activities improve while using fewer natural resources.



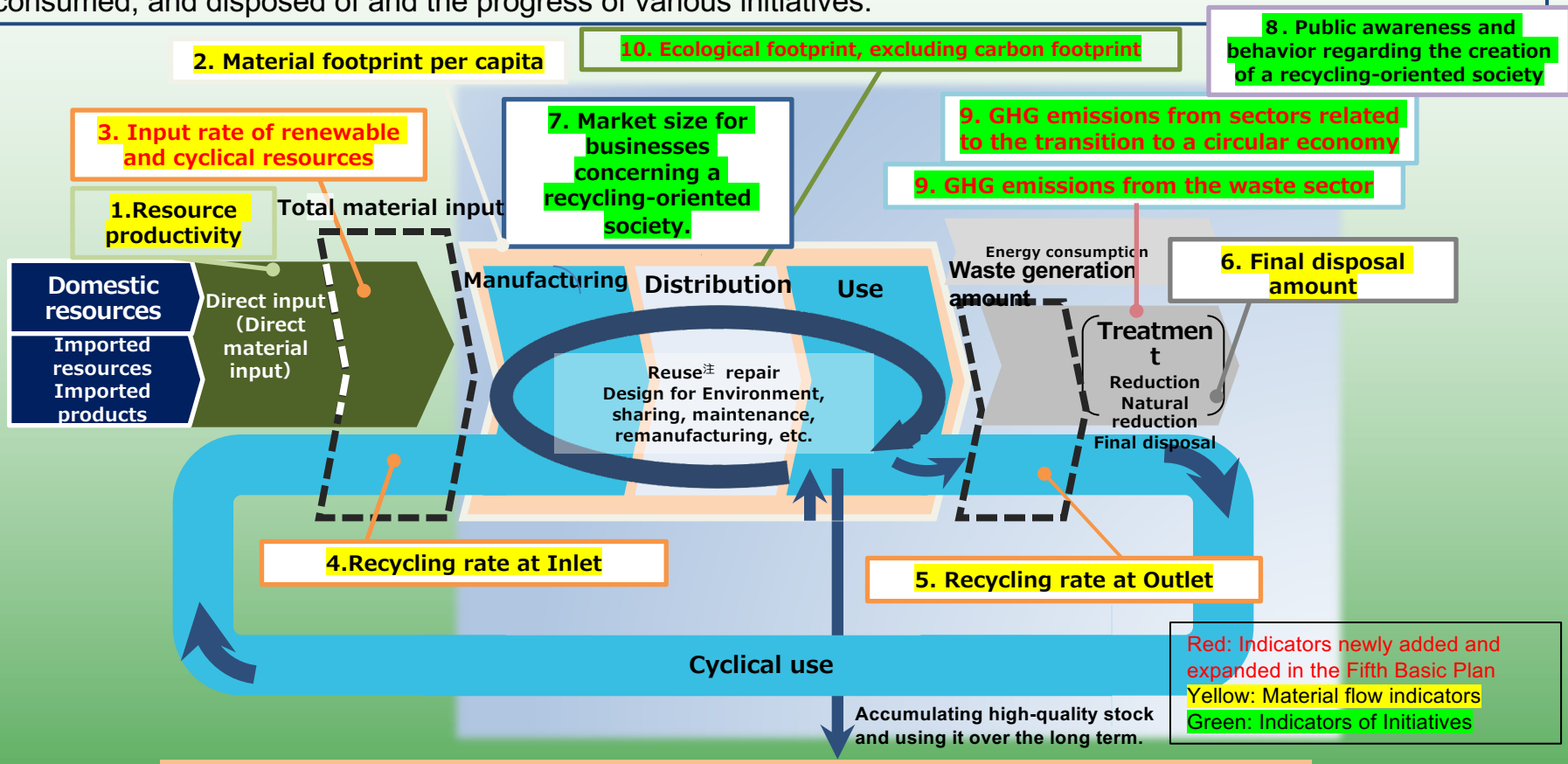
⑥ Final disposal amount

The amount of landfill waste. Promoting measures that curb waste emissions and improve recycling has reduced landfill waste. Implementing measures toward transitioning to a recycling-based economy can be expected to reduce it further.



Indicators for Assessing the Overall Status of a Recycling-Oriented Society (Outline)

■ Establish ten indicators to grasp the overall status of a recycling-oriented society.
They assess the cross-section of the material flow of resources to determine the amounts extracted, consumed, and disposed of and the progress of various initiatives.



※ Some input materials are either exported (as products) or consumed (such as food and energy). For simplicity, these factors are omitted from the diagram.
Note: Some of these are counted as cyclical use in the statistics.

3. Essential Roles of Waste Management

1. Disaster Waste Management
2. Chemical Control for Cleaner Material Cycles
3. COVID-19 and Essential Waste Management Works

A ship stranded and left on a building at Otsuchi town, May 7, 2011

Great East Japan Earthquake and the Damage

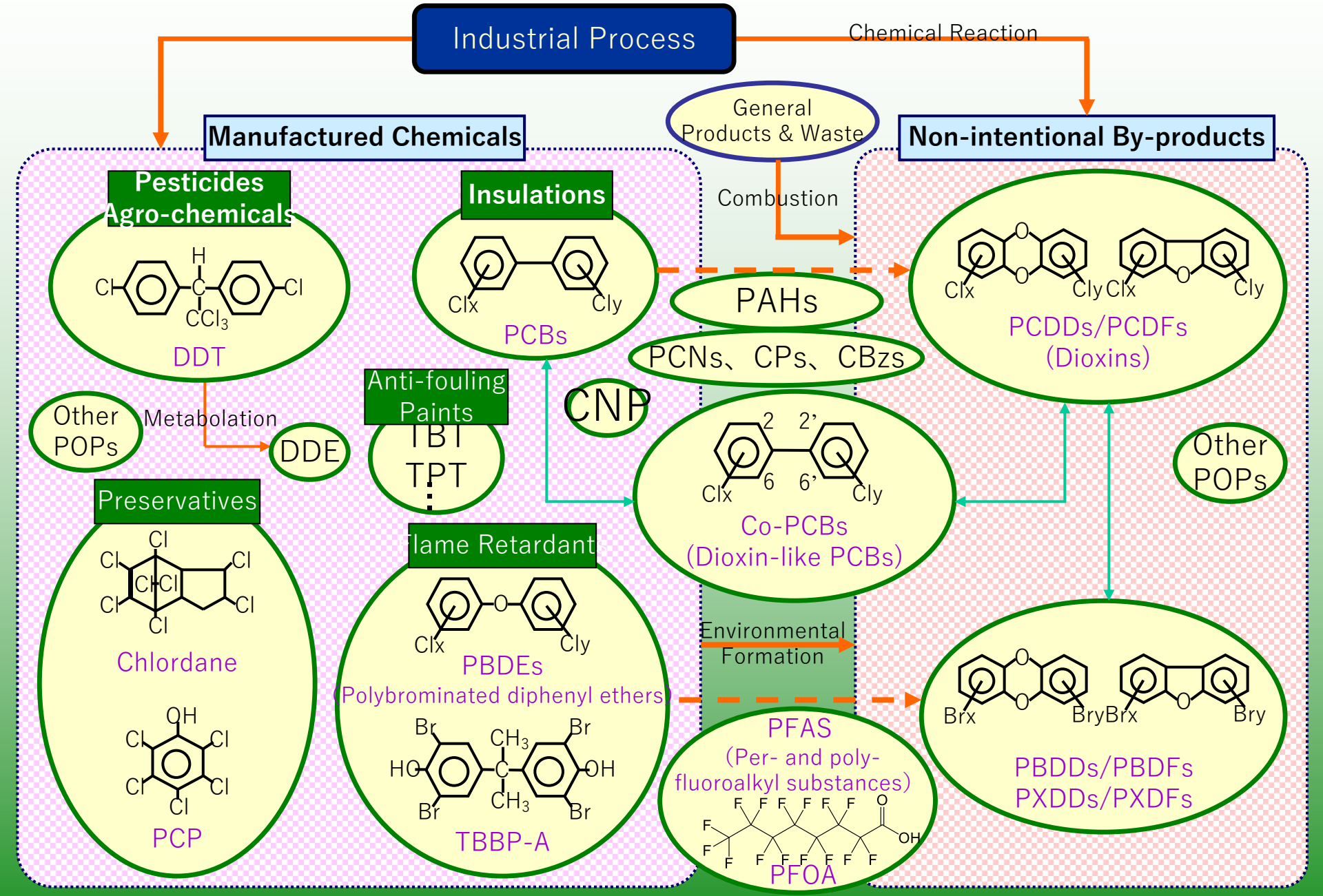
- **The Great Tohoku Earthquake: occurred at 14:46, March 11, 2011**
  - **Magnitude of 9.0, the largest earthquake ever recorded in Japan**
  - **Followed by a giant Tsunami with more than 10 m of wave height and a maximum 38.9m of backwash**
  - **Death toll: 15,899 Missing persons: 2,529 as of March 6, 2021**
- **More than 100,000 of fully or partially destroyed houses and buildings/ 400,000 of evacuees at the peak**
- **Fatal nuclear accidents brought about by the Earthquake and Tsunami at the Fukushima First Atomic Power Plant**
- **Around 20 trillion Yen of total financial damage**

Amount of disaster waste generated

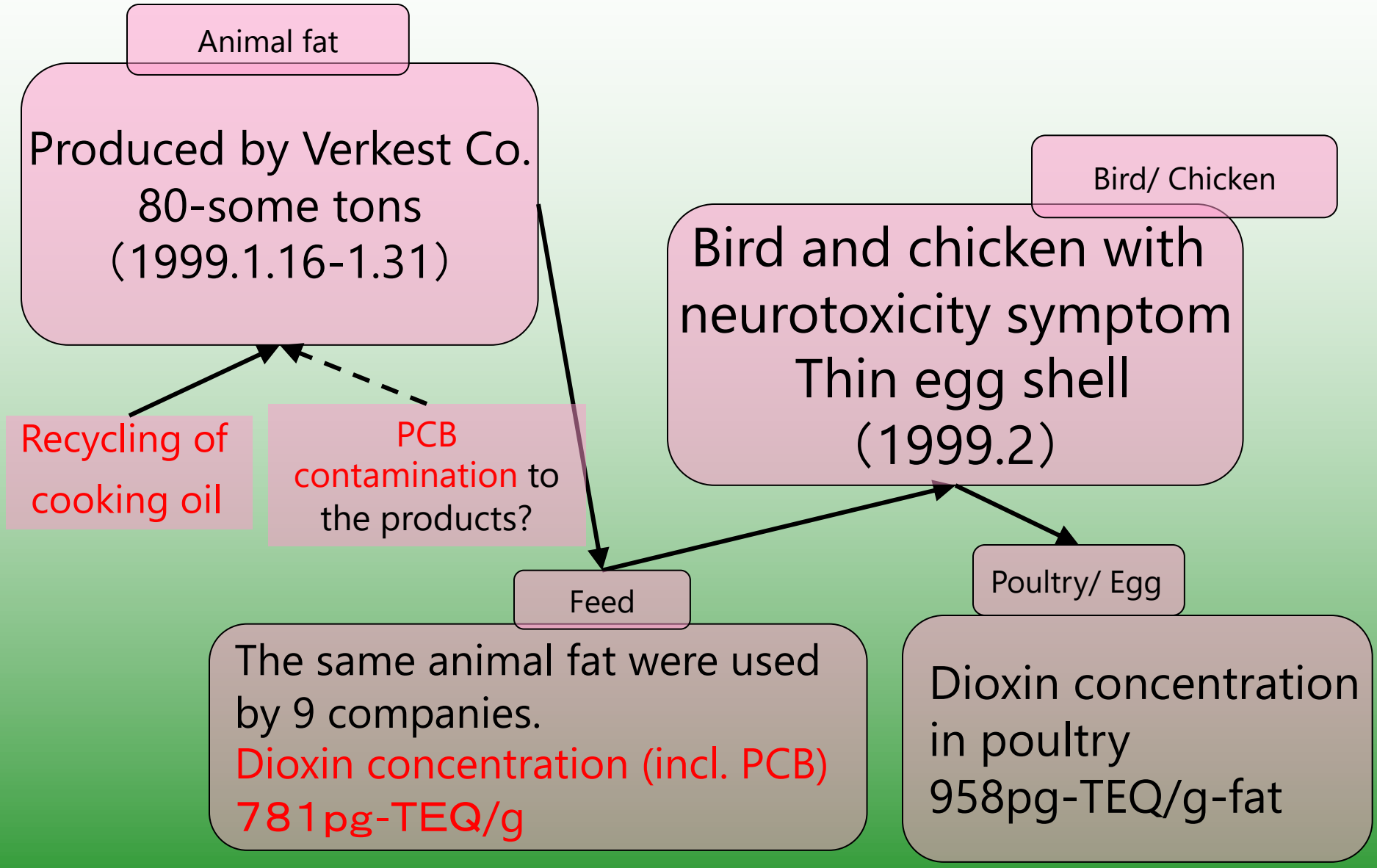
Year	Disaster	Amount of waste
2019	Eastern Japan Typhoon Flood	1.68 million t
2018	Western Japan Heavy Flood	2 million t
2011	The Great East Japan Earthquake	25 million t
2010	2010 Haiti earthquake	Around 23 - 60 million t
2009	Terremoto dell'Aquila (Italy)	Around 1- 3 million t
2008	2008 Sichuan earthquake (China)	20 million t
2005	Hurricane Katrina (U.S.)	76 million m^3
2004	Hurricane Frances & Jeanne (U.S.)	3 million m^3
2004	2004 Indian Ocean earthquake and tsunami	10 million m^3 (only in Indonesia)
1995	The Great Hanshin-Awaji Earthquake (JPN)	15 million t

Note :Some modification was made on review article by Brown et al.[4)]

Examples of Persistent Organic Pollutants - Manufactured Chemicals and Non-intentional By-products



PCB Contamination of Belgium Poultry and the Problem Structure



“Clean/ Cycle/ Control”, 3C Concept

- **Basic concept for technologies and society systems with the control of hazardous wastes and persistent chemicals**
- **Avoid the use of hazardous chemicals and the use of alternatives.（Clean）**
- **In case there is no appropriate alternative substances and the use of specified material is essential because of its crucial effect, recycling should be the principle.（Cycle）**
- **Emission control to the environment, and the decomposition and stabilization of stock substances and wastes which have been used in the past.（Control）**

Sakai, S. Environ. Sci. & Pollut. Res. 7(4) 225-232 (2000)

***We have no choice except pursuing these two ways to save livings and this planet.**

UNCRD/UN DESA High-Level Regional 3R and Circular Economy Forum in Asia and the Pacific

Aligned with SDGs and with support of MoE-Japan, UNCRD 3R & CE initiative calls for lasting supply security of resources as the basis for sustainable development. It aims to provide a policy framework to implement 3R & resource efficiency measures to achieve circular economic development – an alternative economic growth model which is not at the expense of finite natural resources and ecological assets, rather regenerative. UNCRD's 3R & circular economy initiative brings up both the policy, scientific & research community & private sector to convene on an annual basis the high-level Regional 3R & Circular Economy Forum in Asia-Pacific to strengthen the science-policy interface in addressing 3R & resource efficiency as the basic for economic growth, pollution prevention and strengthening resilience of cities & communities, and after all, to achieve the international agendas & agreements – SDGs, Paris Agreement, NUA, among others.

1st Japan 2009 → 2nd Malaysia 2010 → 3rd Singapore 2011 → 4th Vietnam 2013 → 5th Indonesia 2014 → 6th Maldives 2015 → 7th South Australia 2016 → 8th India 2018

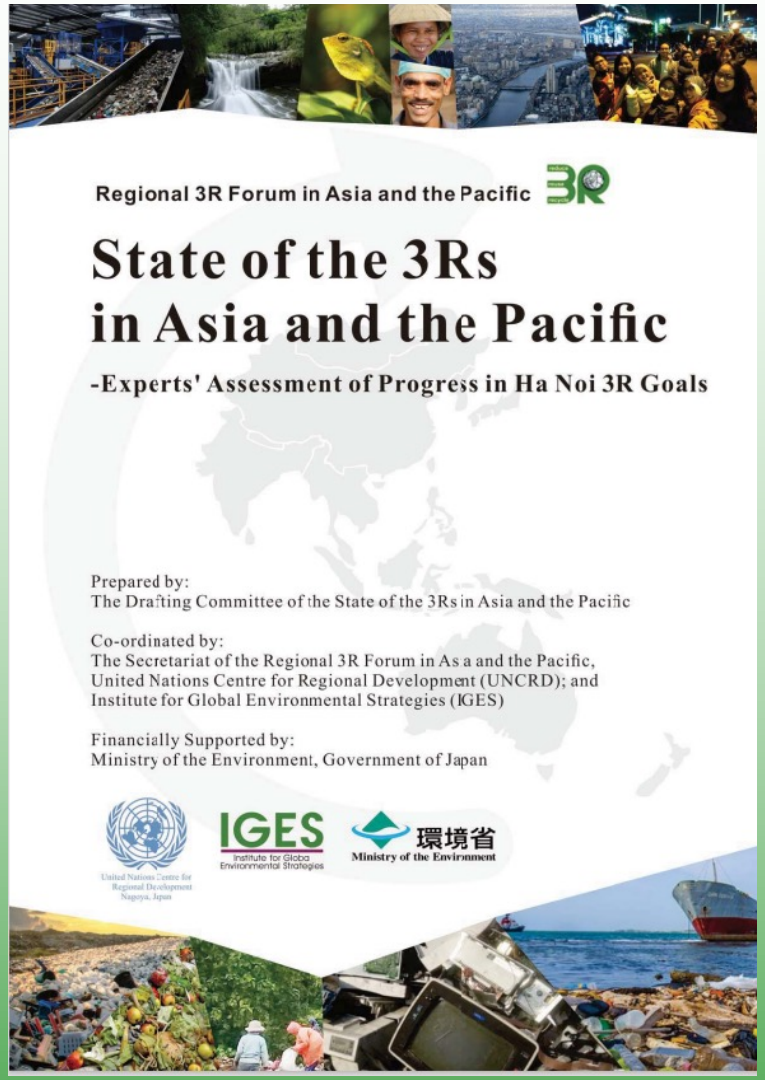
- 1st: Tokyo 3R Statement
- 3rd: Singapore Recommendation
- 4th: Ha Noi 3R Declaration (2013-2023)
- 5th: Surabaya 3R Declaration
- 6th: Male 3R Declaration
- 7th: Adelaide 3R Declaration on Circular Economy
- 8th: Indore 3R Declaration on Clean Water, Land, Air in Cities

9th Thailand 2019 → 10th Webinar 2020 → 11th Cambodia 2023 → 12th 2024 (India – tbc)

- 9th: Bangkok 3R Declaration Towards Prevention of Plastic Waste Pollution through 3R and Circular Economy
- 12th: Jaipur 3R & CE Declaration (2025-2035) expected to be adopted on 5 March 2025 at 12th Forum in Jaipur chalking a pathway for Asia-Pacific to advance cicular economy

First State of 3Rs in Asia and the Pacific

- Launched during 8th Regional 3R Forum in Indore, India in 2018.
- Developed a synthesis and status report to assess current status of 3R policy implementation in the region.
- This report has developed 11 country reports and a regional report (Bangladesh, Cambodia, PR China, India, Indonesia, Japan, Malaysia, the Philippines, Singapore, Thailand, Viet Nam and Pacific Island Countries).



Special Thanks for Science Community Cooperation with Policy and Business Model Development in the Fields of 3Rs and Waste Management