

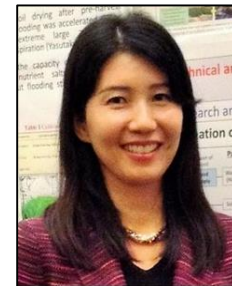
# **R/D Study on Plastic Waste Recycling/Circulation by Thermo-hydrolysis Processing using Subcritical Water Reactor**

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# Presentation Summary



## 1. Background of our R/D study

of Current Concerns over Massive Plastics Use and Disposals

## 2. 3Rs + Renewables

New Strategic Policy toward Plastics Recycling/Circulation

(1) Reduce, (2) Recycle, (3) Bioplastics, (4) Incineration

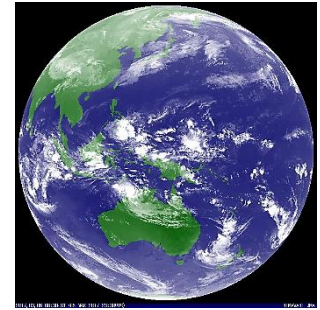
## 3. Verification on the Workability of SCW Reactor

Proved to be Innovative enough in Plastic Waste Recycling /Circulation Business

## 4. Conclusion and Future Tasks

Multi-billion Dollars Business Model & New Jobs for People

# Vision toward Plastics Waste Recycling In the World by Subcritical Water Technology



## ○ **Plastics Waste Recycling enabled by Subcritical Water Tech.**

The SCW/MRM is proved to be workable to dissolve plastics very fast to promote recycling and circulation of plastic-mixed urban waste.

## ○ **Contribution to Plastics Recycling/Circulation Policy**

The SCW/MRM can enable the mixed-plastics recycling/circulation for the following objectives:

- (1) Production of compost (soil conditioner),
- (2) Production of biofuel and/or bioplastics,
- (3) Promotion of methane fermentation,

thus realizing plastics recycling/circulation policy urgently needed in the world.

# 1. Background of our R/D Study on Plastics Recycling



On the Land

Bottom

**Case of B City, India**  
**(गंगा)**

Top

**Case of J City, Indonesia**

Daily Amount > 6,000 tons,  
Eq. to 2,000 truck loads

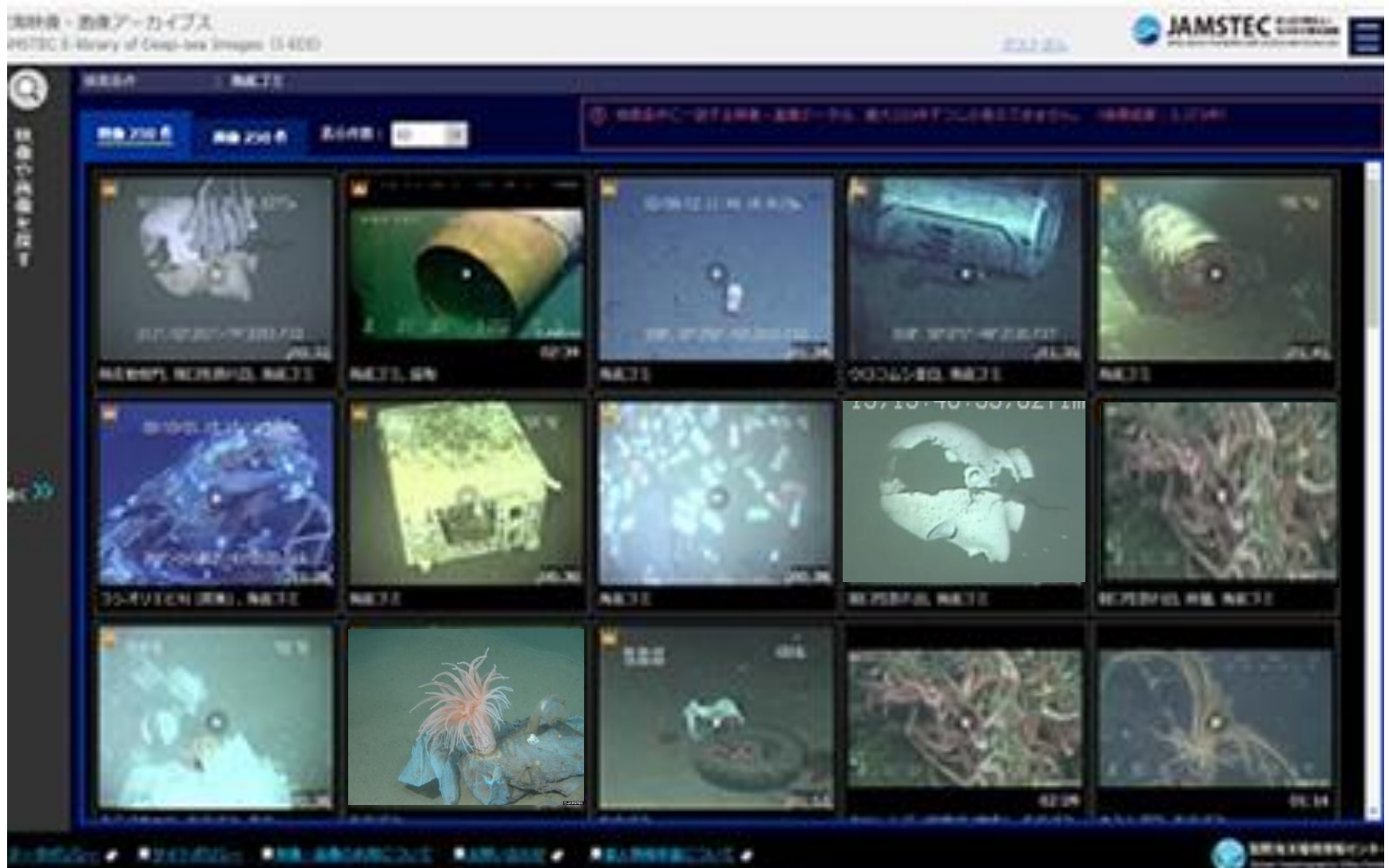


**Garbage Time Bomb?**



# Bottom of Deep Seas\_\_\_\_ a ‘Tomb of Plastics’?

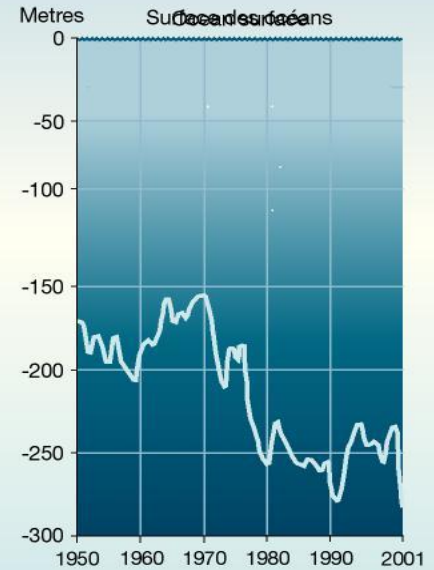
In the Deep Sea



**Fishing yield, in tonnes per km<sup>2</sup> per year**  
Fish, molluscs and crustaceans

0.05 0.2 1 3 5 10

Sources: Ifremer; FAO; *Ecosystems and Human Well-Being, Synthesis*, Millennium Ecosystem Assessment, Washington DC, 2005. Based on a map by François Carré, University of Paris IV. Map outline: Gall-Bertin projection.



PHILIPPE REKACEWICZ  
MARCH 2005



Source: NASA **Garbage Patch** Visualization Experiment



## 2. Strategic Approach toward Plastics Recycling/Circulation

### Japan

2016 **17** million tonnes  
2017 **9.4** million tonnes

Overseas: 0.08  
3Rs+Renewable  
Strategy

**1.7** million tonnes

1950

# WORLD

The world plastic\* production almost reached 350 million tonnes in 2017.

Source: PlasticsEurope Market Research Group (PEMRG) / Conversio Market & Strategy GmbH

### EUROPE

(EU28+NO/CH)

### Circular Economy Strategy

2016 **60** million tonnes  
2017 **64.4** million tonnes

Marine Debris **8.0** million tonnes

**335** million tonnes  
**348** million tonnes

2016

2017

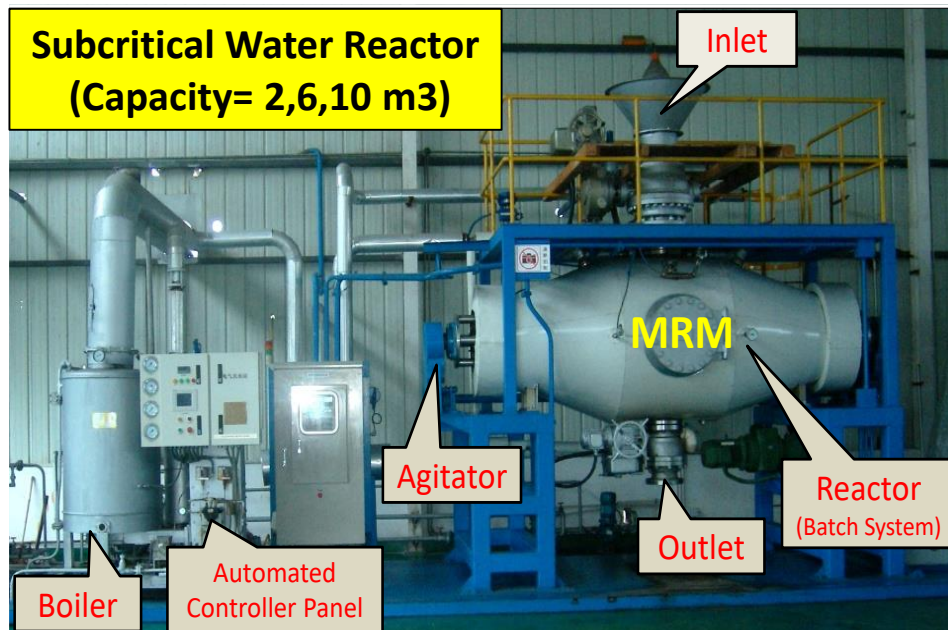
Source: Plastics Europa + Japan's Statistic of Plastics Production and Disposal

# 3. Verification of the Workability of Multiple SCW Reactor

How it works to decompose/dissolve various bio-waste & plastics

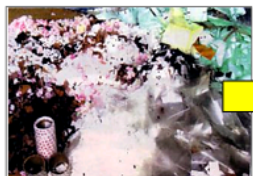
## Applicable to Various Bio-wastes

- ◆ From decomposing of organic materials to dissolving of plastics



## Simple & Speedy

- ◆ Saturated steam from a boiler combined with agitation system
  - 100-200°C@10-20 atm (1-2 MPa)
  - Processing Time: 10-60 min.
- ◆ High performance with smaller energy consumption (2m3 Case)
  - 2m3 @ 10 batch/day = 20m3/day = 10 ton/day (0.5 ton/m3)
  - Equivalent to garbage amount of 10,000 people



*Plastic-mixed Biowaste*



*Fish Residue*



Destroy Lignin Layer to Reveal Cellulose



*Wood Chips*

**Multi-Functional  
Recycle Machine  
(MRM System)**



# Road Map of Japan, 2018

## Current Status of the Biomass Utilization Technology

Regarding “the current state of biomass utilization technology and roadmap” (hereinafter referred to as “technology roadmap”), which was decided along with the “biomass commercialization strategy” in September 2012, a review was conducted based on the information from relevant ministries and the National Research and Development Corporation.

### ◆ Newly added technical case

#### **Thermochemical conversion/fast hydrolysis (Subcritical Water)**

Raw materials: Wood-based, herbaceous, food waste, sewage sludge, livestock waste etc.

Products: feed and fertilizer

Technology level: Research and demonstration (partly put into practical use)

Current status: This technology decomposes organic materials efficiently and converts it into resources using subcritical water region which is below the critical point (temperatures of 100-200 degrees Celsius and pressures of 10-20 atm.). Various technological developments such as high-performance compost and detoxification of bacteria are expected.

May 17, 2019 Biomass Utilization Promotion Council decision

Quoted from "the current status of the biomass utilization technology and its roadmap

# Verification Test (1): Hydrolyzing of Plastics by SCW Processing



## ① Raw Materials: Plastic-mixed Food Residues

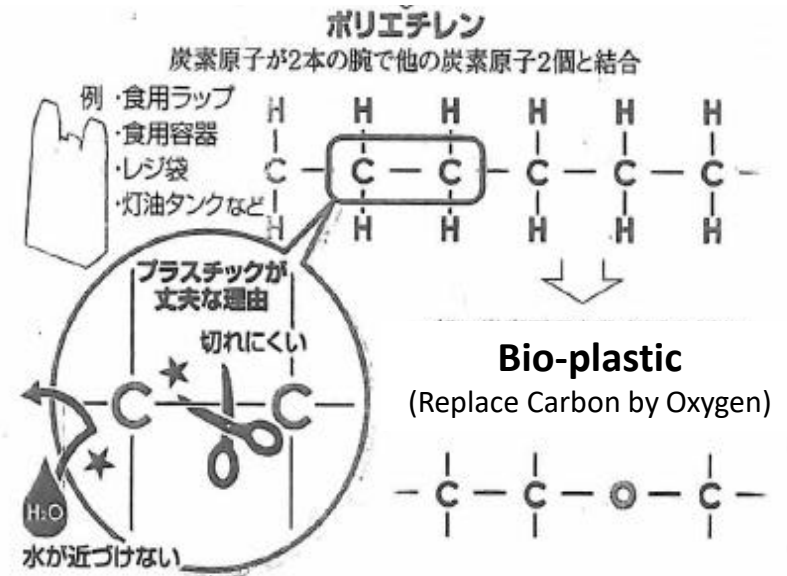


## ② Subcritical Water Processing (130°C/12atm@10min.)



## ③ Hydrolyzed Plastics (Converted into alcoholic liquid)

## Hardly Decomposable Structure of Polyethylene (PE)



## Results:

Hydrocarbon structure of plastic (PE) is durable and hydrophobic, therefore hard to be dissolved by water.

SCW processing is proved to be workable to hydrolyze them shortly into alcoholic liquid, useful for methane fermentation and/or biofuels

# Verification Test (2): Hydrolyzing of Plastics by SCW Processing



① Raw Materials:  
Plastic-mixed Urban Waste  
(Shanghai, China, 2008)



*'Garbage Time Bomb'*

**Solution to solve Bottlenecks of  
Current Landfill Systems**



② Subcritical Water Processing  
(180°C/15atm@20-30min.)

**Results:**  
(Shanghai, 2008)

- ◆ SCW processing is proved to shortly dissolve plastics components, thus realize organic fertilizer production as circular economy business model.
- ◆ It could help solve bottlenecks of current landfill systems, plus create plastics-based biomass plastics production models.



③ Final Product  
(Organic Fertilizer)



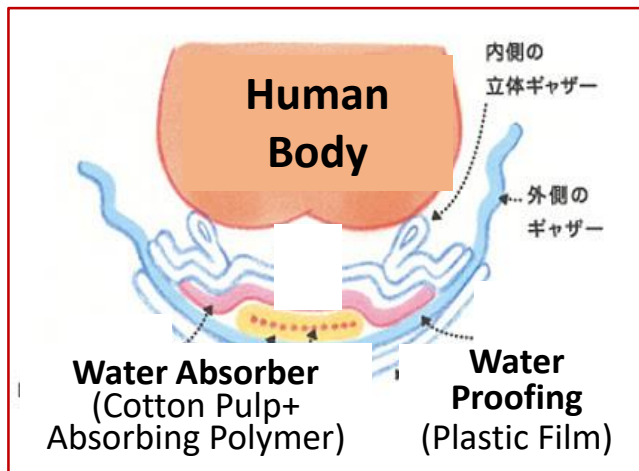
# Verification Test (3): Hydrolyzing of Paper Diaper by SCW Processing



①Raw Material: Used Paper Diaper  
(Plastic-mixed Organic Waste)

②Subcritical Water Processing  
(190°C/13.5atm@30min.)

③SCW-hydrolyzed  
Product mixed with  
Dissolved Plastics



**Structure of Paper Diaper**  
(Plastic + Organic Fiber)

## Results:

Paper diaper is plastic-organics-mixed compound. After disposal, it becomes wet and unhygienic, plus costly for incineration, posing heavy financial load to municipalities.

The diaper is proved to be hydrolyzed/dissolved by SCW processing quite shortly.

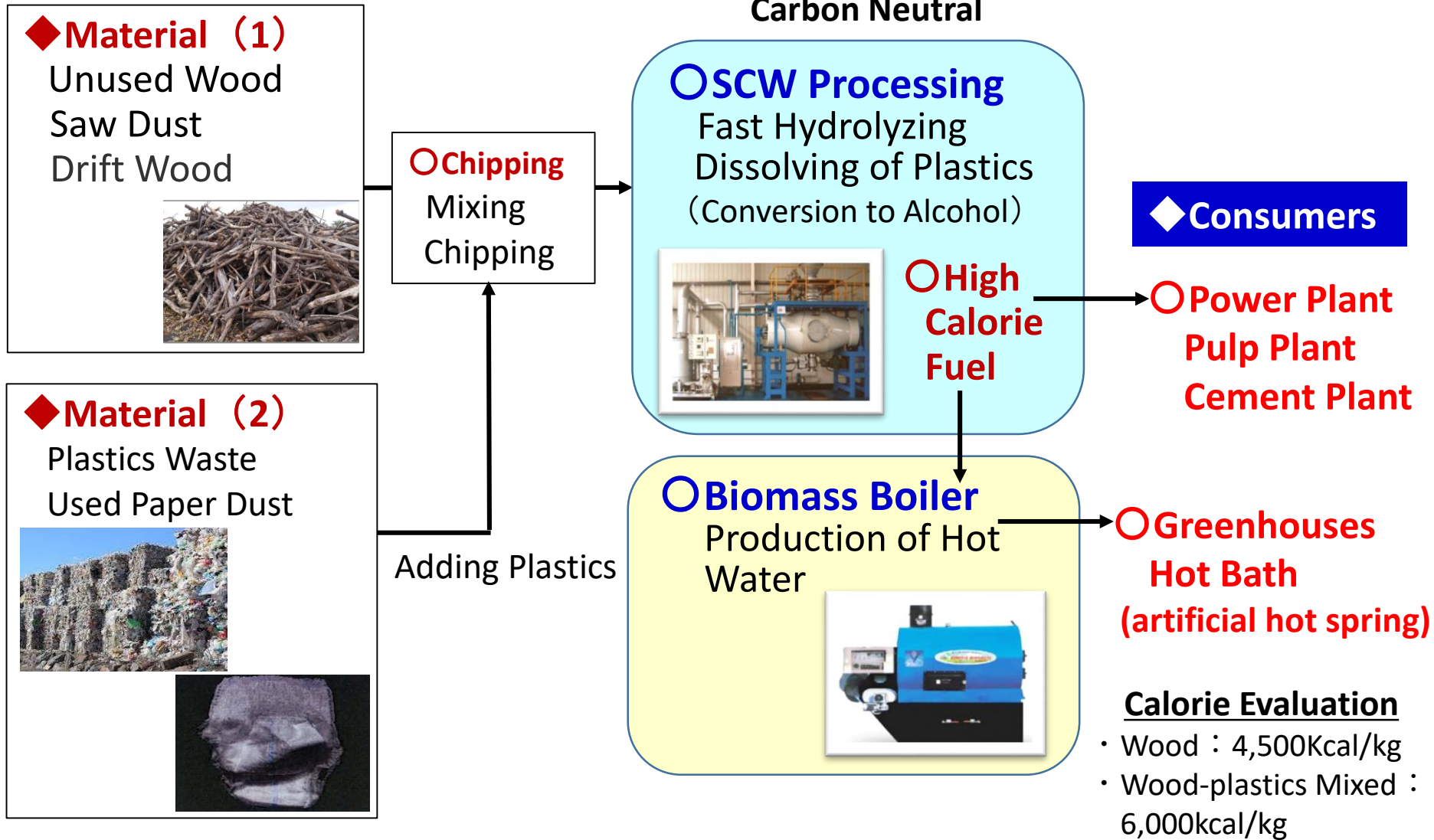
The processed final product forms fine fiber-based material to be utilized as high calorie biofuel and/or paper container.



*SCW Processing of  
Medical Waste including  
Used Shringe by  
Multiple Recycling Machine  
(MRM)*

# Solution (1) : Production of High-calorie Solid Fuel

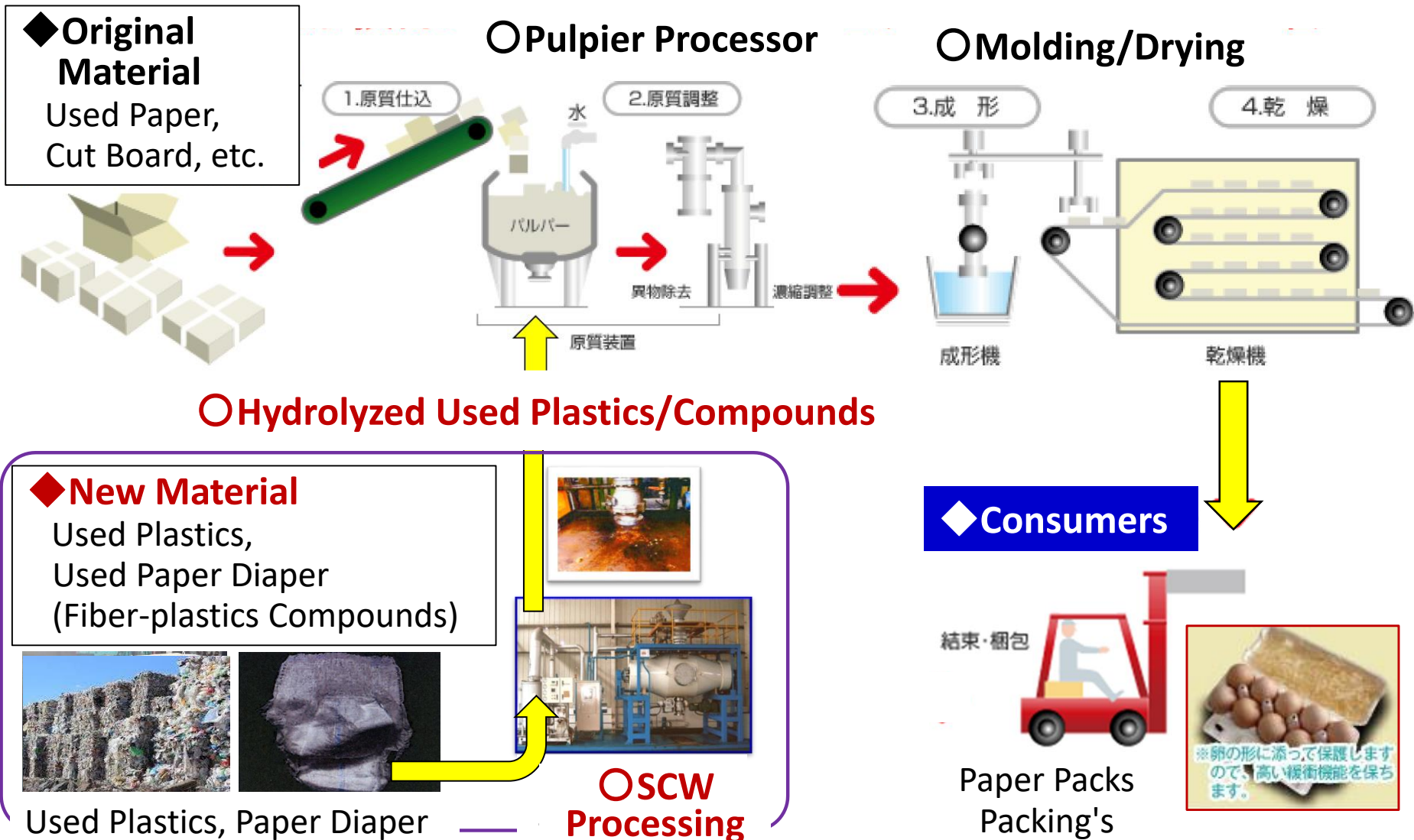
Solid Fuel for Warming Greenhouses and/or Hot Bath (Artificial Hot Spring)





# Solution (2) : Production of Recycled Paper Packs

## Mold Tech.+ SCW Reactor to Produce Recycled Paper Packs



# Conclusion & Future Tasks

## Conclusions:

- **The Subcritical Water reactor** is proven to be enough functional to hydrolyze plastics and its compounds fast.
- The machine is contributable to plastics recycling by producing **high calorie fuel** and/or **recycled paper packs**.

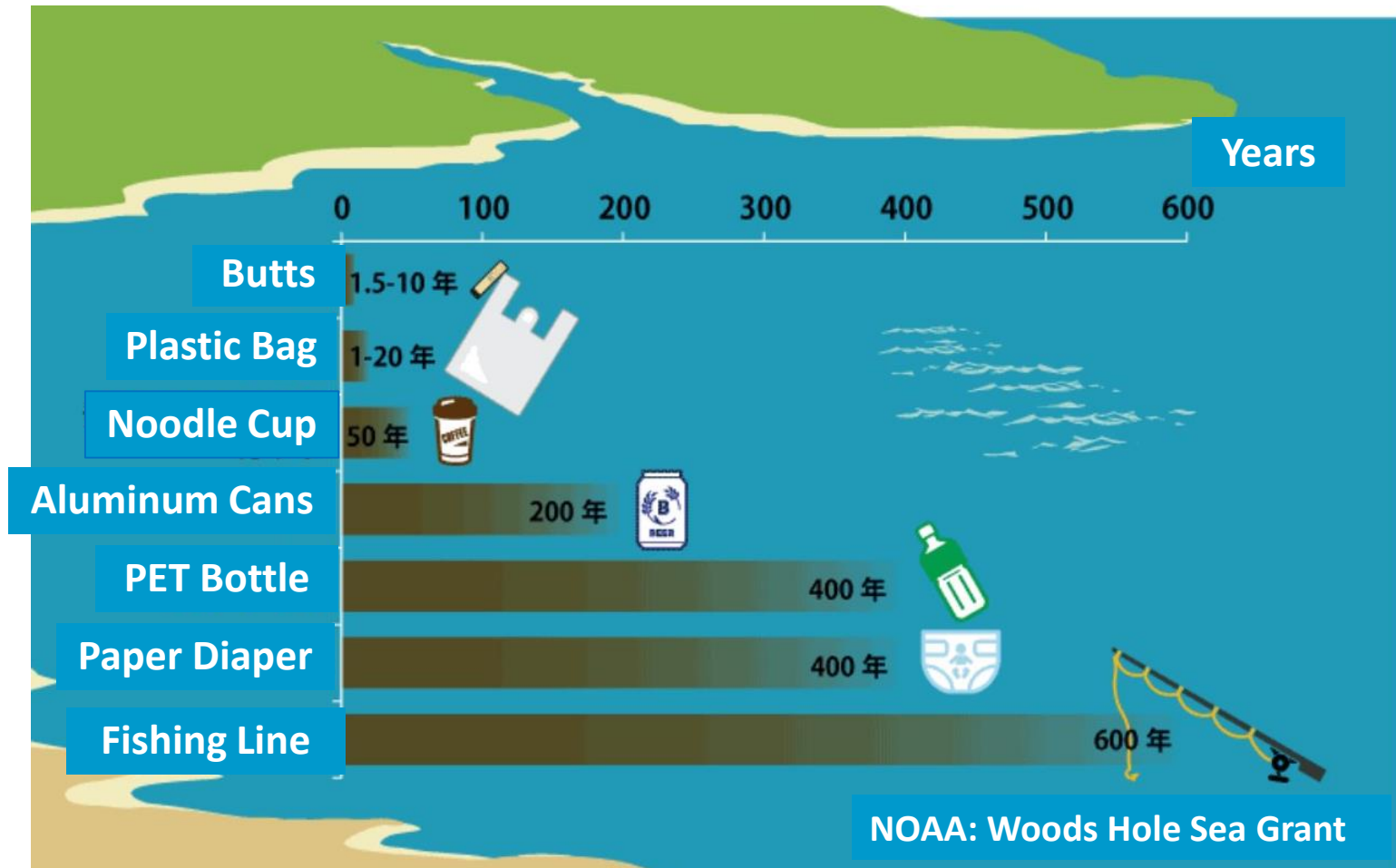
## Future Tasks:

- **Business model creation** in any countries where recycling of plastics is strongly requested.

No. of SCW Units (6m3)	10 units for processing 100,000 tons/y (300 tons/d) of Plastics
Initial Cost	Approximately 2,500 million yen (24 million US\$)
Annual Sales Income*	Approximately 2,000 million yen (19 million US\$) on the condition of price evaluation of the product: 20 yen/kg

\*Additional income may be expected to accept plastics waste from waste collectors.

# Thank you for your kind attention.



Life Longevity of Plastics/Metal Materials



# Total Integration in “Resources-from-Biowaste” Model

## Carbon Field

### Logging Residues



Barks

*Sustainable Use of Wood Resources*

## 【Core Tech.】 SCW Reactor

Multiple-function  
Recycling Machine



Creation of  
Recycle-oriented  
Sustainable  
Community  
Models

### Wood-based Cattle Feed Hub



Ranchers &  
Breeder

Collection  
of Excreta

## Value-added Organic Farming



*Reduction of massive  
chemical fertilizer use  
in farmlands  
Production of value-  
added agri-business.*



*Volume Reduction  
of Plastics Waste*

### Functional Compost (Bio-pesticide Effect)



**Domestic Waste**  
(Biowaste Portion  $\doteq$  60%)

Separation

### Recycling Hub

## Bio-Waste

- Urban Biowaste
- Food Residues
- Animal Excreta
- Barks, etc.

## Biomass Field

*Prevention of Water Contamination by Garbage Landfill System*