Inaugural Meeting of the Regional 3R Forum in Asia, Tokyo, 091111

E-waste Management for the Sound Material Cycles and Persistent Chemicals Control

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Kyoto Workshop on 3R (Reduce, Reuse & Recycle) and Waste Management, Kyoto, Japan, 29-30 October, 2009

Main Topics

1) Policy and technical developments on 3R developments and waste management
-- the present status and trends for the future

2) Policies on household hazardous waste management and their regional control systems

Invited countries/ organizations:
European Union (EU), UK, Germany, Italy, Sweden, U.S.A., China, Korea, Viet Nam,

Summary of Kyoto Workshop on 3R and Waste Management

1. Waste management attracts great attention because it is part of the social infrastructure system in each region. It is an important issue in society for citizens and industries of each region to promote waste management.

2. The role of 3R policies has expanded not only as a measure for waste management but also for the preservation and effective use of natural resources, the management of hazardous chemical substances, and the reduction of greenhouse effect gas (GHG).

3. Many issues related to chemical substance control still remain to be taken up in waste management and 3R policies. Approaches towards household hazardous wastes are required in some regions.

E-waste Management for the Sound Material Cycles and Persistent Chemicals Control

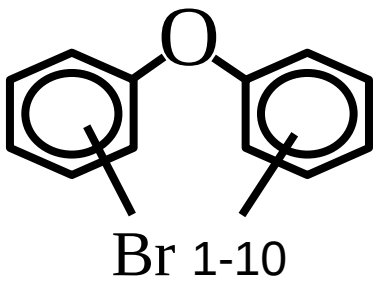
1. E-waste and Chemical Related Issues
    1. Brominated Flame Retardants (BFRs)
    2. Mercury (Hg)
2. E-Waste Recycling System Developments
3. “Clean, Cycle & Control” Concept as Hierarchical Chemical Management

E-waste Management for the Sound Material Cycles and Persistent Chemicals Control

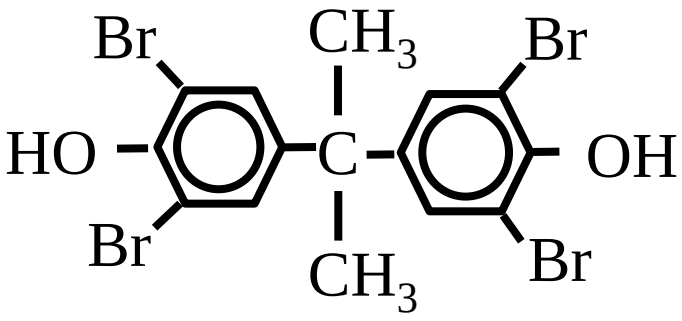
1. E-waste and Chemical Related Issues

(1) Brominated Flame Retardants (BFRs)

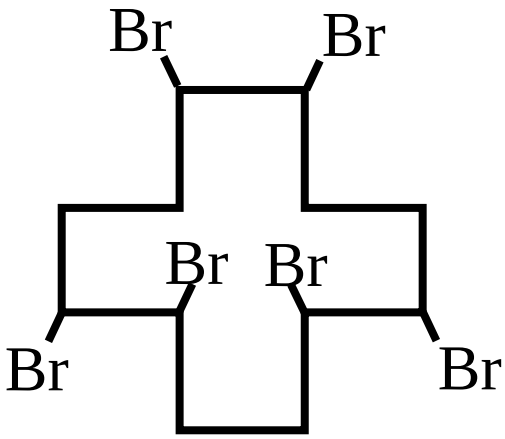
Chemical structure of BFRs and PBDD/DFs



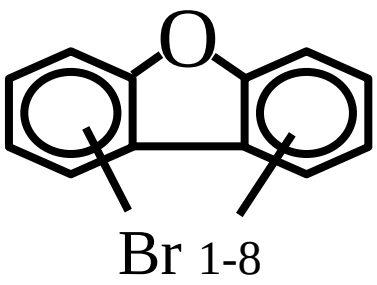
PBDEs



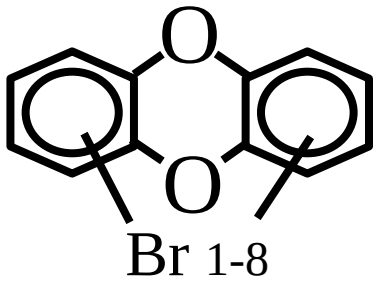
TBBPA



HBCD

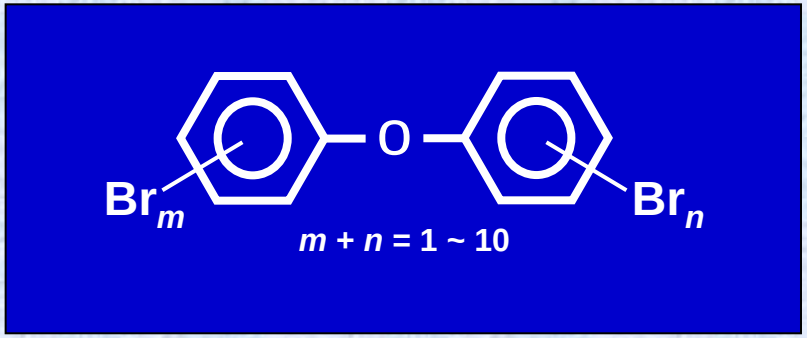


PBDFs



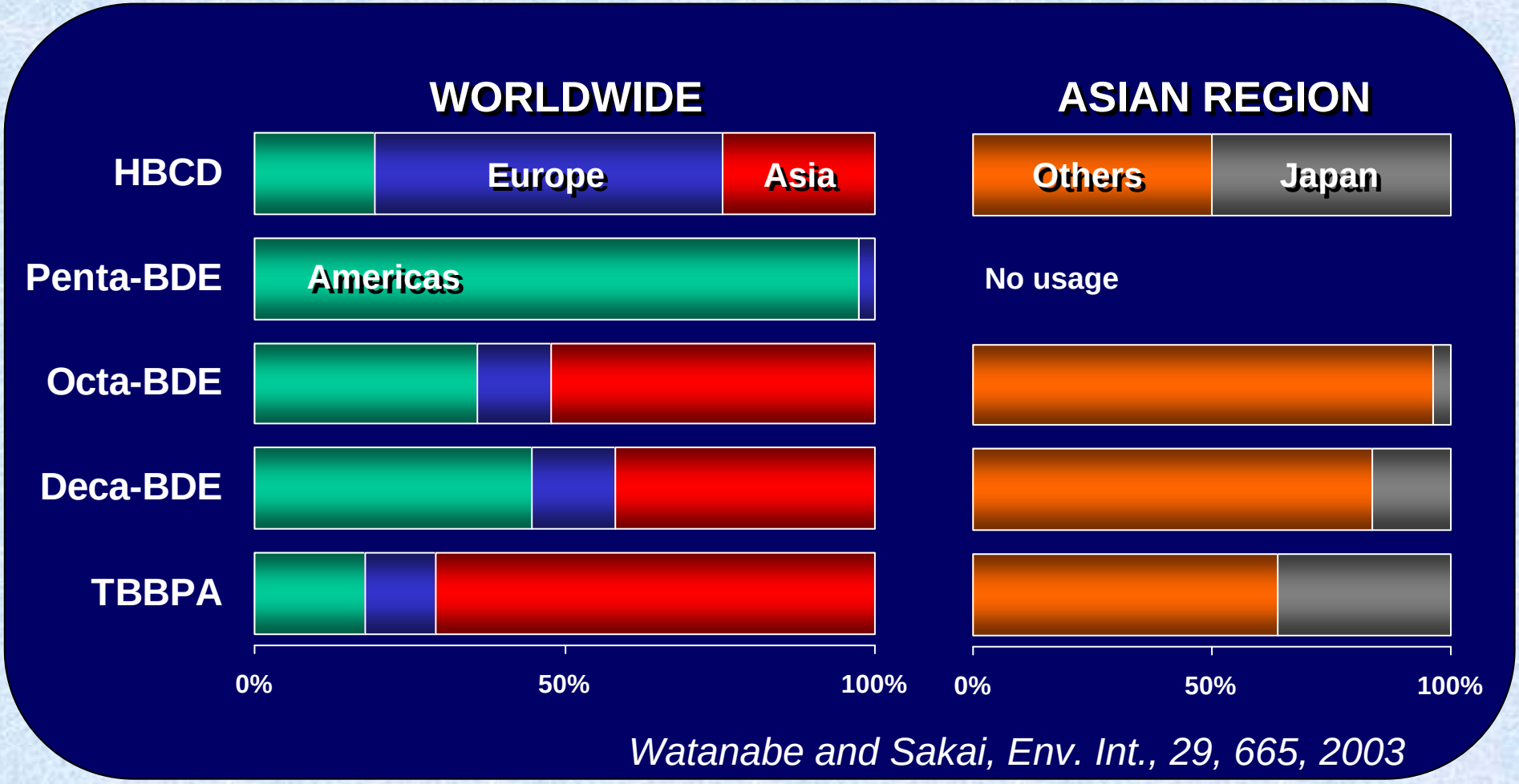
PBDDs

Polybrominated Diphenyl Ethers (PBDEs)



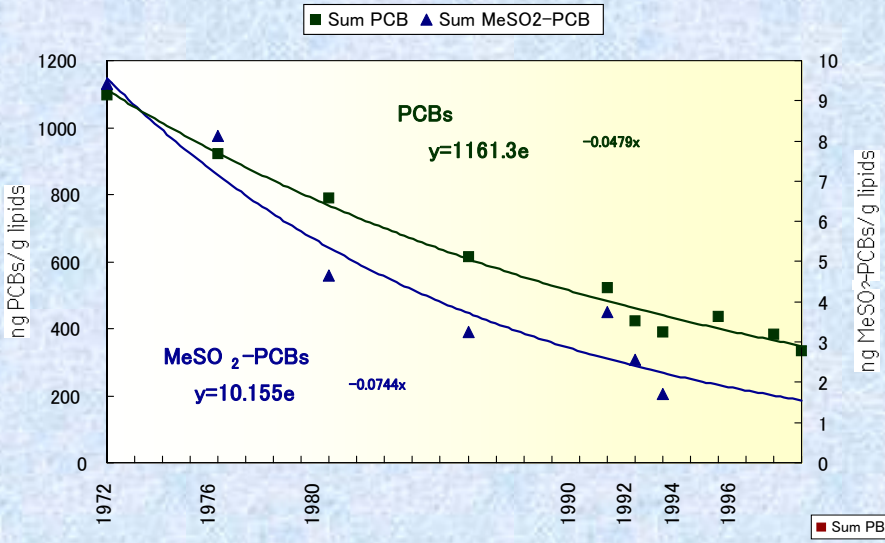
- Common additive flame retardants
- Used in high impact polystyrene, polyurethane foam, textile coatings
- Structure and properties are comparable to persistent organic pollutants (POPs) such as PCBs and DDTs
- Toxicity
  - Alteration of thyroid homeostasis by hydroxylated metabolites
  - Neurobehavioral effects
  - Carcinogens

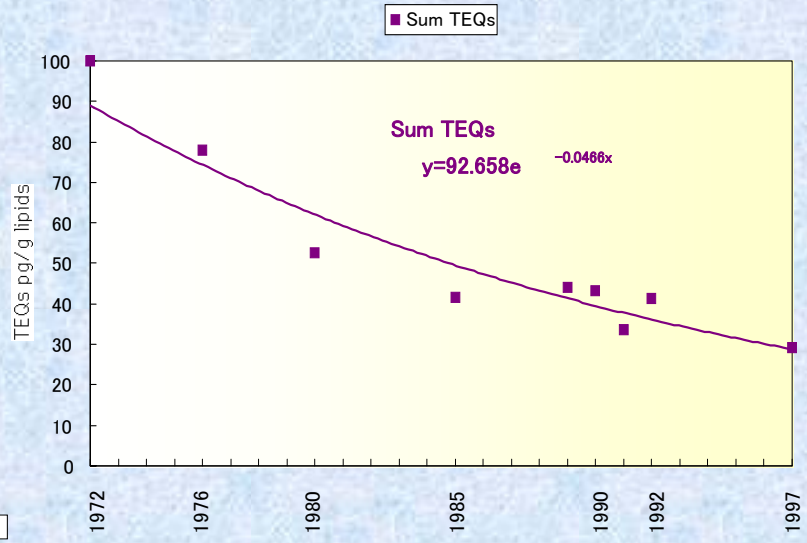
Annual Consumption of Brominated Flame Retardants in Asia in 1999

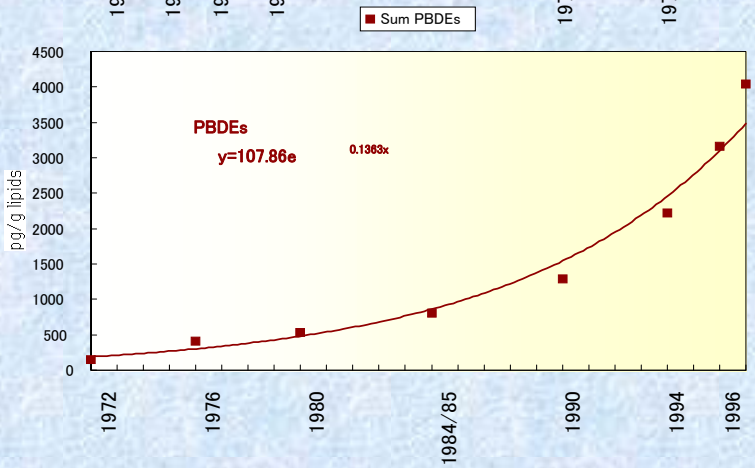


Watanabe and Sakai, Env. Int., 29, 665, 2003

Time Trends of POPs in Human Milk by Norén & Meironyté







Norén & Meironyté Chemosphere, 40, 1111 (2000)

Inside of TV set cover

Organic Bromine Compounds in TV set back cover and Inside Dust

TV Back Cover

Sample ID	K (Late '80s)	L (Early '90s)	M (Late '90s)	Average
PBDDs/DFs4-8 (ug/g)	100	240	510	280
PBDEs (ug/g)	36,000	91,000	77,000	68,000
TBBPA (ug/g)	11	3,400	21,000	8,100

Dust Inside TV cover

Sample ID	G (Late '80s)	H (Early '90s)	I (Late '90s)	Average	Dust of Air Conditioner
PBDDs/DFs4-8 (ug/g)	8.5	1.6	2.1	4.1	0.0059
PBDEs (ug/g)	200	160	320	230	4.2
TBBPA (ug/g)	4.1	11	37	17	0.15

Tamade et al, Organohalogen Comp.,56,189, 2002

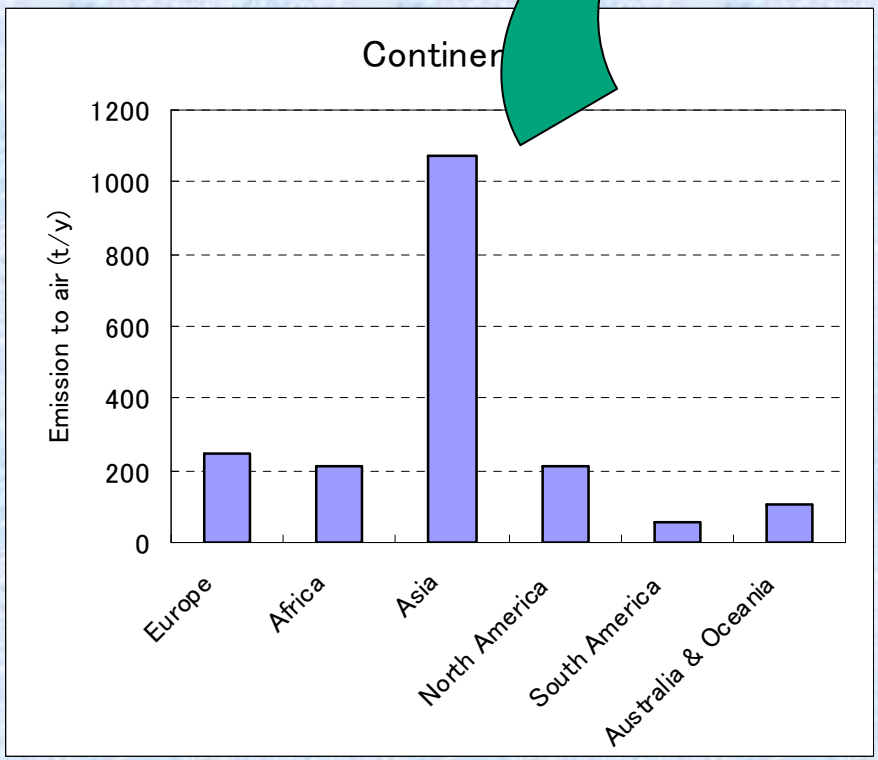
E-waste Management for the Sound Material Cycles and Persistent Chemicals Control

1. E-waste and Chemical Related Issues

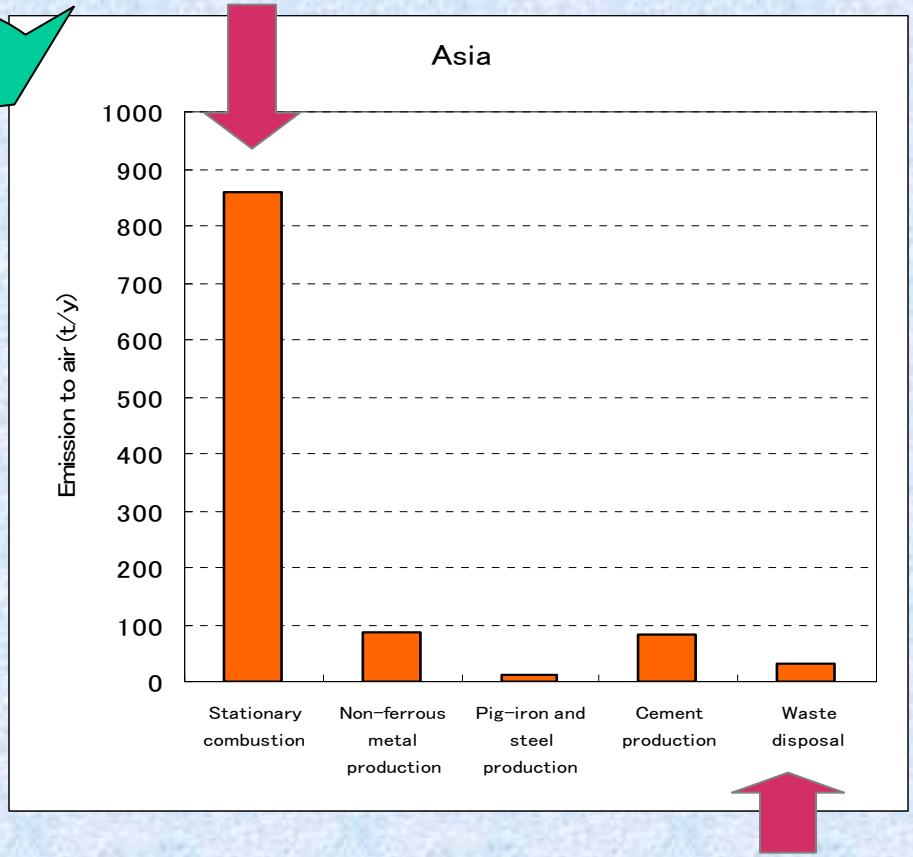
(2) Mercury (Hg)

Global Inventory and Asia

Asia



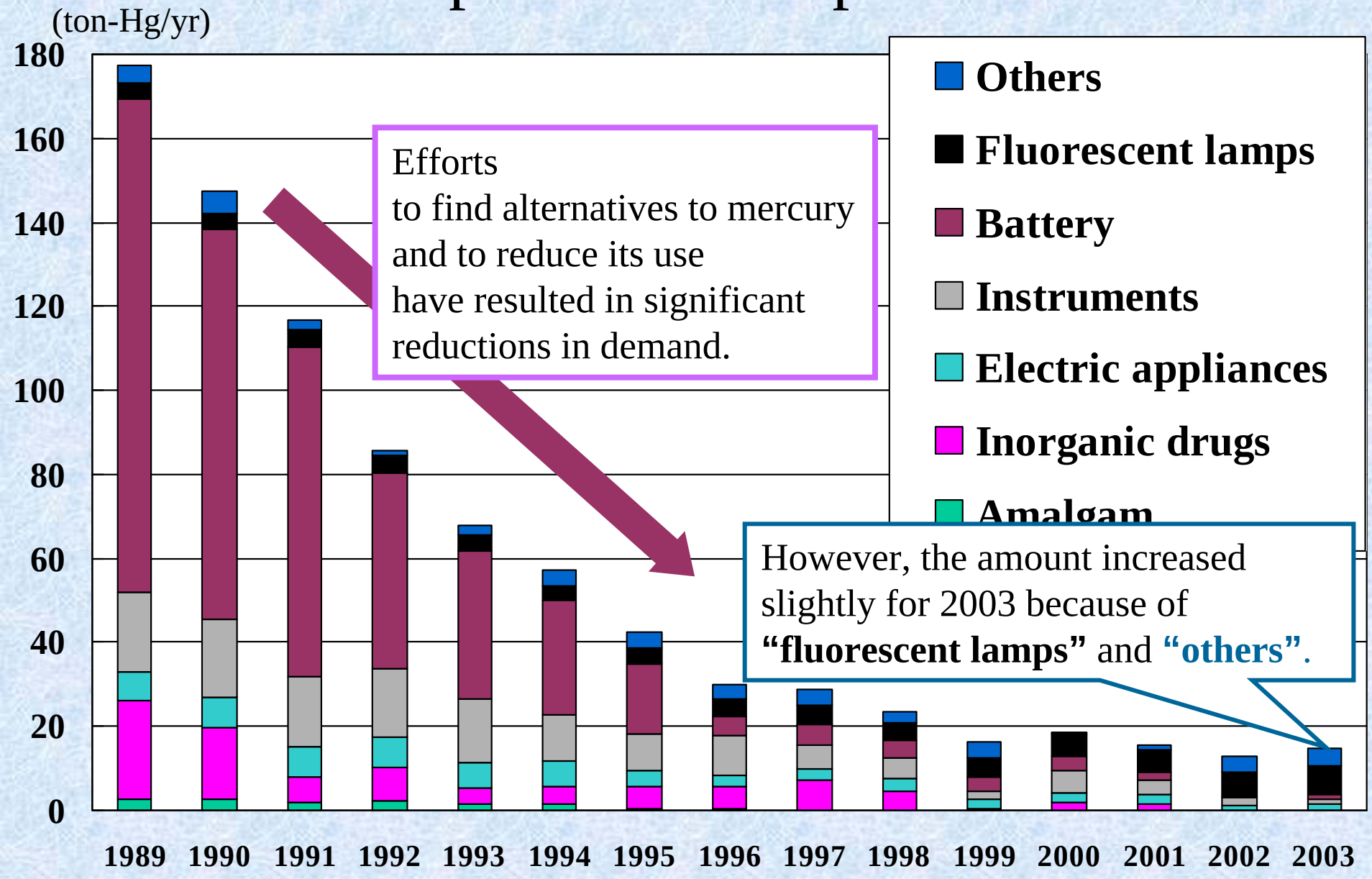
Coal Combustion



Waste incineration ←Japan

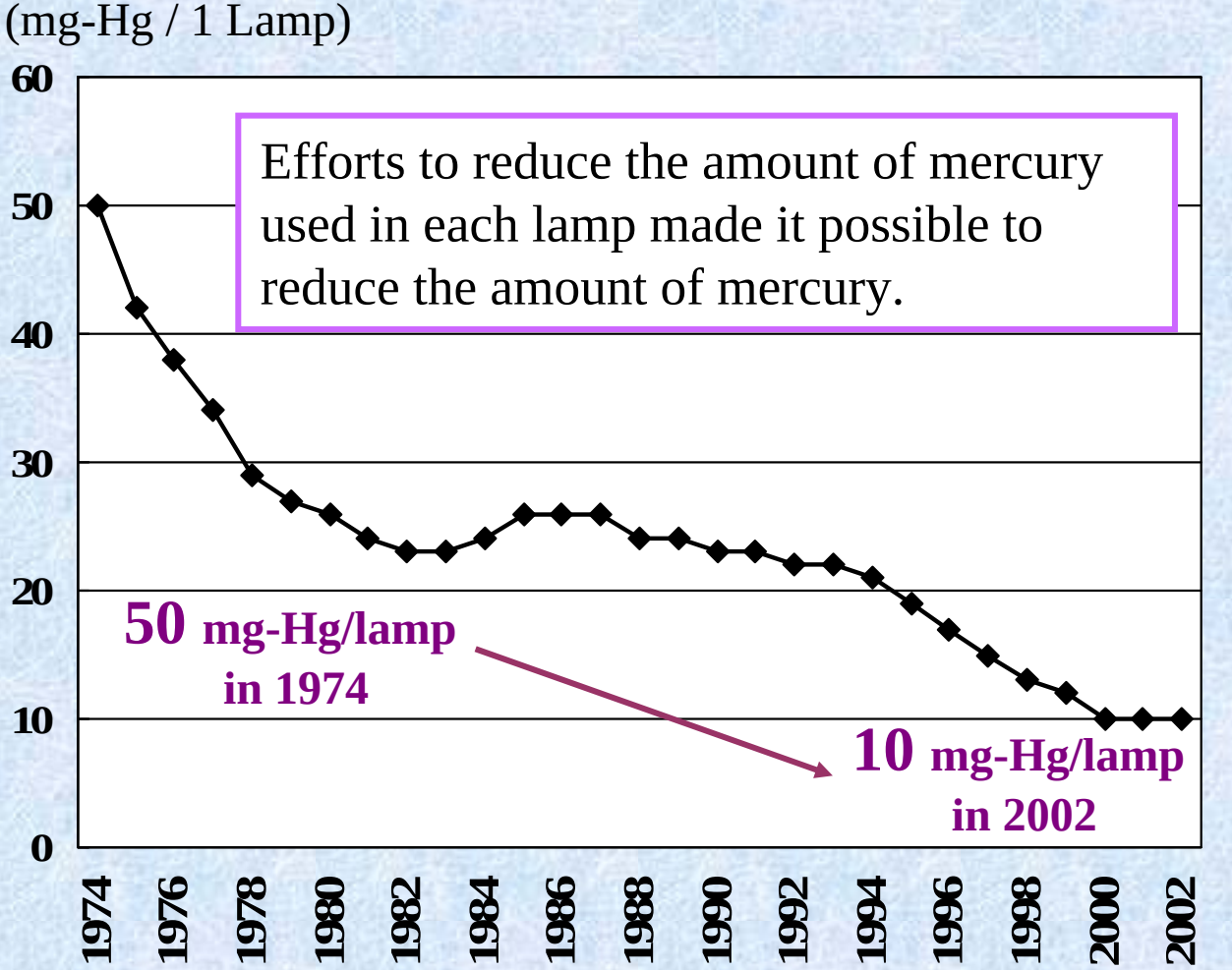
UNEP, Global Mercury Assessment (2003)

Products: Domestic demand of mercury for products in Japan

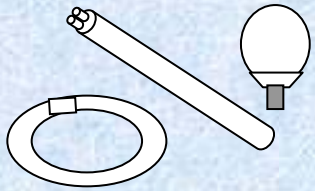


Products: *Fluorescent lamps*

Fluorescent lamps include a small amount of mercury as an essential substance; however, they are energy-efficient and widely used for domestic lighting.

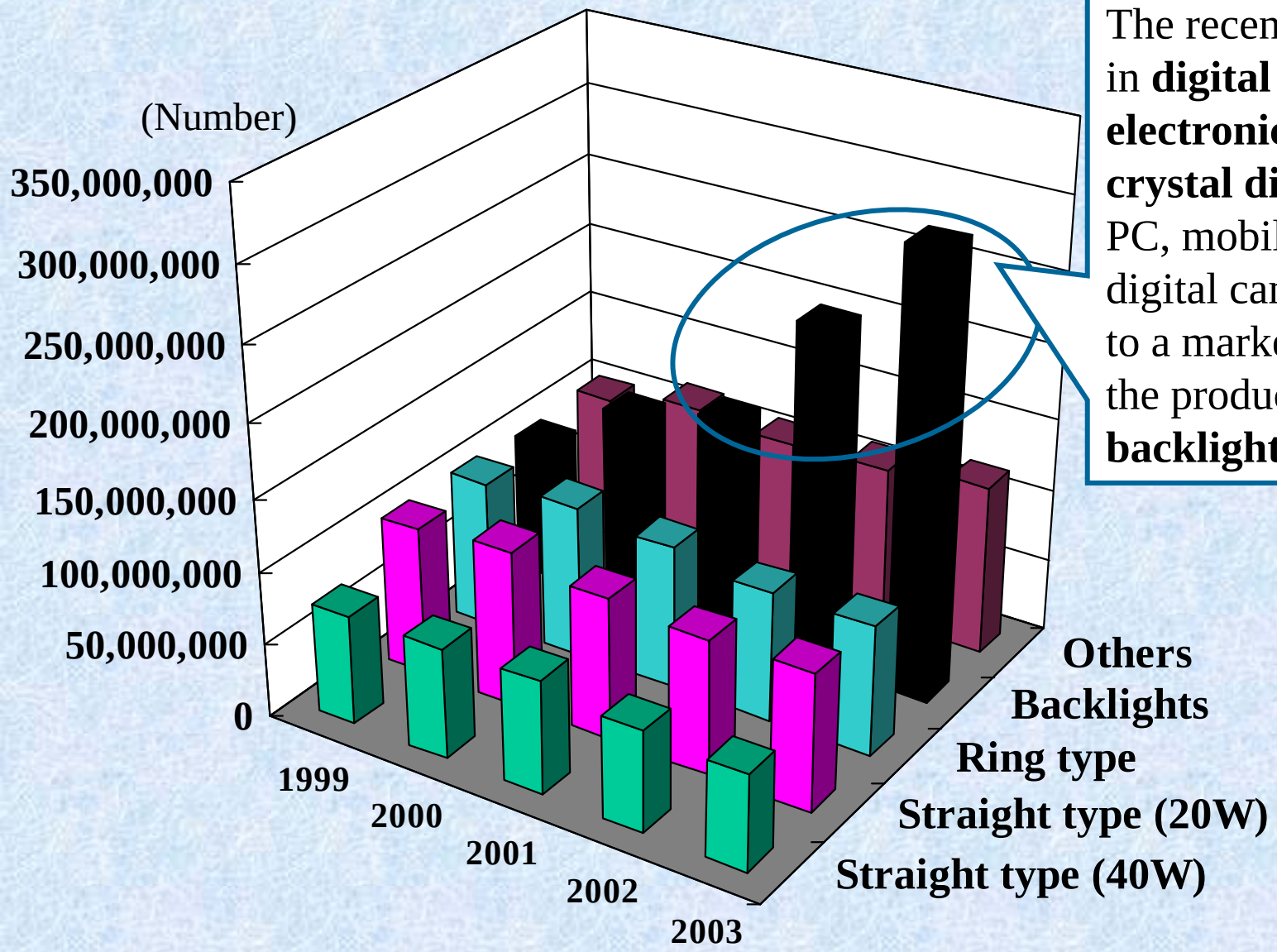


The average amount of mercury used in each lamp in Japan



On the other hand, despite efforts to develop a replacement technology, nothing seems to be superior to mercury in terms of efficiency and economy.

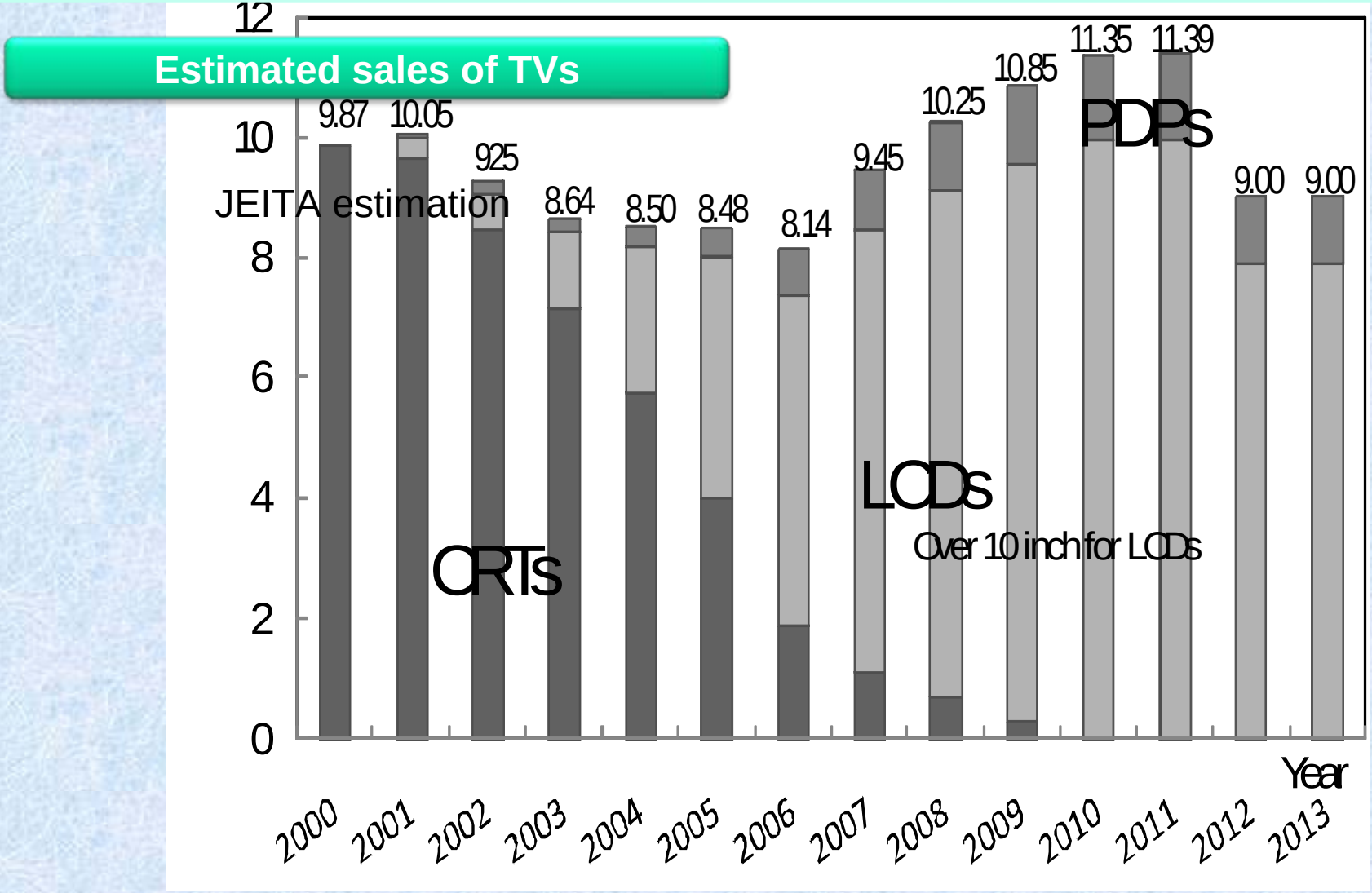
Domestic sales of fluorescent lamps



The recent rapid increase in **digital home electronics with liquid crystal displays** (TV, PC, mobile phones, and digital cameras) has led to a marked increase in the production of **backlights**.

Change of TV model and recycling

Liquid crystal displays (LCDs) and plasma displays (PRDs) spread rapidly as alternatives to cathode-ray tube TVs (CRTs)

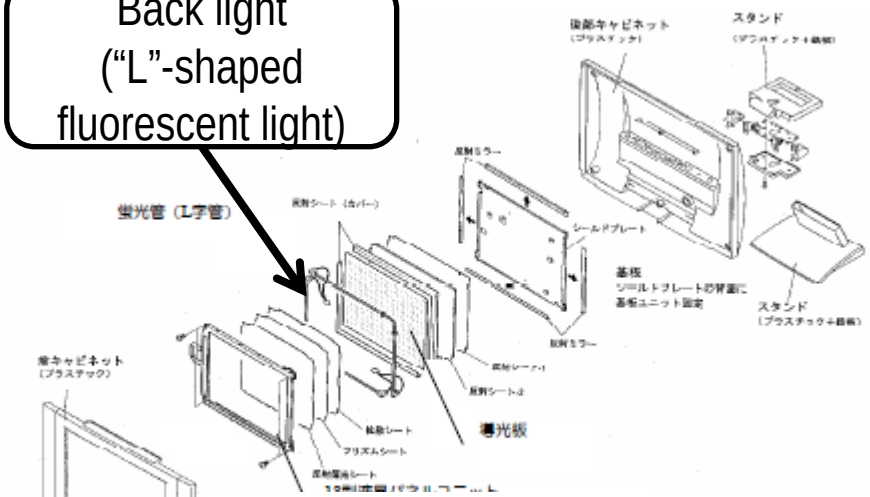


Liquid crystal display TV and Mercury

Backlight behind panel glasses: multiple fine fluorescent tubes containing mercury and shipment of fluorescent tube for backlight: 3 times increase in 2005 compared with 2001 → Total amount of mercury used for backlight: 4 times increase in 2005 from 2001.

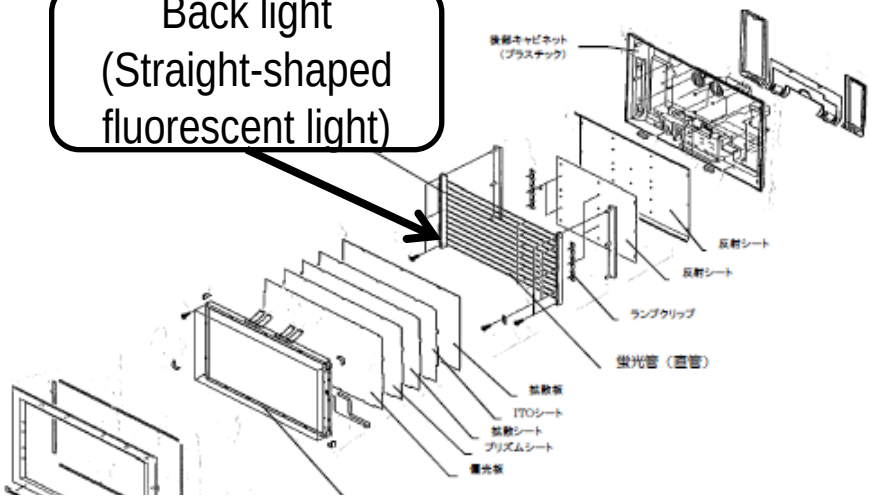
a) Size: 20V or smaller

Back light ("L"-shaped fluorescent light)



b) Size: 20V or larger

Back light (Straight-shaped fluorescent light)



Central Environment Council Waste and Recycling Committee, July 9, 2009

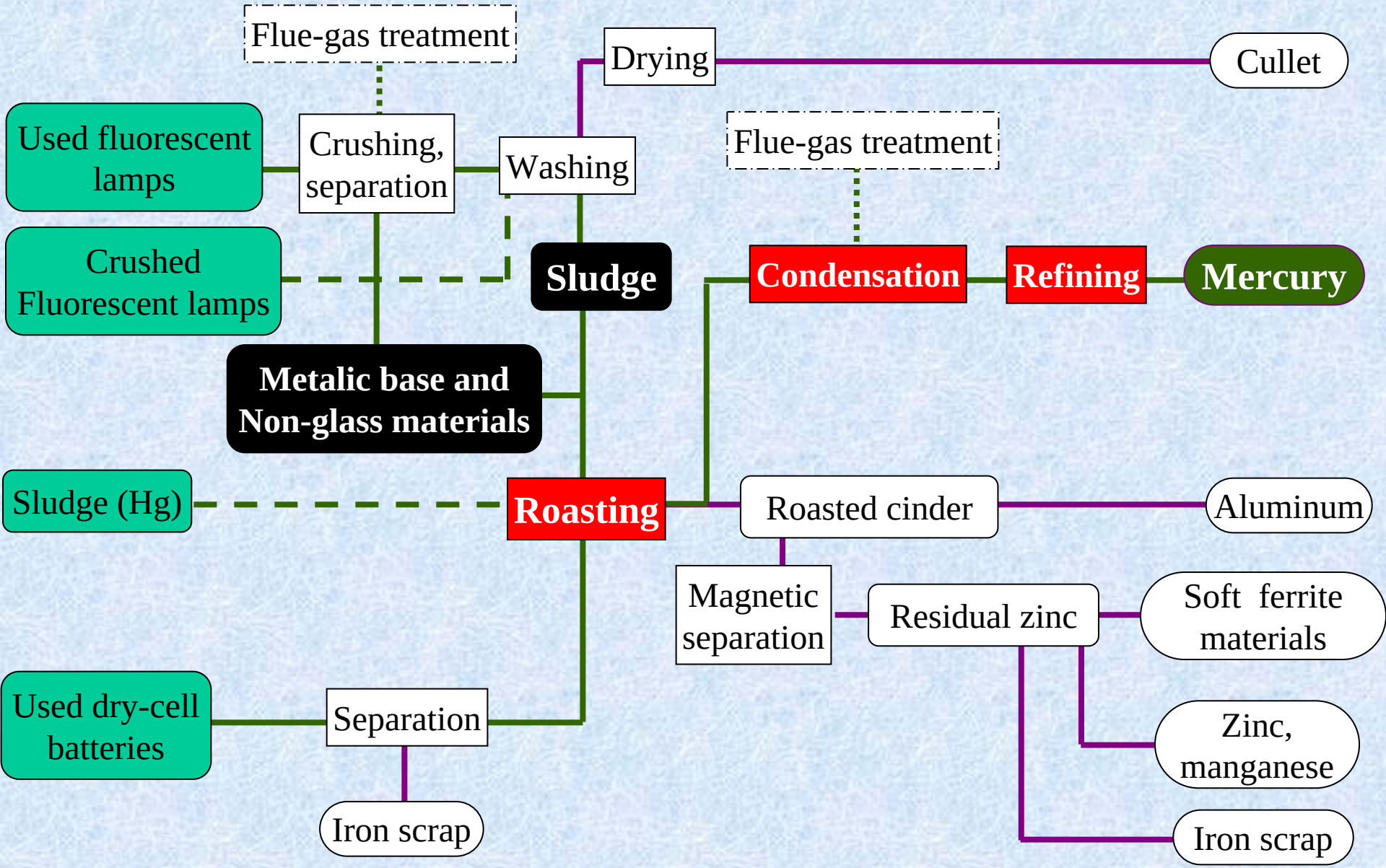
Annual Shipment of Fluorescent light for Back-light Devices

Year	2001	2002	2003	2004	2005	Thousand Quantities
Shipment to Market	152,184	233,320	306,988	403,750	498,168	

Annual Use of Hg for Fluorescent light for Back-light Devices

Year	2001	2002	2003年	2004	2005	(Kg)
Amount of Hg	362	562	745	985	1,386	

Treatment flow chart for used fluorescent lamps and dry-cell batteries at the Itomuka mercury recycling plant



The Itomuka plant has some facilities for different kinds of waste materials with optimum methods

- Large multi-health roasting furnace
- For sludge etc.
- Capacity (Approx.): 100 ton/day

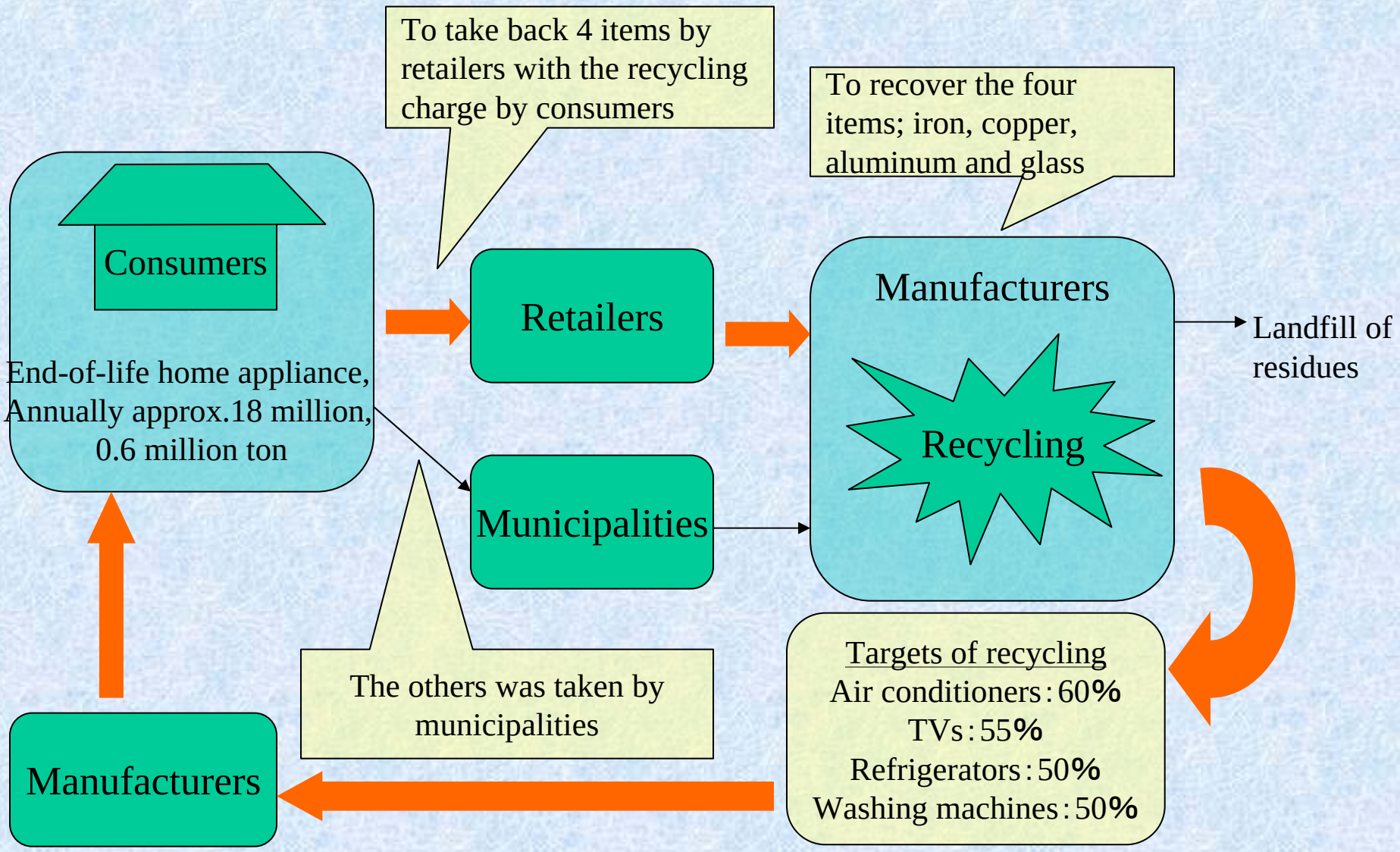
- Rotary furnace
- For dry-cell batteries
- Capacity (Approx.): 20 ton/day

- Condenser tower

E-waste Management for the Sound Material Cycles and Persistent Chemicals Control

2. E-Waste Recycling System Developments

Processes of waste home appliances after the enactment of the Home Appliances Recycling Law



Outline of home appliances recycling in Japan

Conditions for target goods

1）Difficulty of disposal by municipalities
2）Take-back possibility by retailers when replaced
3）Economic reality can be expected for recycling
4）Possibility of environment-conscious designing

→ Air conditioner
Tube TV
Refrigerator
Washing machine

Status of maintenance of recycling facilities(2008)

Japanese Basic Stat. Population (Thousand)	Area (km^2)	Number of Recycling Plants	Number of Collection Sites
127,770	377,923	48	380

Responsibilities of manufactures

Responsibility of recovery of Freons from air conditioner & refrigerator.

Required recycling rate of 50-60% depending upon the kind of items（recycled resource amount/waste product）

Recycling charge for 4 home appliance items(2008)

Air Conditioner	CRT TV	Refrigerator	Washing Machine	
3675*	2835	4830	2520	(Yen)
23	18	30	16	(Euro)
32	25	42	22	(USD)

*3150 after April 2007

1 Euro = 160 Yen

1 USD = 115 Yen

Note: Fees in the table include tax.

New targets of home appliance recycling (2008)

Air conditioner：70% （10%↑）

CRT TV：keep recycle rate unchanged, 55%

Refrigerator： 60% （10%↑）

Washing machine（include cloth drier）： 65% （15%↑）

Liquid crystal display (LCD), Plasma display (PLD)： 50%

View of old and new recycling rates

	Air Conditioners	CRT-TVs	Refrigerators	Washing Machines	PDPs & LCDs
Current Rate	60%	55%	50%	50%	-
Estimated Rate	70%	55%	60%	65%	50%

Footnote for the calculation above

Product life times of liquid crystal display and plasma display were unknown, so weighted averages were calculated based on the numbers of shipment in 2002 (about 1 million（84%）and nineteen thousands（16%）, respectively）

Weighted averages were taken for automatic washing machine, washer of double-layered structure, electric cloth drier, and cloth drier based on the numbers of shipment from 1997 to 2001 (about 2.9 million（12%）, nineteen million（80%）, 1.7 million（7%）, twenty thousands（1%）, respectively）

Dismantling Waste TV

Example of Dismounting a TV set

TV set

Back Cabinet

Front Cabinet

CRT

Printed Circuit Board

Crashed and then valuables to be collected

Explosion protection band

Shadow Mask

Panel Glass

Electron Gun

Deflection Coil

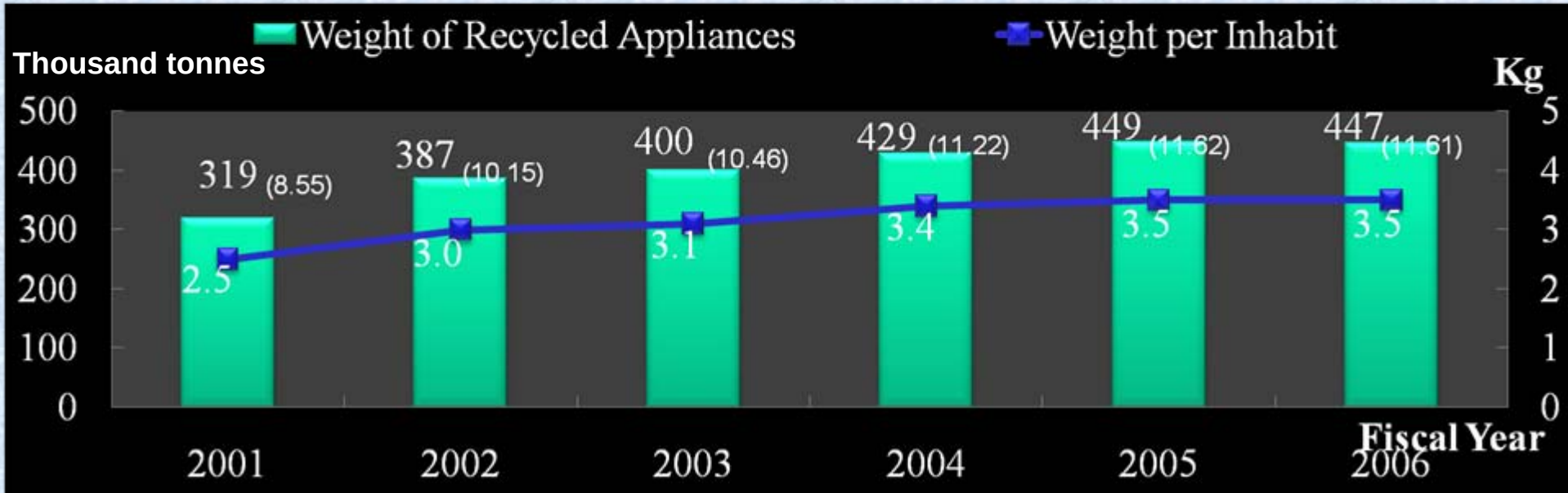
Funnel Glass

Collected

High Pb

Recycling performance of home appliances in Japan

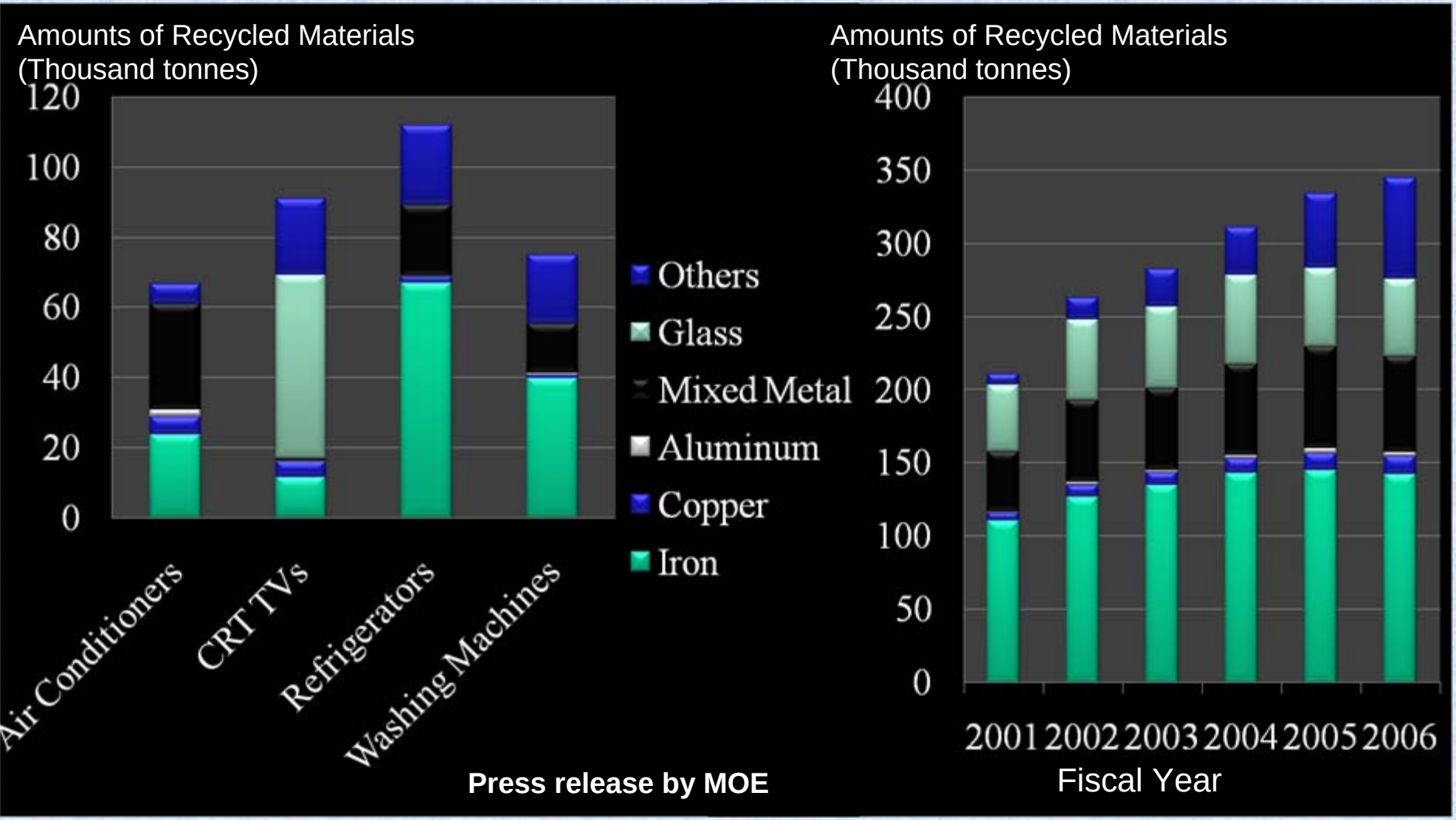
- About a half of the flow are recycled. Favorable growth of recycling from year to year as seen in the chart below
- Annual unit weight of recycled appliances is 3.5 kg per person
- WEEE directive which targets all electric and electronic goods in EU requires at least 4 kg of recycling rate per person →we almost reached this goal by 4 items.



() means number of collected appliances (million units).

Resource recycling by home appliance recycling of Japan

Increased amount of recovered resources
Increase in plastic recycling rate（”others”）



Press release by MOE

Characteristic of home appliances recycling system in Japan

1. **Confine target items for recycling to large size appliances**
2. **Consumers pay recycling charge**
3. **Physical responsibility to recycle waste home appliances is imposed on manufactures**

Organization for Economic Co-operation and Development (OECD) defines Extended Producer Responsibility（EPR） as follows; shift of a part of or all physical/ financial responsibility to manufactures from local authorities.

E-waste and Persistent Toxic Chemicals

3. “Clean, Cycle & Control” Concept as Hierarchical Chemical & Waste Management

“Clean/ Cycle/ Control”, 3C’s 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）**

Mercury from the standpoint of Clean/ Cycle/ Control

- Avoid the use of mercury as much as possible to avert negative impact to human health and to control its global-scale transport and concentration. Disuse of mercury catalysts in caustic soda industries and transfer to non-mercury dry cells are the present examples. Its limited use to the very essential case and the trade restriction is the global trend（Clean）
- Recycling and reuse should be fundamental for the products which can not avoid the usage of mercury: e.g. fluorescent (Cycle)
- Emission control into the environment will be the last defense measure to avoid ultimate mercury pollution (Control)

BFRs from the viewpoints of Clean/ Cycle/ Control

- From the viewpoint of 3C's principle, which is the priority "clean" or "integrated measures"? - Chaos-
- PBDEs are persistent organic pollutants in the environment which have bioaccumulation. They are toxic for lever and nervous system and affect thyroid hormones.
- PeBDE and OBDEs received a risk assessment as "effective", and their production was voluntarily stopped in Europe and Japan.
- As to BFR, seeking for control measures will be continued along with seeking for clean measures.

Summaries (1)

1. Japan's Home Appliance Recycling Law, which was enforced in 2001, is targeting TV sets, Refrigerators/Freezers, Washing Machines, and Air Conditioners. Recycling cost is charged to the consumers at a time of discarding the product. Physical responsibility to recycle waste home appliances is imposed on manufactures.

2. The number of recycled home appliances increased from 8 million items in 2001 to 12 million items in 2006. The total weight is about 460 thousands ton, of which 70-80 % are recycled and reused. Major materials to be reused are Irons, Coppers, and Aluminiums.

Summaries (2)

3. 3R perspectives from persistent chemicals are essential for E-waste management. The 3C concept (Clean/Cycle/Control) can be proposed as a similar concept of 3R for a measure of controlling chemical substances and hazardous wastes.
4. Phase-out of Penta-BDEs and Octa-BDEs internationally is one of reduction measures for BFR. Deca-BDE is still used and more research is necessary from transformation and toxicology. Mercury is controlled stringently and globally in the total lifecycle.