



Recycling PBDEs to New Products including Toys and Consumer Products

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Today's Presentation

1. *Introduction*
2. *Current situation of waste containing PBDEs in Japan*
3. *Unintentional contamination of PBDEs in consumer products*

Stockholm Convention on Persistent Organic Pollutants (POPs)

	2001	COP4 2009	COP5 2011	COP6 2013	COP7 2015	COP8 2017	COP9 2019	COP10 2022
Pesticides	Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Mirex, Toxaphene	Chlordecone, HCH, lindane	Endosulfan		PCP		Dicofol	
Fluorinated compounds		PFOS PFOSF					PFOA	PFHxS
Brominated flame retardants		HBB POP-BDEs		HBCD		DecaBDE		
Chlorinated compounds	HCB PCB	PeCB			HCBD PCN PCP	SCCP		
Unintentional POPs	HCB PCB PCDD/DF	PeCB			PCN	HCBD		

- Listing of new chemicals
- POP waste management

Brominated Flame Retardants

➔ Most of the newly added POPs for global elimination are plastic additives

International Regulations on PBDEs

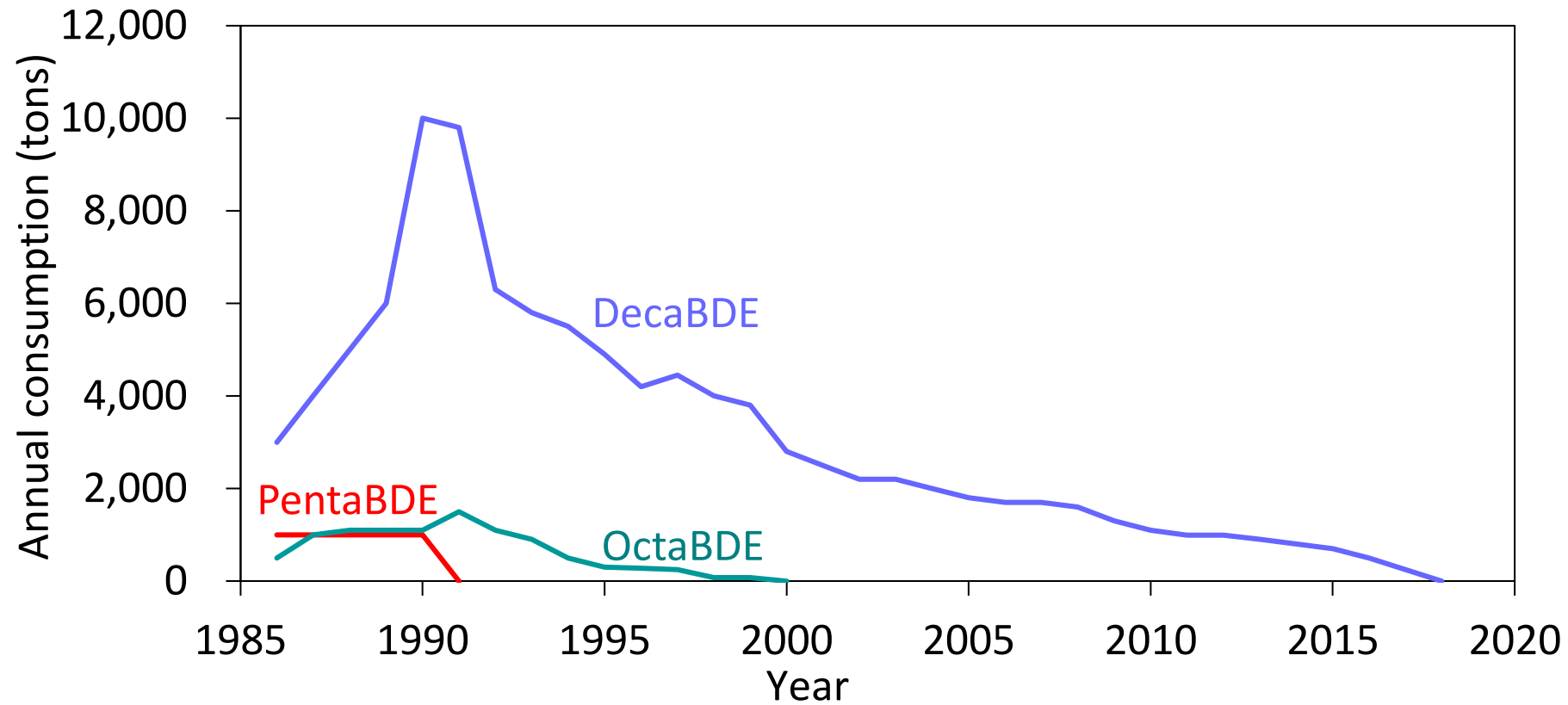
	Main use	Listing year to the Stockholm Convention	Recycling exemption	Low POP content for waste under the Basel Convention (Basel LPC)	EU RoHS directive maximum concentration value (RoHS MCV)
PentaBDE	Polyurethane foam, printed circuit board	2009 (tetra- to heptaBDEs)	Yes	[50 mg/kg as a sum] or [500 mg/kg as a sum] or [1,000 mg/kg as a sum]	1,000 mg/kg as a sum (mono- to decaBDE)
OctaBDE	Electronic casing				
DecaBDE	Electronic casing, textile coating, building insulation	2017 (decaBDE)	No		

❖ *Wastes containing POPs higher than Basel LPC*

➔ *Should be destroyed or irreversibly transformed*

➔ *No material recycling*

PBDE Consumption in Japan



- ❖ *Material recycling (Resources utilization)*
- ❖ *Proper disposal (POP wastes)*

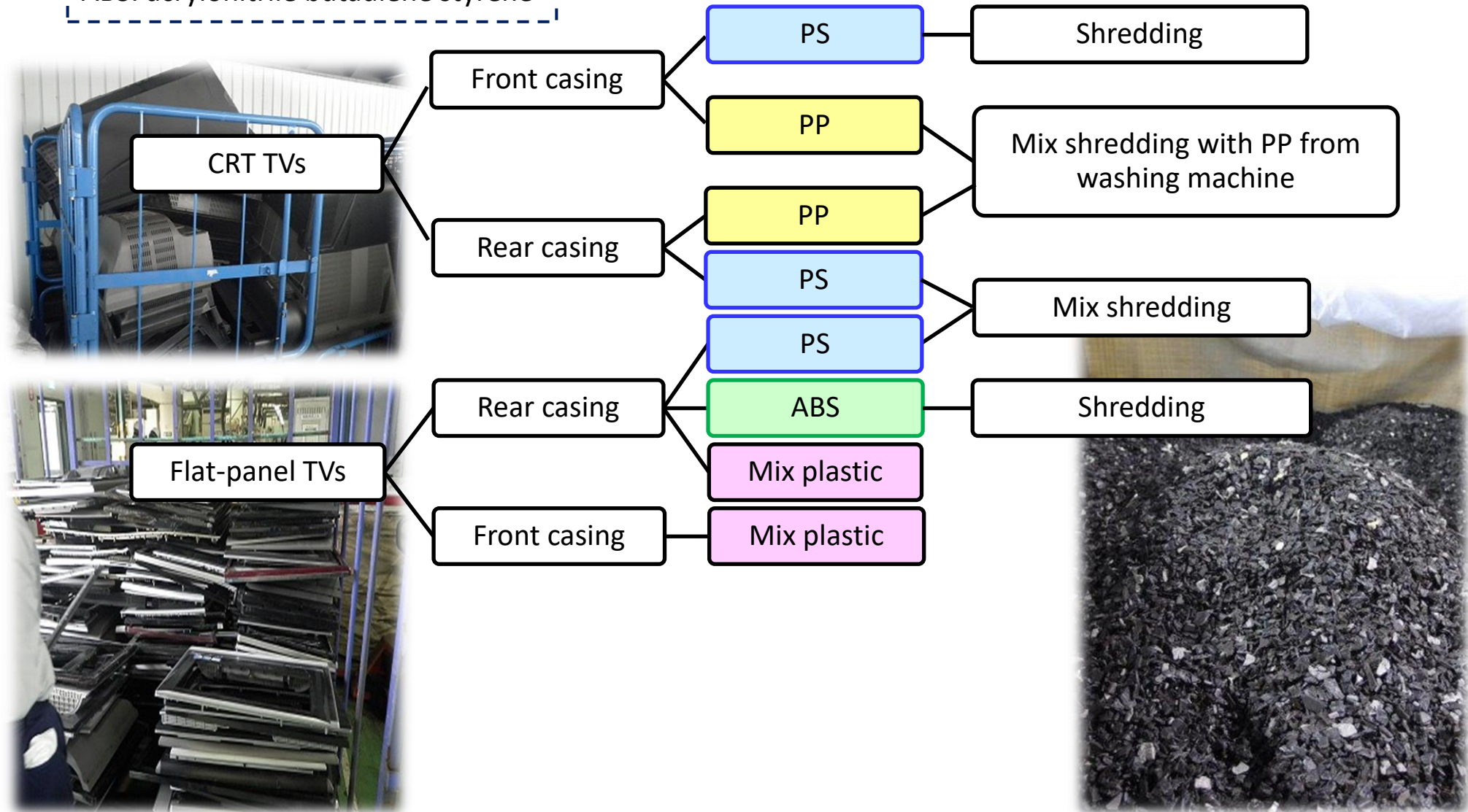
Home Appliances Regulated by Recycling Law in Japan

		Target rates for material recycling	Components that may contain DecaBDE	DecaBDE use period
Air conditioners		>80%	Electric box	Until 2005?
Televisions	CRT	>55%	Casing, electric box	Until 2004?
	Flat-panel	>74%	N/A	-
Refrigerators & freezers		>70%	Electric box	Until 2004?
Washing machines & cloth dryers		>82%	Direct drive motor	Until 2004?

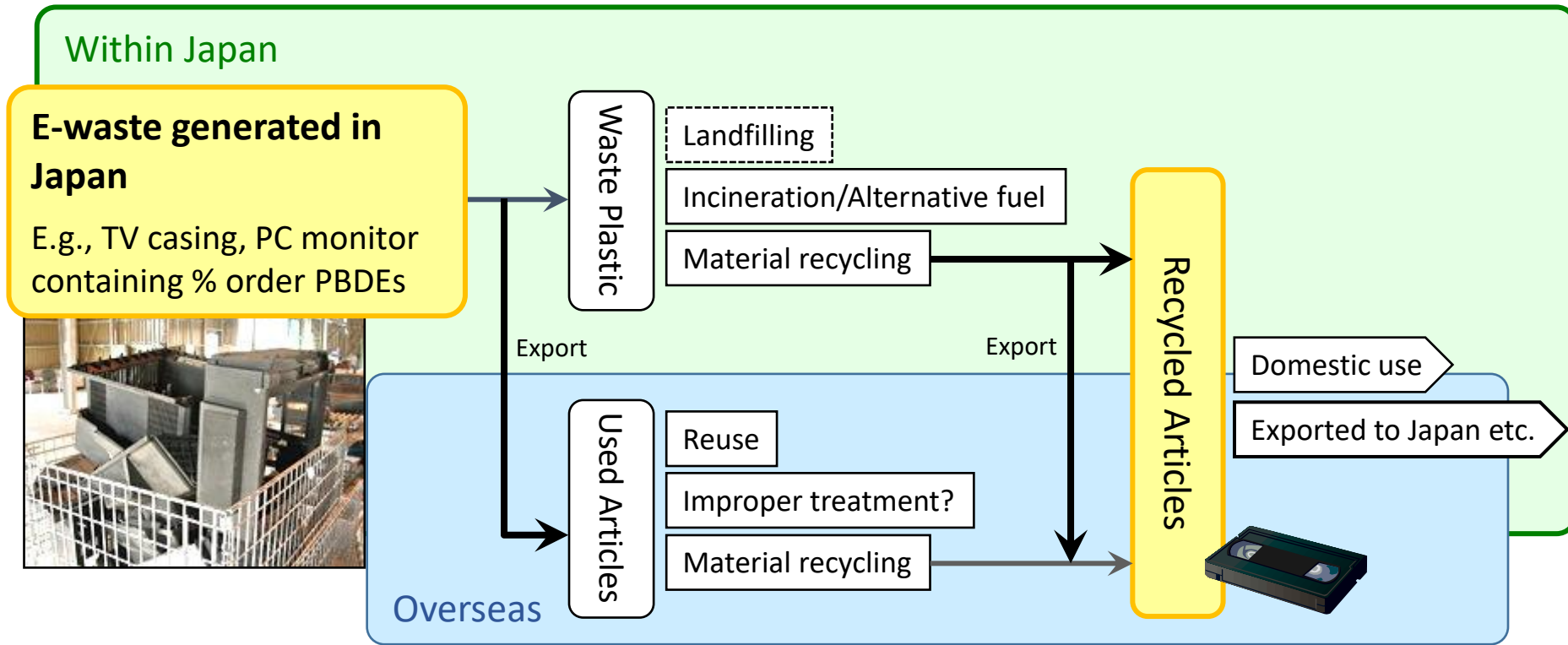
- ❖ There are 47 WEEE recycling facilities in Japan treating about 1,200,000 units/year.
- ❖ The amount of decaBDE consumption will be large in CRT casing.

Example of TV Casings Recycling Process in Japan

PS: polystyrene;
PP: polypropylene;
ABS: acrylonitrile butadiene styrene



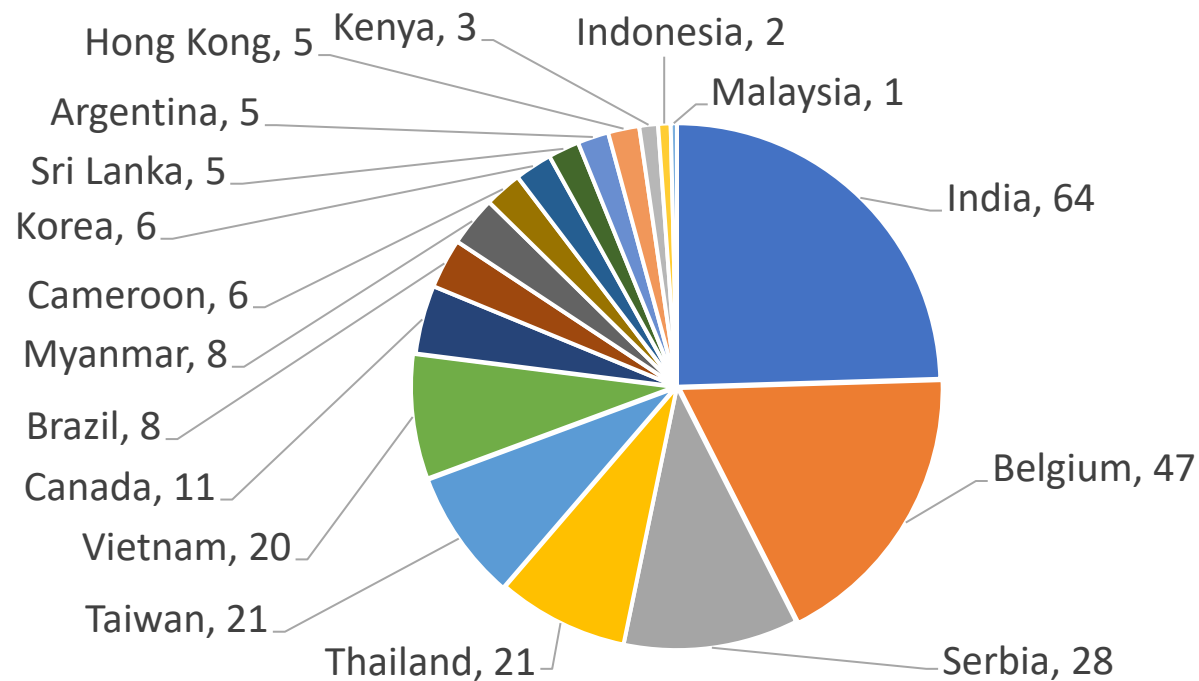
International Circulation of End-of-life Products containing PBDE



- ✓ E-waste plastics and their recyclates are not always consumed in Japan but are exported to other Asian countries.
- ➔ We conducted a survey to understand the current status of the international circulation of PBDE-containing waste plastics.

Plastic Samples Investigated

Category	No of Items	No of Components
Giveaway toys	187	393
100-yen shop products	92	228
Cheap plastic products purchased overseas	261	518
Total	540	1,139



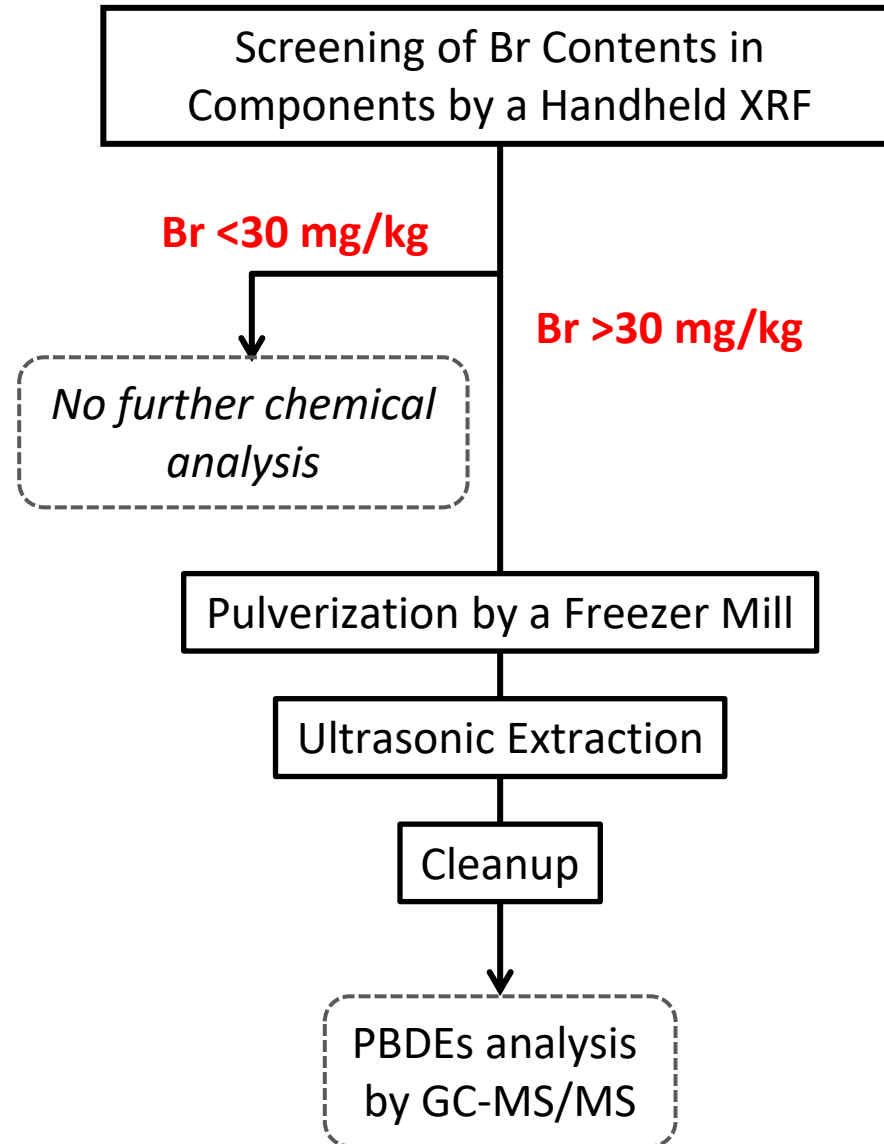
Examples of 100-yen Shop Products



Examples of Plastic Products Purchased Overseas

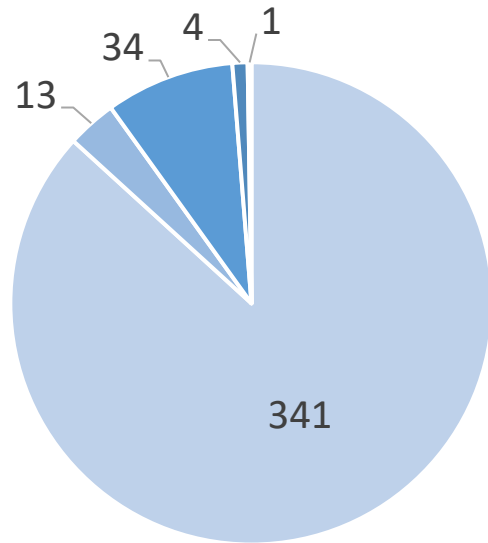


Methods

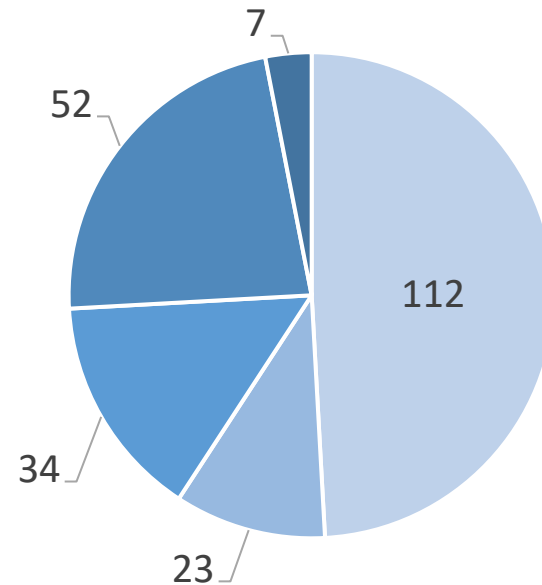


Br Contents in Plastic Components ($n = 1139$)

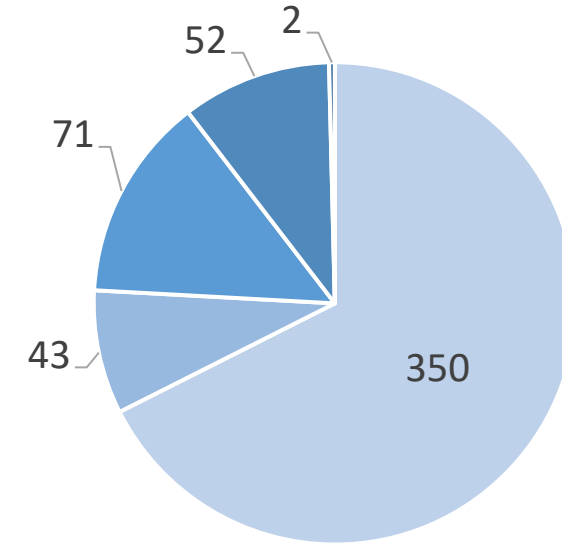
Giveaway toys
($n=393$)



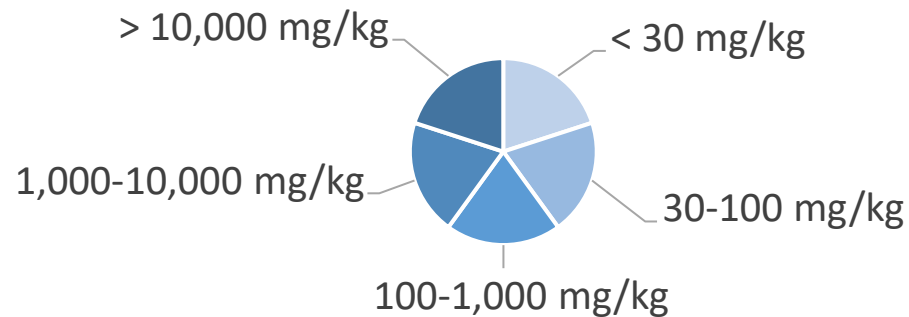
100-yen shop products
($n=228$)



Cheap overseas products
($n=518$)

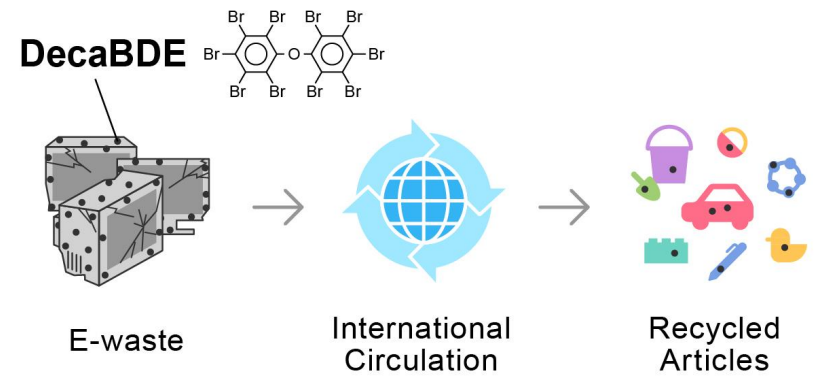
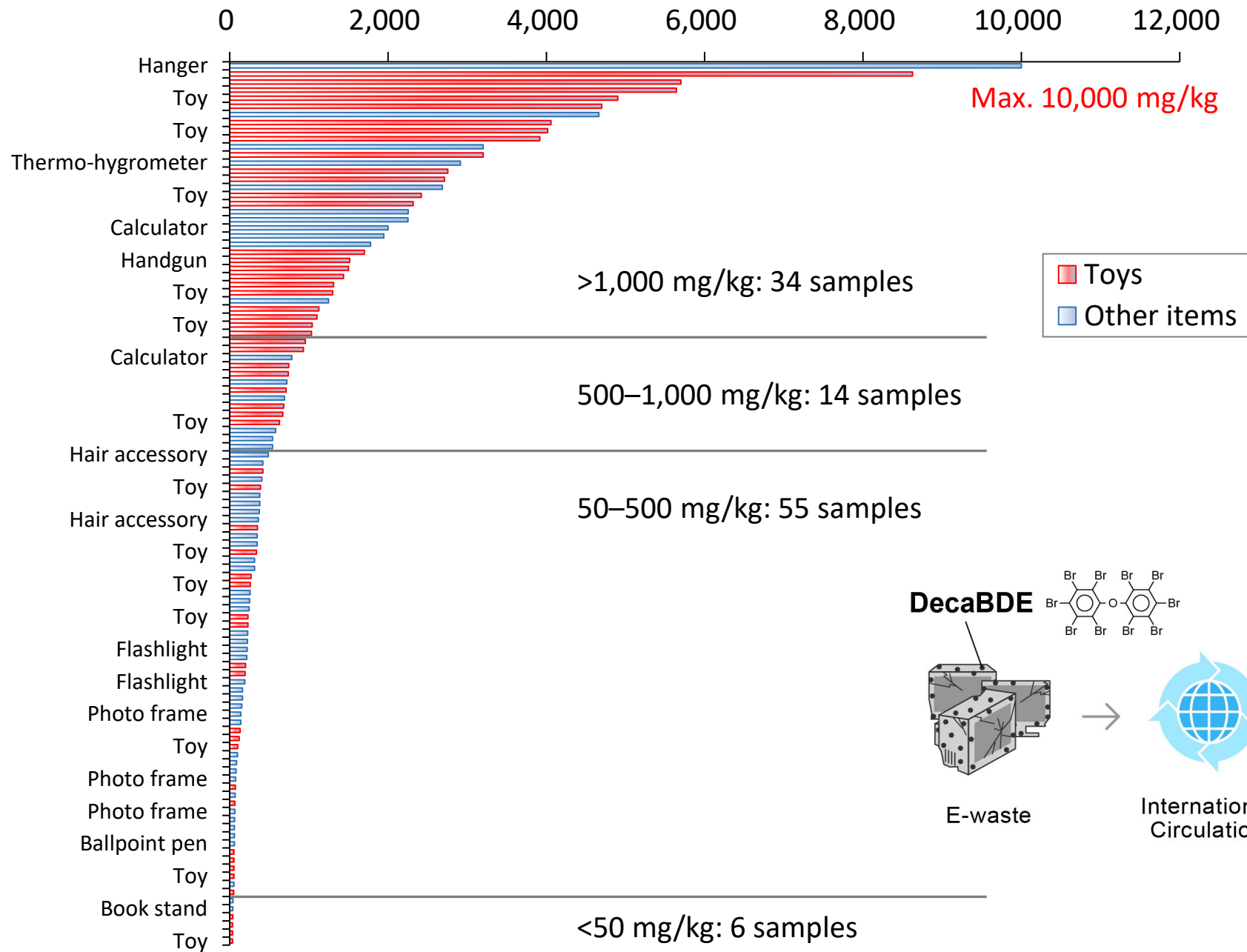


Legends



→ 219 components with >30 mg/kg Br were conducted further PBDE analysis

PBDE Contents (mg/kg) in Plastic Components ($n = 109$)



PBDEs Found in Toys

8,600 mg/kg in a guitar



200 mg/kg in a toy car



740 mg/kg in a Reversi



2,800 mg/kg in a toy gun



3,900 mg/kg in accessory beads toys



PBDEs Found in Other Items

10,000 mg/kg in a clothes hanger



380 mg/kg in a water pipe joint



2,000 mg/kg in a calculator



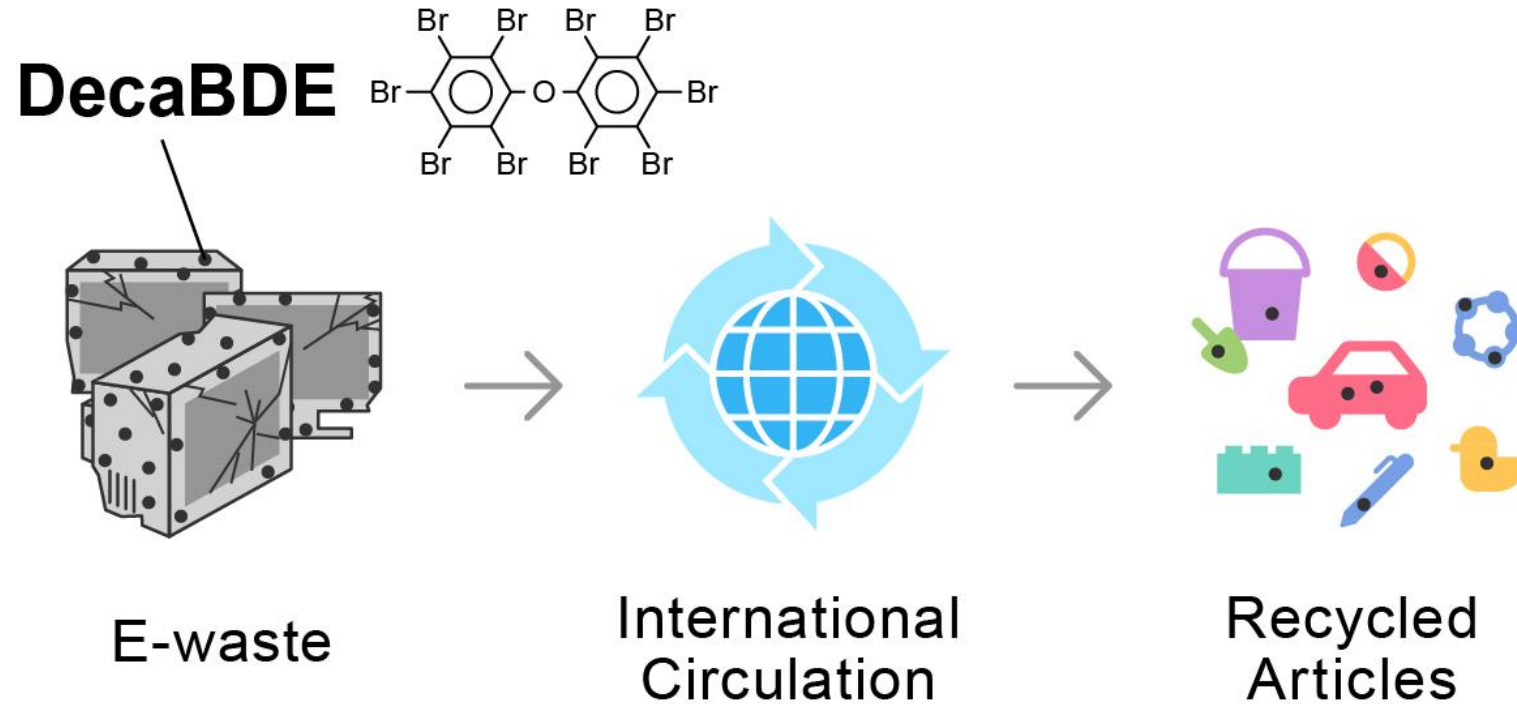
4,700 mg/kg in a flashlight



490 mg/kg in hair accessories



What Can We Do Now?



- A step closer to the POP-free environment, we need more communication with policy makers and recycling industry.
- Support for capacity building of POP analysis in circulating resources in developing countries.

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*Thank you very much for
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Recycling plastics containing decabromodiphenyl ether into new consumer products including children's toys purchased in Japan and seventeen other countries[☆]

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HIGHLIGHTS

- 540 plastic products (1139 components) purchased in 18 countries were investigated.
- About 20% of all samples had bromine $\geq 30 \text{ mg kg}^{-1}$ and 10% of all contained PBDEs.
- PBDEs in e-waste plastics transfer to products to which humans have daily exposure.
- High PBDE contents were found in black-colored or painted plastic products.
- Most of bromine-positive samples contained non-PBDE flame retardants.

GRAPHICAL ABSTRACT

