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Regional Workshop on  
E-waste / WEEE Management

# E-waste related research at NIES

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# Content

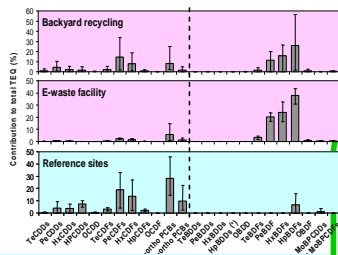
- Research on e-waste at NIES
  - Material flow analysis
  - Reuse/recycling
  - Environmental impacts
- Classification of e-waste recycling technology in Asia
- Conclusion

# International Material Cycle of E-waste

## Environmental Impact of e-waste recycling in developing countries



Analyze env samples from recycling sites in India, Vietnam and Philippines. High-level DXN, heavy metals have been confirmed.

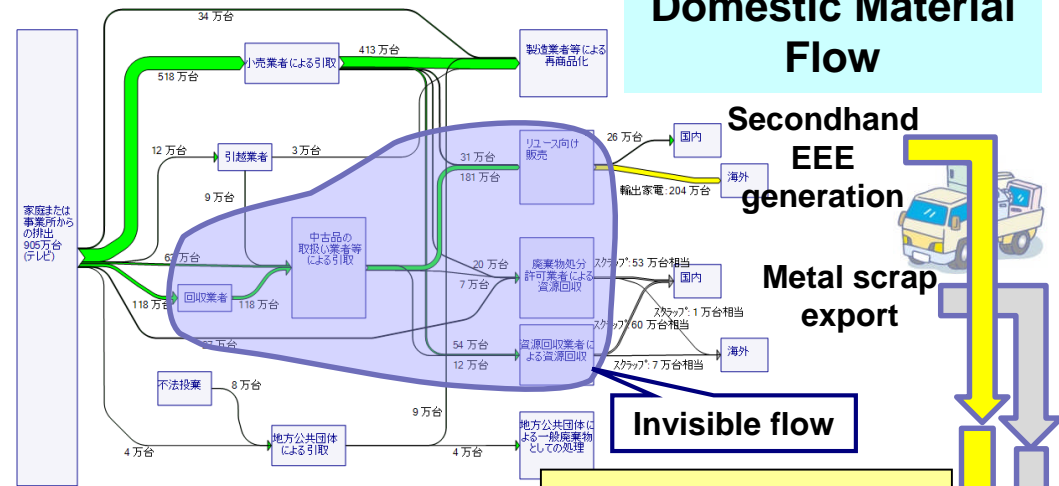


## Generation, import, reuse, dismantling situations in Asian developing countries

Reuse condition of exported CRT TVs from Japan. Many PWBs have been exported to Mainland China.

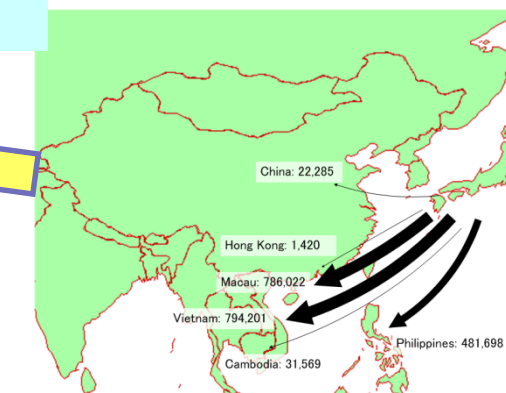


## Comparison of E-waste recycling systems in different countries

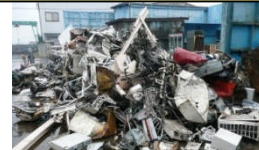


NIES Workshop on E-waste (The 6th WS was held on Dec 7, 2009)

Japan's Export control on Secondhand CRT TVs was implemented in June 2009. Destination changed to Vietnam and Macau in 2009 to exploit weak import control.

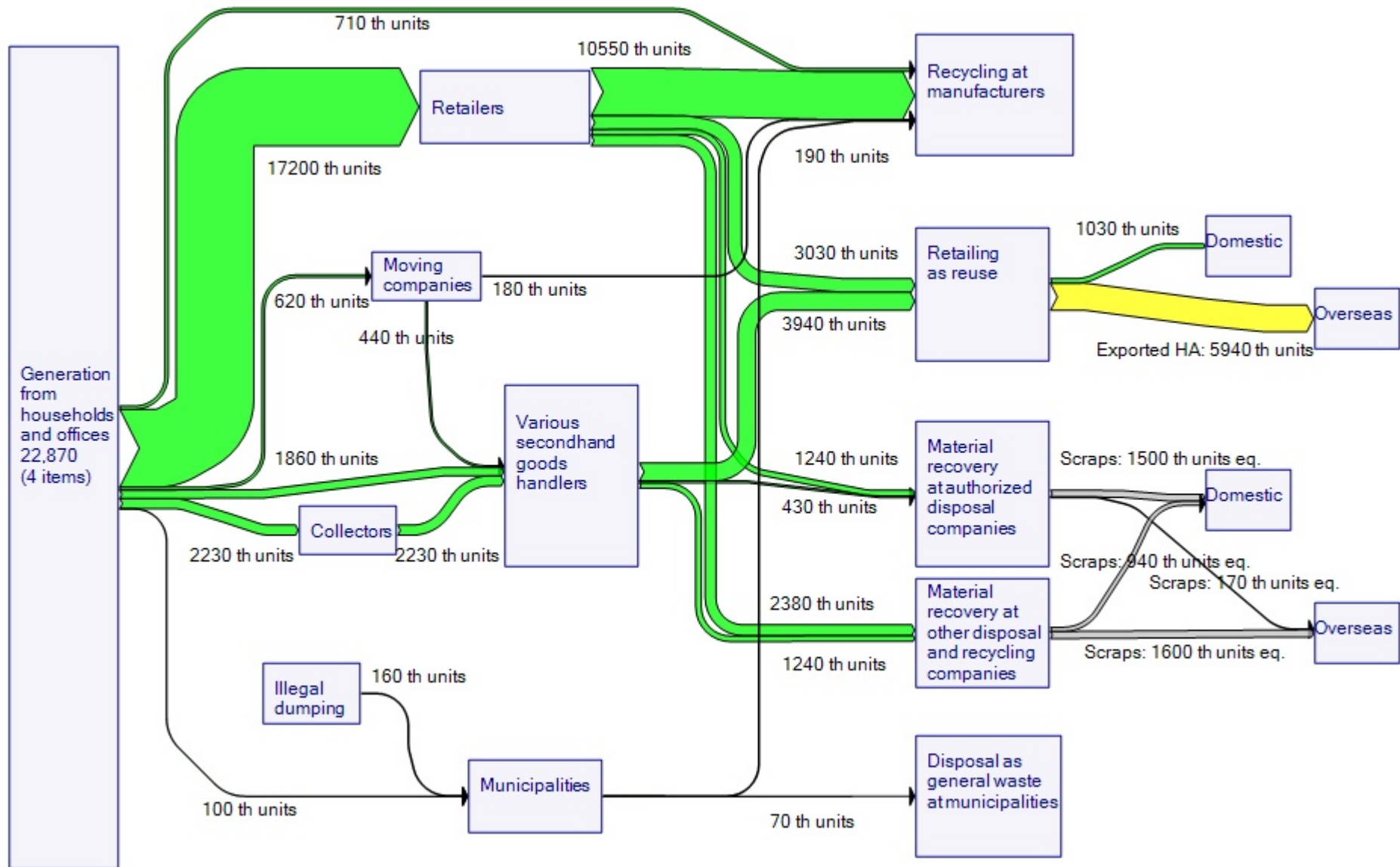


## Secondhand CRT TV export in 2009 International Flow



Home electric appliances are mixed with metal scraps. Proper export control is recommended. Fire accident would generate DXNs.

## Metal scrap

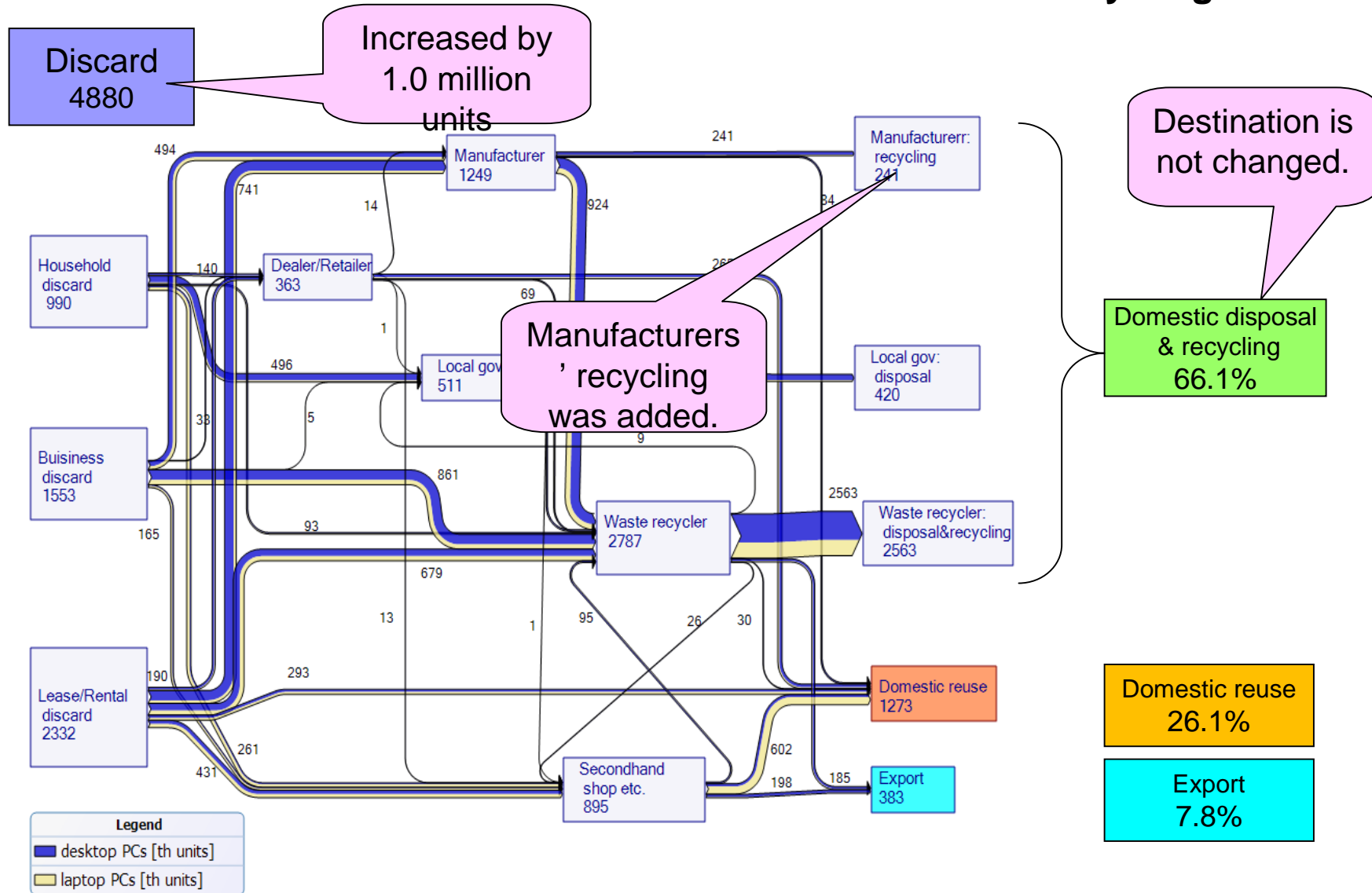


Domestic material flow of end-of life home appliances of Japan in FY2005 (estimated by METI and MoE)

- Possible overestimate of generation
- Not considered disposal/recovery channels between households and offices
- Gap between inflow and outflow data

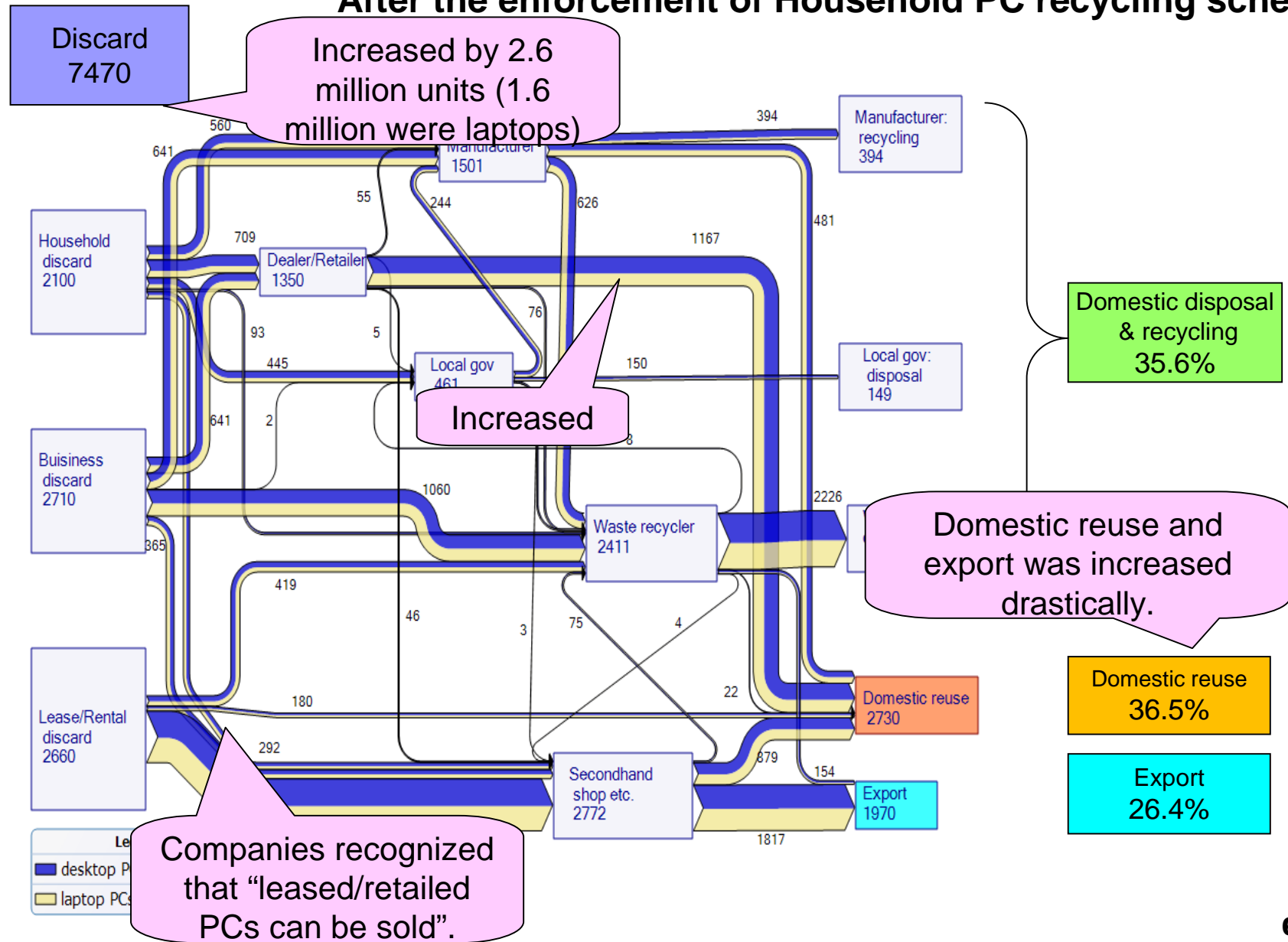
# Material Flow of Used PCs in Japan (2001)

After the enforcement of Business PC recycling scheme

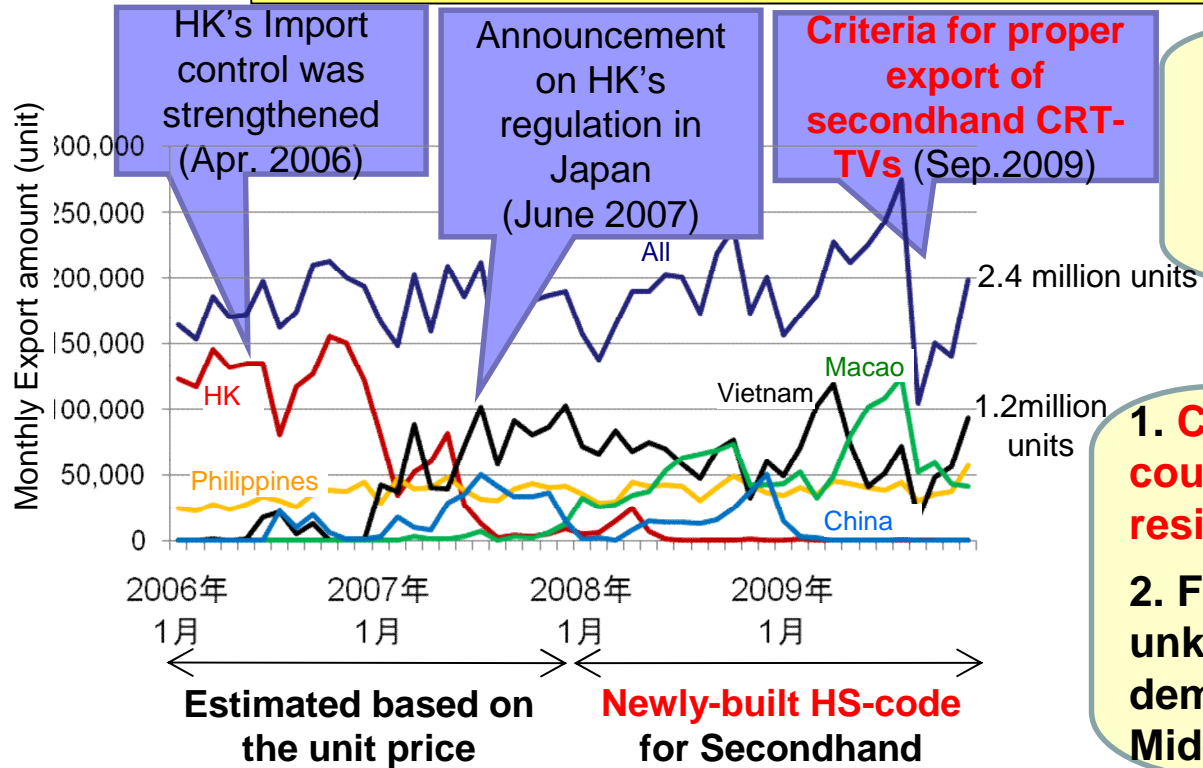


# Material Flow of Used PCs in Japan (2004)

After the enforcement of Household PC recycling scheme

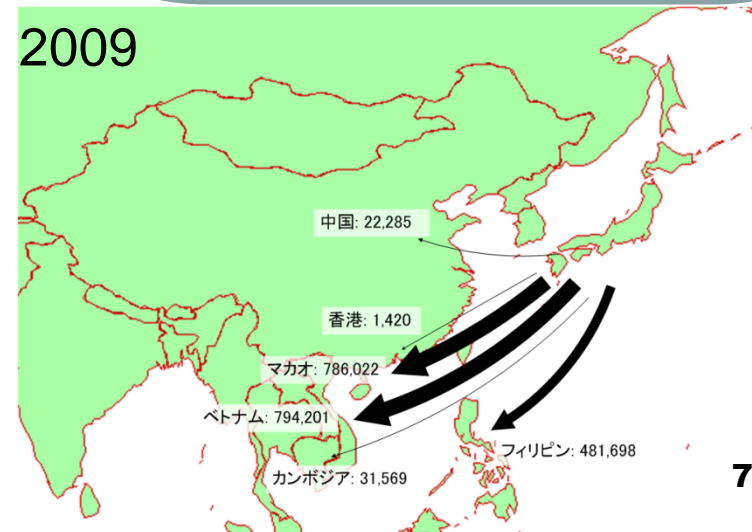
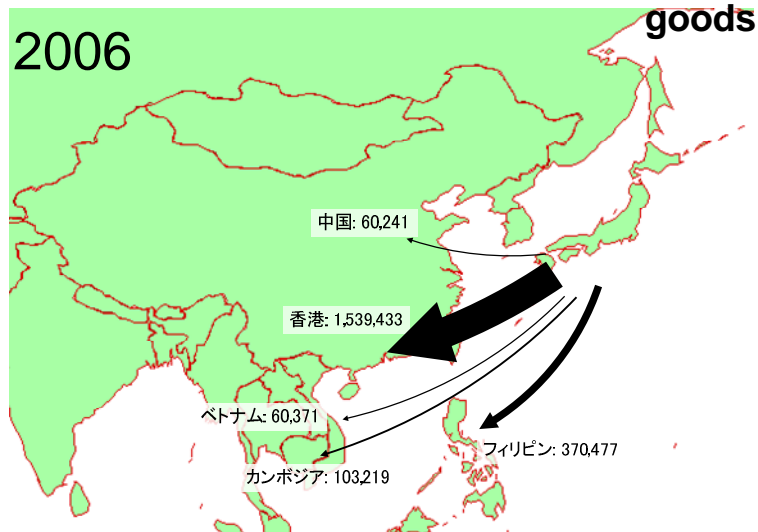


# Secondhand CRT-TV export from Japan

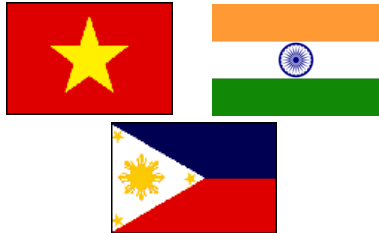


Result of the tightening of regulations, export destination has been changed (exploiting weak import control).

1. Cooperation among Asian countries and management of residues is also needed.
2. Final destinations are still unknown.. (probably there is a demand in southern China or Mideast)



# Assessment of Environmental Impact on E-waste



- Surveyed sites**
- E-waste recycling sites (dismantling, shredding, open burning of Cu wires/cables)
  - Lead acid battery recycling sites (Dismantling, smelting)
  - Au, Ag recovery sites (Smelting Au, Ag from E-waste)



Analyze dioxins from burned materials from mixed metal scraps

Foreign surveys

Domestic surveys



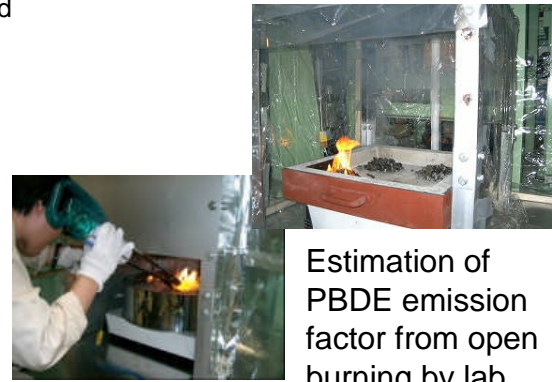
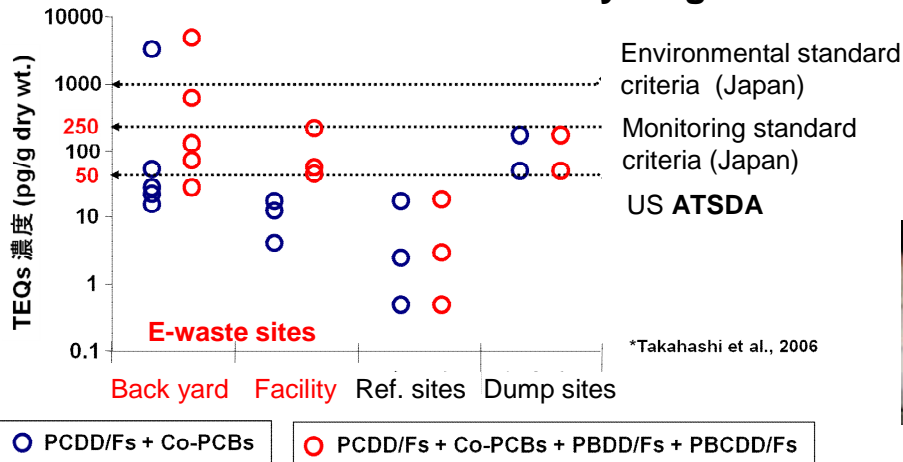
**Environmental samples** : floor dust at work place, soils, residues from e-waste recycling sites  
**Human samples** : blood, hair, urine

Confirming the env. and human impacts by analyzing organic/inorganic substances

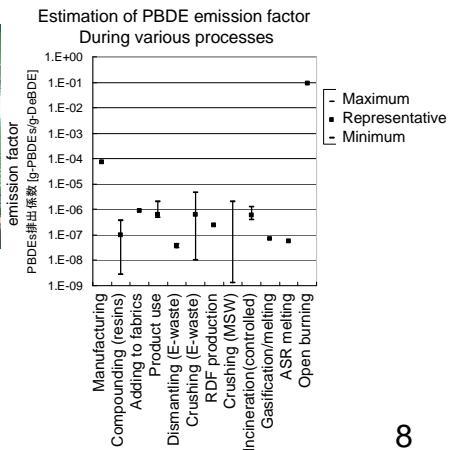
Mechanistic analysis of generation of chemicals  
 Applying simple and rapid analysis methods (ex. Dioxin bioassay)

Laboratory experiment for modifying the informal recycling of e-waste

Dioxin level in soils at E-waste recycling sites in India



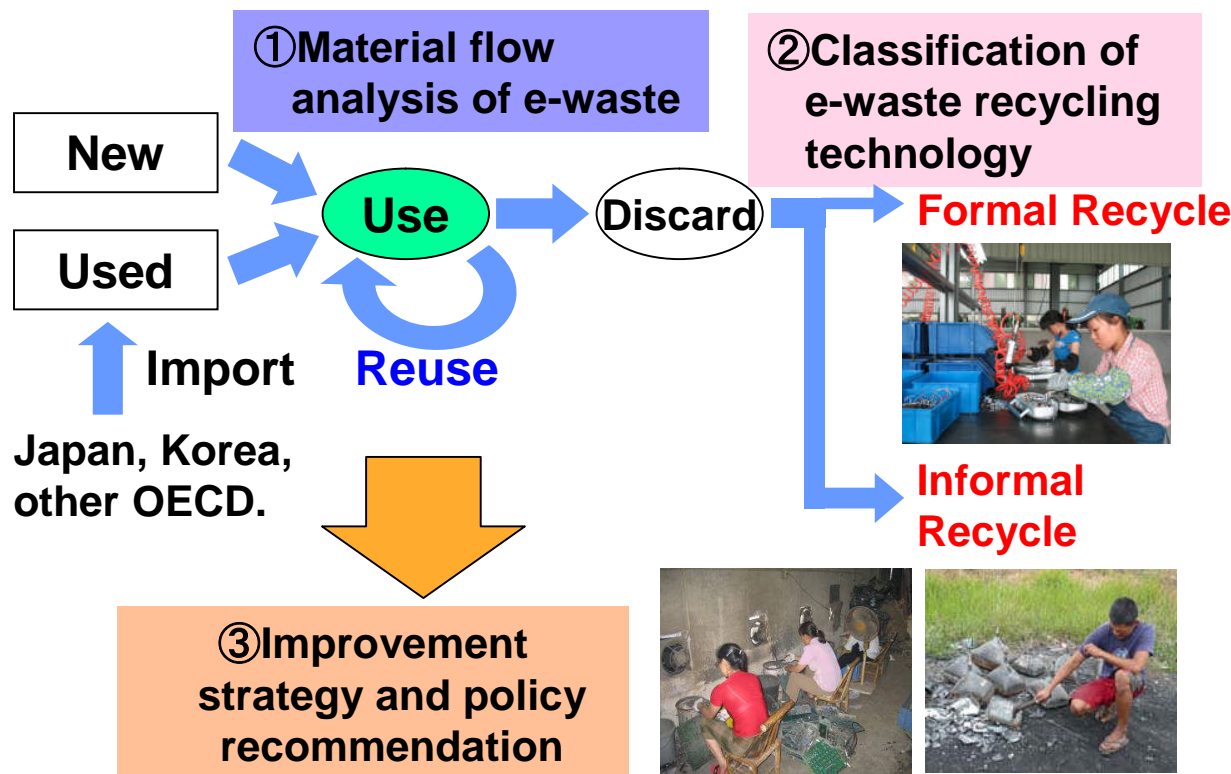
Estimation of PBDE emission factor from open burning by lab. experiment



Research Grant for Promotion to the Sound Material-Cycle Society from Ministry of the Environment of Japan

# Classification of e-waste recycling technology in Asia (FY2009-2011)

- Elaborate the material flow data, recycling technology information based on a field survey on e-waste recycling in three Asian developing countries.
- Propose necessary both “soft” and “hard” measures for environmental sound treatment and management of e-waste.



## ①Material flow analysis of e-waste

- Export of used EEE from Japan and Korea
- Improvement of estimation method of used EEE generation

## ②Classification of e-waste recycling technology

- Collect and analyze samples from the environment
- Evaluation of resource recovery (especially metals)
- Hazardous substances emission to the environment
- Price, cost information

## ③Improvement strategy and policy recommendation

- Poverty, work environment
- Desired regulatory control system
- Discover International technological cooperation projects

Target: WEEE(4 items), PC, CRT monitor, Mobile phone

# Informal Recycling in Vietnam



CRT-TV,  
monitor

Dismantling

CRT tube  
Cables  
Cabinet  
PWB

Crushing  
Separation

Scrapping  
Burning

Scrapping

Glass  
Metal

Cu  
Cu

ICs  
Board

Export  
Export

Dumping

Export

Export → Reuse

Extraction

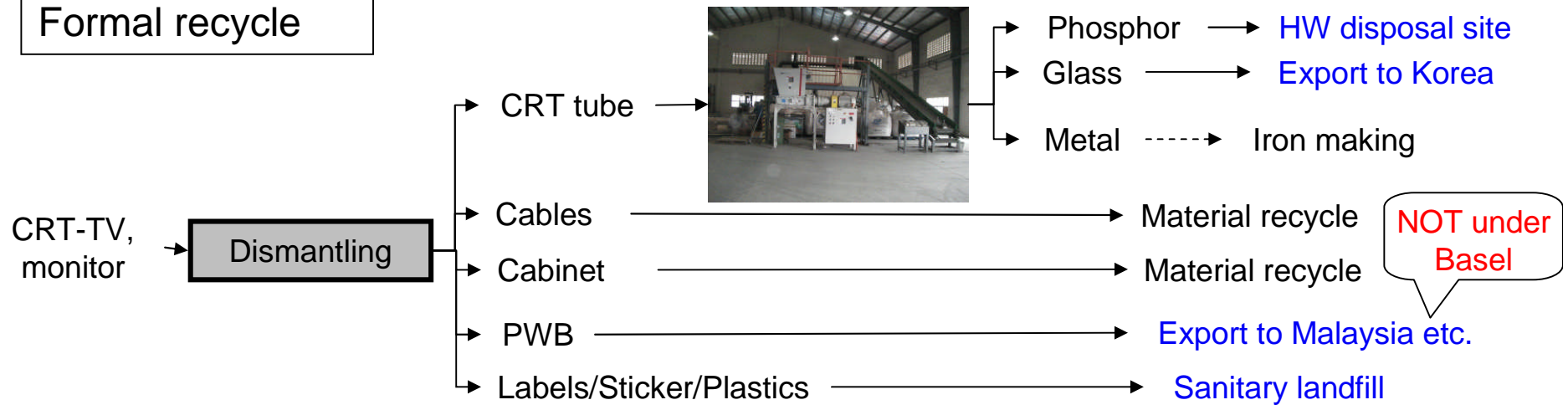
Export → Cu recovery

Proper  
export?

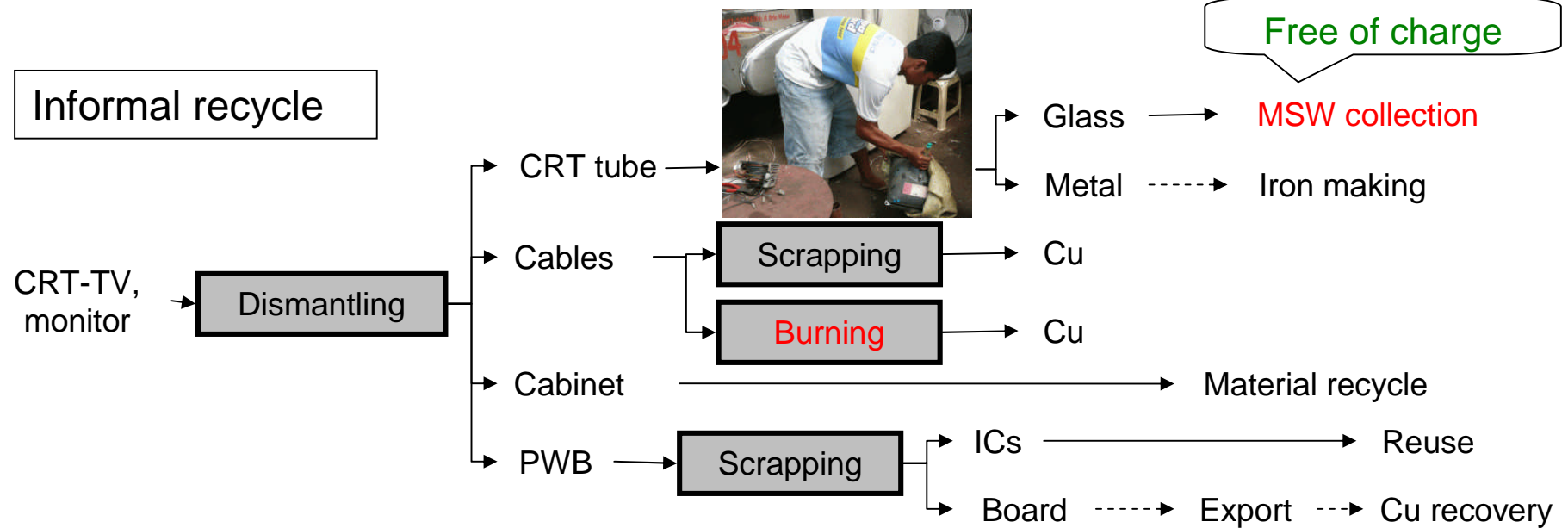


# CRT-TV/monitor Recycling in the Philippines

## Formal recycle



## Informal recycle





# Comparison of Formal/Informal

	Formal TSD	Informal
Establish year	2003	2006
Permit	TSD permit	Balangai permit Mayer's permit
Number of workers	25	4
Investment	Paid-up capital by 2009 PHP 9,000,000	PHP 100,000 (Rent, side cars, wall, etc)
Capacity	50-70t/month  488t (2007) 610t (2008) 333t (2009)	7t/month  Daily treatment amount (pcs) CRT TV/monitor 10 CPU (desktop PC) 2 DVD player/ Oven toaster/ Stereo 3 Refrigerator 1
Cost	CRT TV/monitors treatment cost P30-35/kg	CRT monitor PHP260



## Sales price of the materials recovered from a 19-inch-CRT TV (weight 17kg)

	kg/Unit	Unit price (USD/kg)	USD
CRT	10	0.05	0.5
Plastic	2.5	0.4	1
Printed circuit board (after taking off some parts)	0.4	0.75	0.3
Copper	0.4	1	0.4
Aluminum	0.4	1.2	0.48
Steel	0.5	0.3	0.15
Total	14.2		2.83



# Comparison of workers at formal/ informal sectors in the Philippines

	N=	age	Work period (years)	Educational status	
				Elementary / Junior high	High school/ Univ. and other
TSDs	15	28.7	3.8	0	15
Junkshops	10	26.9	3.4	7	3
Smelters	7	45.1	15.8	1	6

# Destination & Price of PWB

Unit: Peso/kg

	Las Pinas (informal)	Junkshop (informal)	TSD1	TSD2
Amount (t/year)			600	3.6-4.8
Price				
High grade	200-300		15-100	150
Mid grade	80-100		10-12	30-50
Low grade	18-25	14		3-7
Destination	<ul style="list-style-type: none"> <li>■(Parts) Bulacan</li> <li>■(Board) China</li> </ul>	<ul style="list-style-type: none"> <li>■Local recycler (Bulacan)</li> </ul>	<ul style="list-style-type: none"> <li>■Japan (<b>under Basel</b>)</li> </ul>	<ul style="list-style-type: none"> <li>■Singapore</li> <li>■Malaysia etc.</li> </ul>

# Informal and formal recycling processes

	Vietnam	Philippines	China
<b>Informal</b>			
Collection	√	√	√
Manual dismantling	√	√	√
Open burning to recover concentrate metals	√	√	△
De-soldering PWBs	NA	NA	√
Leaching of gold from PWBs	△	√	△
Open dumping	√	√	√
Export of PWBs	√	√	NA
Export of CRTs	√	NA	--

	Vietnam	Philippines	China
<b>Formal</b>			
Collection B2B	√	√	√
<b>Collection C2B</b>	--	--	△
Manual dismantling	√	√	√
CRT: (Semi-) automatic crushing and separation	--	√	√
CRT: Panel/Funnel separation	--	--	√
CRT: glass cullet cleaning			
Pyrometallurgical processing in local smelters	△	√	√
Hydrometallurgical processing in local facilities	--	√	√
Export of PWBs	√	√	NA
Export of CRTs	√	√	--
Disposal in general landfills	√	√	√
Disposal in incinerators	√	--	√



# Problems/issues

## Technological issue

1. Infrastructure (Crushing machine, ventilation system, tools...)
2. Knowledge, experiences (HW management, efficient dismantling)

## Human issue

1. Worker safety (proper clothing, mask, globe)
2. Knowledge of Hazardous substances (education)
3. Socioeconomic cause (poverty)

## Institutional/ financial issue

1. Comprehensive legal framework on e-waste (ex. Definition of e-waste)
2. Enforcement and compliance with general environmental regulation
3. Budget shortage, expense of treatment fee



# Conclusion

- It has been difficult to clearly link environmental pollution with e-waste recycling activities
  - Burning and dismantling activities seems to be the main cause for occupational and secondary exposure.
  - There are not many information on precious metal extraction processes.
- There are little research have done on workers recognition levels, motivation behind their behaviors and livelihood.
- It is important to find out what makes people engage in informal recycling or the way of choosing processes.



# References

- 1) A. Yoshida, T. Tasaki and A. Terazono (2009) Material Flow Analysis of Used Personal Computers in Japan. *Waste Management*, 29: pp.1602-1614
- 2) A. Yoshida and A. Terazono (2010) Reuse of secondhand TVs exported from Japan to the Philippines, *Waste Management*, 30: pp. 1063-1072
- 3) A. Supulveda et al. (2010) A review of the environmental fate and effects of hazardous substances released from electrical and electronic equipments during recycling: Examples from China and India.
- 4) NIES, IDE-JETRO and Kyoto Univ (2010) FY 2009 Report on Classification of e-waste recycling technology in Asia ( in Japanese)