

# Science-Policy-Business Interface towards Economic Utilization of E-waste

Special Session - 3R Policy & Science Cooperation by UNCRD and 3RINCs  
The 3<sup>rd</sup> 3RINCs (3R International Scientific Conference on Material Cycles and  
Waste Management)

Melia Hotel (Hanoi), Viet Nam, 9-11 March 2016

**Dr Sunil Herat**

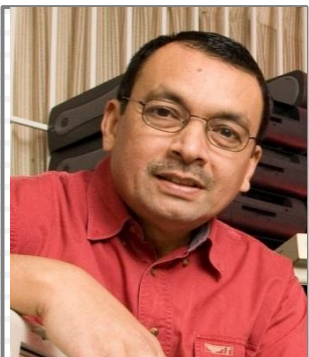
**Senior Lecturer in Waste Management**

**Griffith School of Engineering**

Griffith University, Brisbane, Australia

Email: [s.herat@griffith.edu.au](mailto:s.herat@griffith.edu.au)

Webpage: <http://tinyurl.com/sunil-herat/>



# What is E-waste?

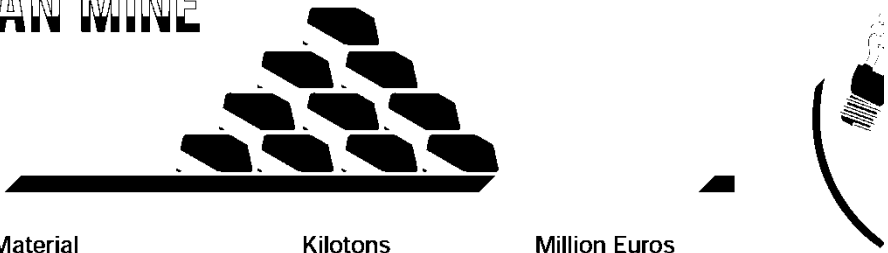
- Temperature exchange equipment (refrigerators, freezers, air conditioners, heat pumps).
- Screens, monitors (televvisions, monitors, laptops, notebooks, and tablets).
- Lamps (fluorescent lamps, compact fluorescent lamps, high intensity discharge lamps and LED lamps).
- Large equipment (washing machines, clothes dryers, dish washing machines, electric stoves, large printing machines, copying equipment and photovoltaic panels).
- Small equipment (vacuum cleaners, microwaves, toasters, electric kettles, electric shavers, scales, calculators, radio sets, video cameras, electrical and electronic toys, small electrical and electronic tools, small medical devices, small monitoring and control instruments).
- Small IT and telecommunication equipment (mobile phones, GPS, pocket calculators, routers, personal computers, printers, telephones).

# Global E-waste Generation

- During 2014 world generated around 41.8 million tonnes (Mt) of E-waste
- Global e-waste generation to reach 50 Mt by 2018 (annual growth rate of 4 to 5%)
- Asian region produced the highest amount of e-waste (16 Mt or 38% of total), followed by Americas (11.7 Mt) and Europe (11.6 Mt).
- The top three Asia-Pacific countries with the highest e-waste generation in absolute quantities are China (6 Mt), Japan (2.2Mt) and India (1.7Mt).
- Source: Global E-waste Monitor 2014 (UNU)

# Global E-waste Monitor (UNU)

## URBAN MINE



Material	Kilotons	Million Euros
<b>METAL</b>		
Iron, Steel (Fe)	16,500	9,000
Copper (Cu)	1,900	10,600
Aluminum (Al)	220	3,200
Precious Metals		
Gold (Au)	0.3	10,400
Silver (Ag)	1.0	580
Palladium (Pd)	0.1	1,800
<b>PLASTICS</b>		
PP, ABS, PC, PS	8,600	12,300

**ESTIMATED**  
**48,000,000,000 EUROS**

## TOXIC MINE



### METALS

Mercury, Cadmium, Chromium  
 Lead  
 Lead glass - 2,200 kilotons

### COMPONENTS

Batteries - 300 kilotons

### CHEMICALS

Poly- / Brominated Flame Retardants in Plastics  
 Phosphors  
 PCBs/A Polychlorinated biphenyl (old capacitors)  
 Hexavalent chromium (PVV)  
 Ozone depleting substances (CFCs, HCFC, HFC, HCs) - 4.4 kilotons

# Key components of E-waste resource recovery and recycling chain

- Treat the hazardous compounds contained in e-waste in an environmentally sound manner while preventing secondary and tertiary emissions
- Recover valuable material using efficient processes
- Create economically and environmentally sustainable businesses
- Consider social impact and local context of operations



# E-waste Recycling Technology

Patent Landscape Report on  
**E-Waste Recycling Technologies**

2013

PATENT LANDSCAPE REPORTS PROJECT

in cooperation with **WIPO**  
WORLD INTELLECTUAL PROPERTY ORGANIZATION

## Patent Landscape Reports

### Electronic Waste Recycling

The surge in patenting activity since 2000 points strongly to the commoditization of e-waste as a source of high value materials, such as rare earth and noble metals.

**Patenting activity**  
Number of patent families\*

**Major technology trends**  
Compound annual growth in patent families from 2006-2010

- +37% Conveyor belts for e-waste logistics and sorting
- +57% Battery dismantling
- +38% Recovery of rare earth metals
- +24% Recovery of platinum\*
- +15% Recovery of gold\*
- +25% Recovery of silver\*
- +63% Dealing with hazardous cadmium, mainly from batteries

**Top 5 origins**  
Number of patent families per office of first filing since 1980

**Regional distribution**  
Number of patent families by region of first filing since 1980

**Top 5 applicants**  
Number of patent families filed in at least five territories

**Specializations**  
By economy type

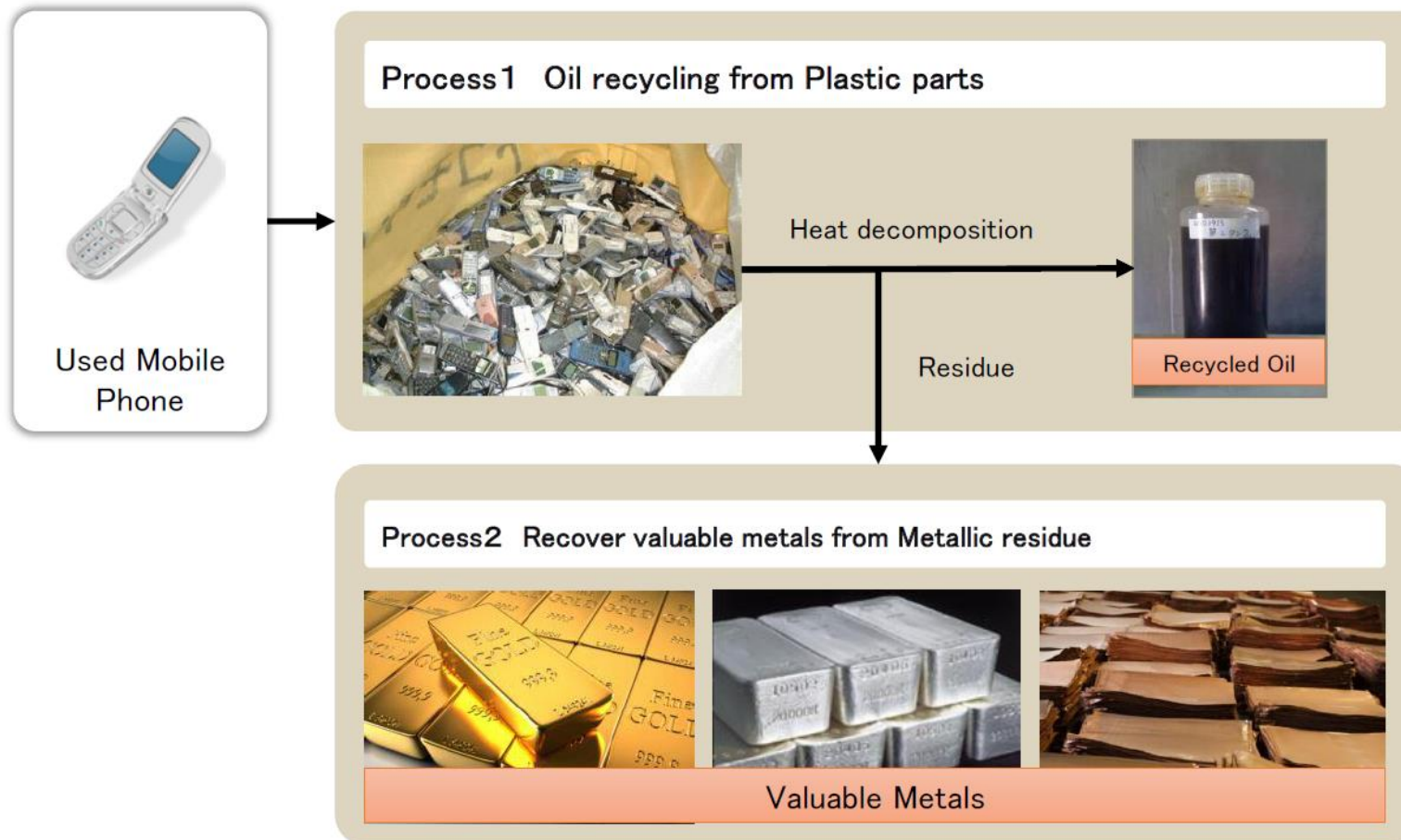
Developed economies	End products as waste source	Plastic recycling	Rare earth extraction
BRICS and other emerging economies	Specific components as waste source	Hazardous materials processing	
	Non-ferrous metals extraction	Further processing, such as smelting or pulverizing	Separation techniques

Key: \*A patent family is a set of patent filings made in various countries to protect a single invention. URL: [www.wipo.int/patentSCOPE/en/programs/patent\\_landscapes/reports](http://www.wipo.int/patentSCOPE/en/programs/patent_landscapes/reports)

# E-waste Recycling Technology

Recycle Process of Used Mobile Phone

Oil recycling for plastic parts of Mobile Phone, then recover valuable metals



# E-waste Recycling Technology

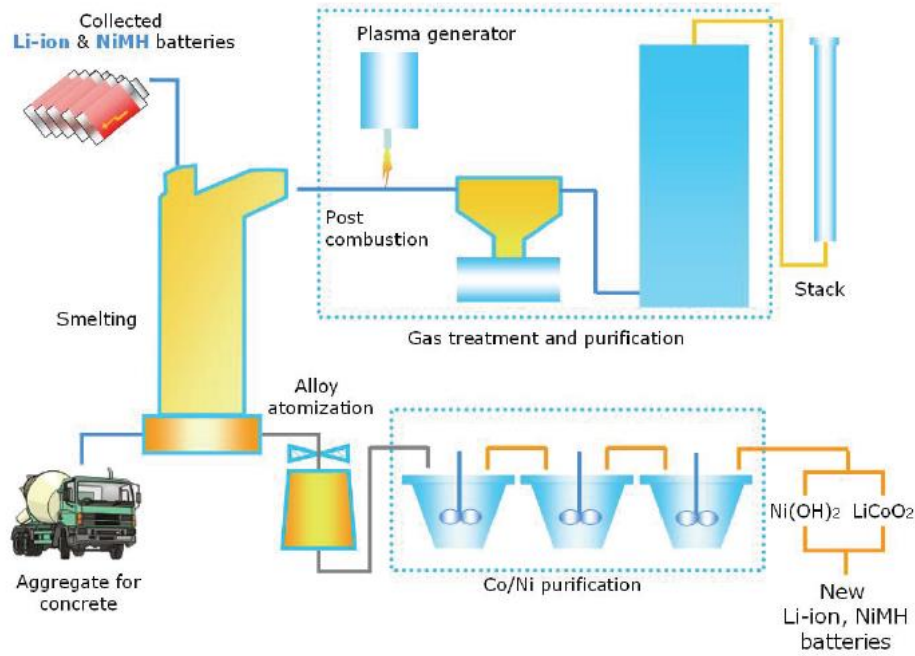


Figure 5.4: Material flows and main process units of Umicore's battery recycling process (by courtesy of Umicore Precious Metals Refining)

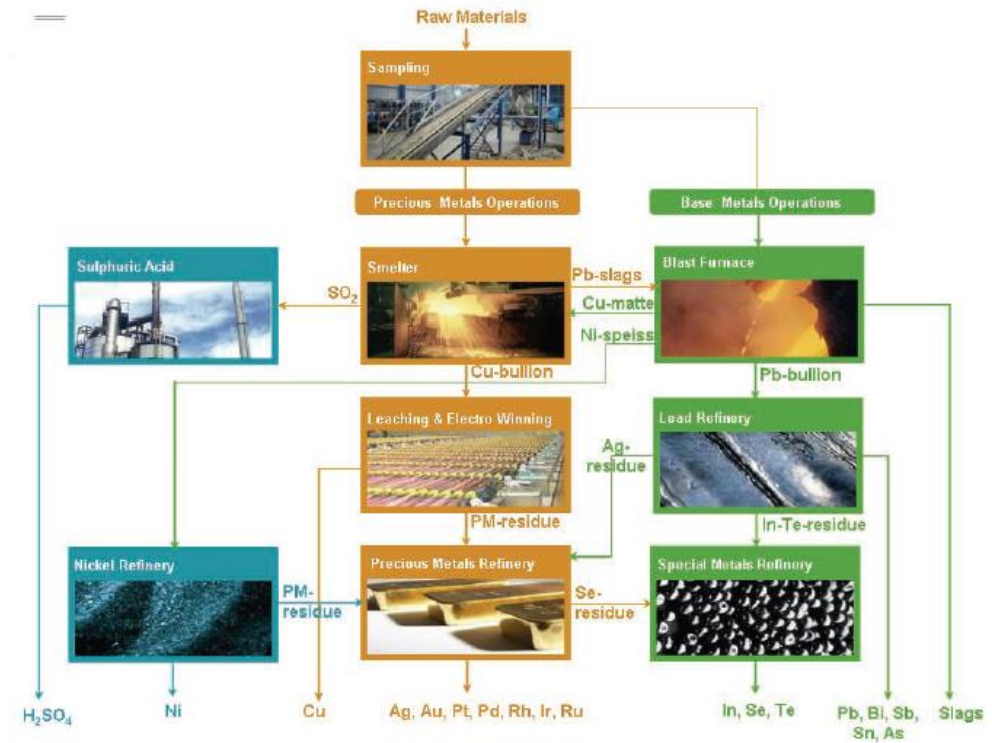
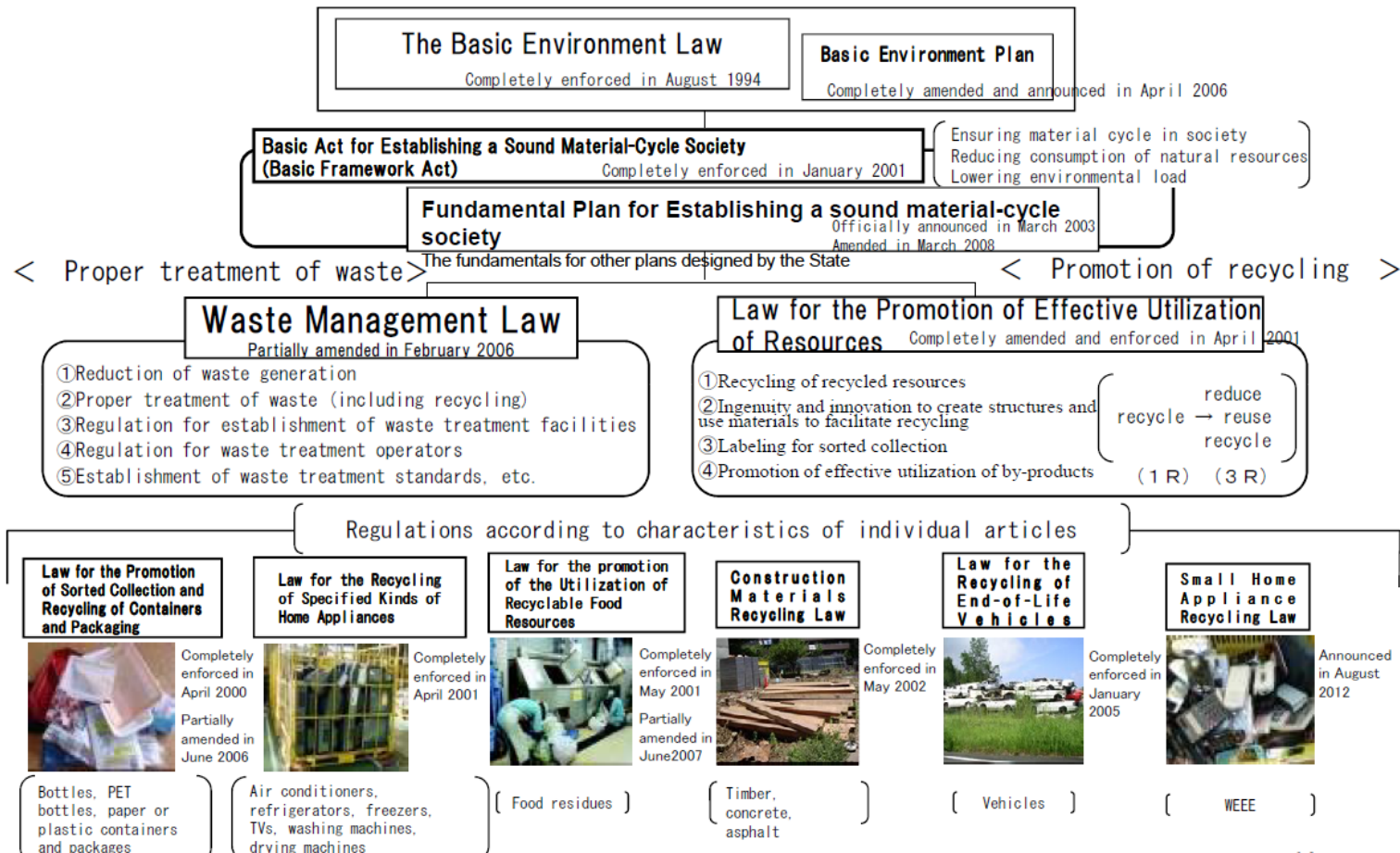


Figure 5.3: Material flows and main process units at Hoboken plant (by courtesy of Umicore Precious Metals Refining)

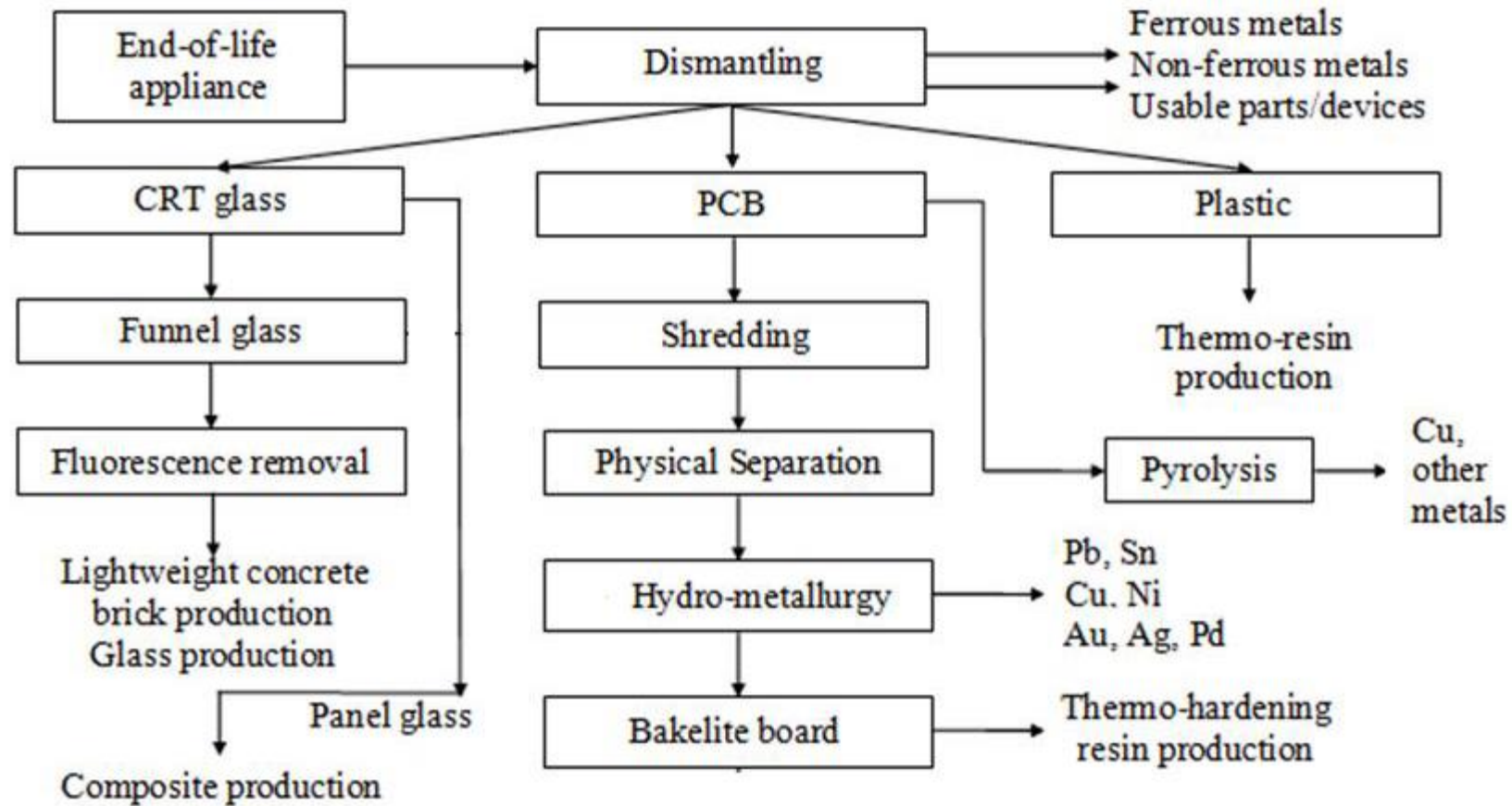


# E-waste Management Policies

## Legal systems for establishing a Sound Material-Cycle Society

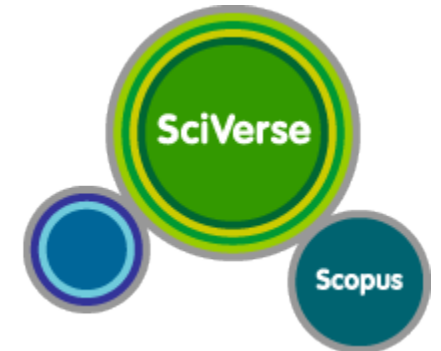


# E-waste Research (Prof Huynh Trung Hai, Hanoi University of Science & Technology)



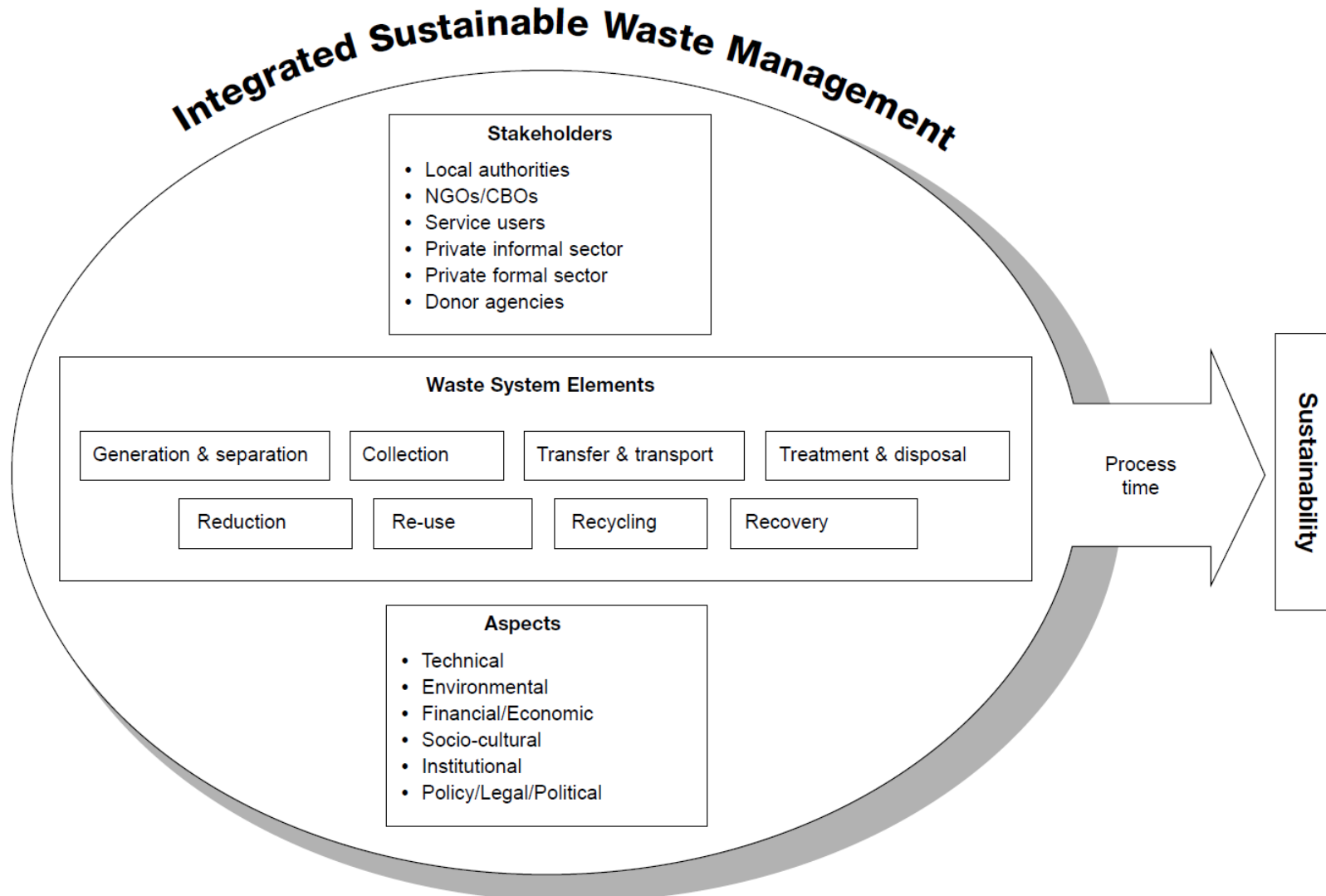
# E-waste - Current Research Focus

- Research on e-waste can be broadly categorised into two components: *Impacts* (e.g. environment, health) and *Solutions* (e.g. technology, policy, management). The former is mainly basic research, conducted by researchers with environmental science, biological, medical and chemical backgrounds, while the latter is multidisciplinary, and has translational value
- Research in Scopus database shows that, as at June 2014, there were 1260 research publications related to e-waste, out of which, only 366 (29%) dealt with **Solutions** to the e-waste problem.



# Integrated Sustainable Waste Management Model

(<http://www.waste.nl/en/concept-tool-iswm>)



# Need for a Science-Policy-Business Interface towards Economic Utilisation of E-waste

## Disconnected

- Heavy emphasis on basic research related to impacts of poor e-waste management
- Policies based on keen-jerk reactions

## Interacting

- Good balance of basic and translational research (Impacts and Solutions)
- Policies based on sound scientific research and relevant stakeholder engagement

# Partnership for Scientific and Policy Cooperation

## Regional 3R Forum

- Objective of the Regional 3R Forum in Asia is to provide strategic policy advices to national government authorities in mainstreaming 3Rs in the overall policy, planning and development.

## 3RINCs

- The aim of 3RINCs is to provide, and serve as a platform for, academic activities that promote a 3R society.

**Thank You!**