2007 CTCI Foundation Environment & Energy Convention

National Taipei University Of Technology

Progress in 3R for Industrial Waste Management in Taiwan

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Jan, 17, 2007

1.Introduction

2.Management and accomplishment of Industrial wastes

3. 3R Management framework for Industrial wastes

4.The impact of WEEE, RoHS and EuP in Taiwan

5. Feature Research Direction for 3R in Industrial Wastes Management

1. Introduction

Introduction

Sustainable development

In 1992, The United Nations Conference on Environment and Development definition

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs

Tendency Toward Environmental Development(1)

Waste

||

Resource in Disguise

||

(Waste)

W

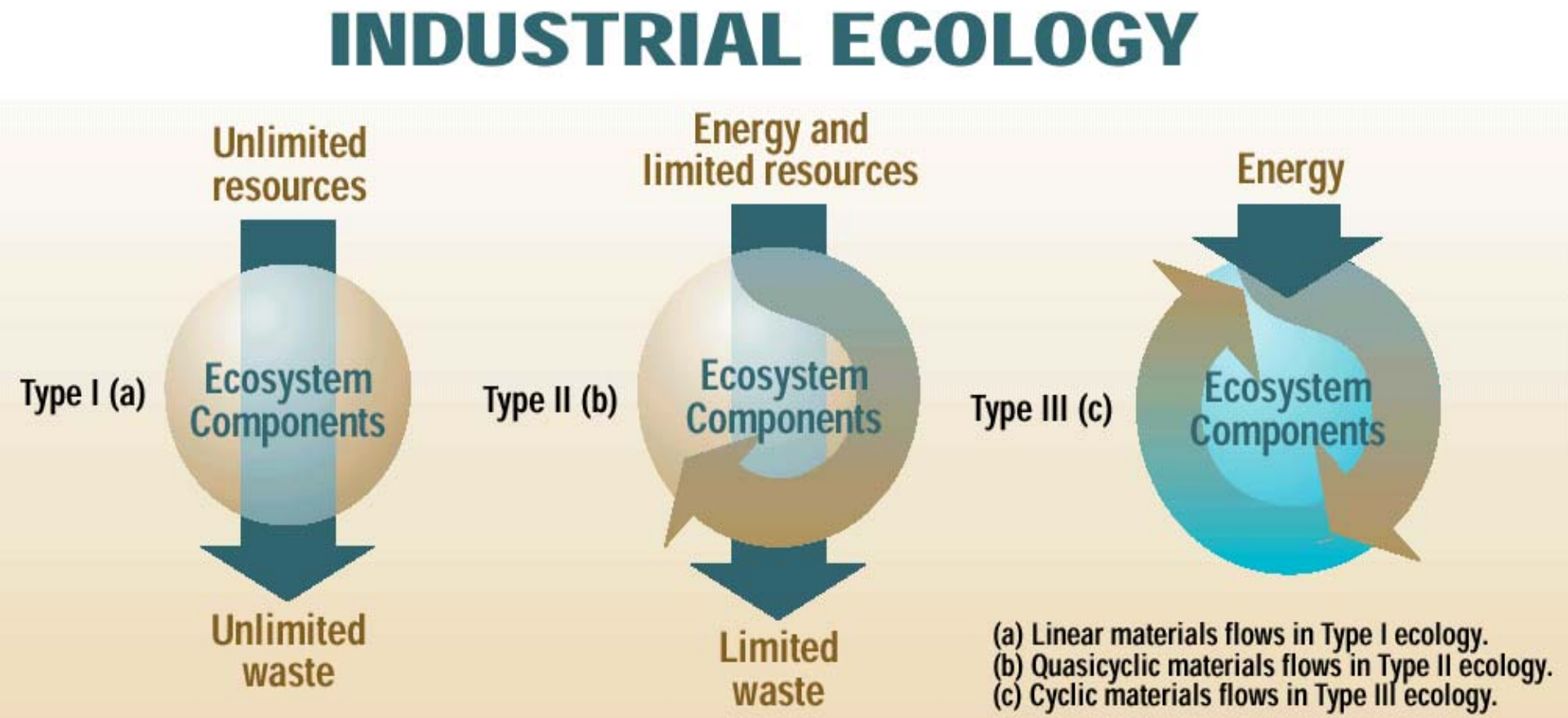
W

M

(Material)

(Money)

Tendency Toward Environmental Development(2)



Tendency Toward Environmental Development(3)

Sustainable development

Principles of Recycling

1. Can not disregard the cost to recycling
2. Recycling must include high additive value
3. Substance recycling is better than energy recycling
4. Recycling based on reduce, reuse and recovery

Direction of Recycling

1. Reduce/Reuse/Regeneration and Recovery
2. Create high additive value
3. Safe treatment for Hazardous and Toxic substances

2. Management of Industrial Wastes

Course of Industrial Wastes

	1960~1980	1990	2000	2008~
Administrative Regulation	Waste Disposal Act	7 TIMES OF REVISIONS	Waste Disposal Act Resource Recycling Act	Sustainable Development Clean Production Industrial ecology Zero waste
EPA	Waste disposal Act declaration Municipal solid waste plan	Recycling 4 in 1 program Establish industrial waste control center	ESTPs	
Industrial wastes	Waste landfill	Treated by oneself Industrial wastes authority responsibility	Sources reduction and Recycling	

Announcement of Recycling for Industrial Waste

2005

- **Categories：370, including 2 resources**
- 33,896 factories (95%) are subject to the authority, including the declaration of 12,525 factories.
- **Total declaration** in weight：**14,940 thousand ton.**
  - **General industrial wastes：1,359 ton（90.9%）**
  - **Hazardous industrial wastes ：1,350 ton（9.1%）**

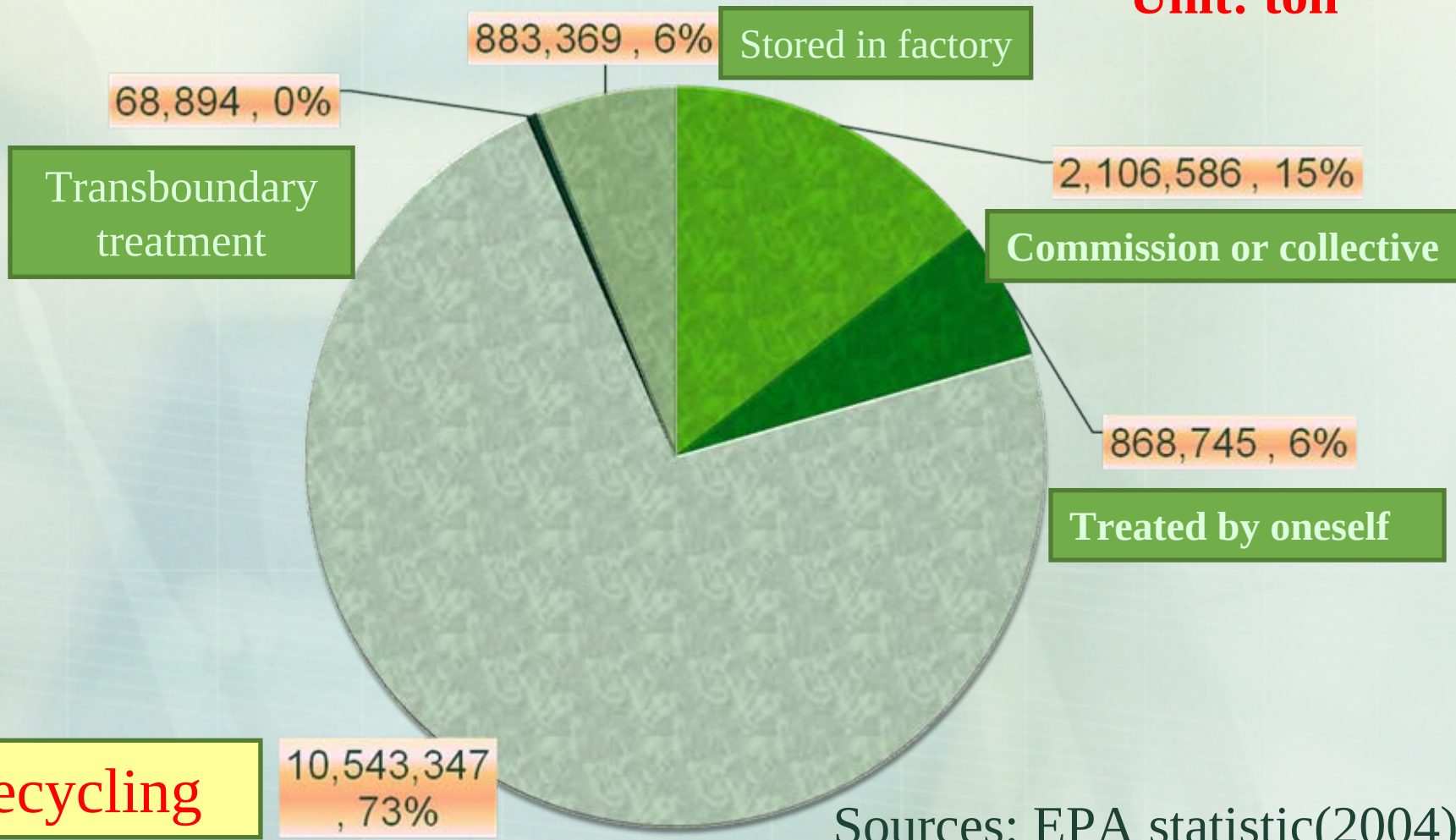
Waste disposal Act

Responsibility：Ministries are responsible to plan the Categories, 92 substance should be recycled.

Industrial Waste Management, the Present Situation

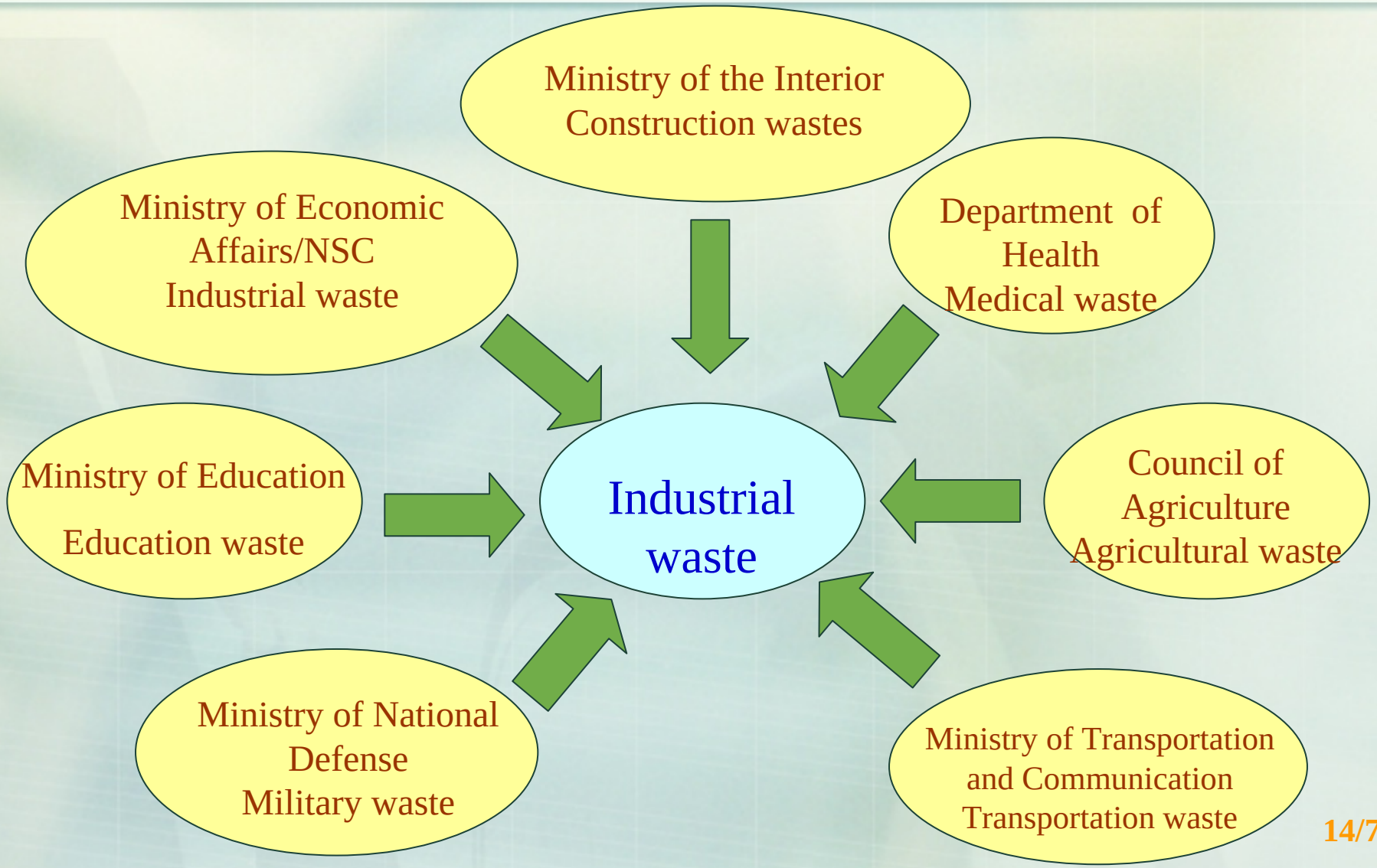
Flow direction and reuse rate

Unit: ton

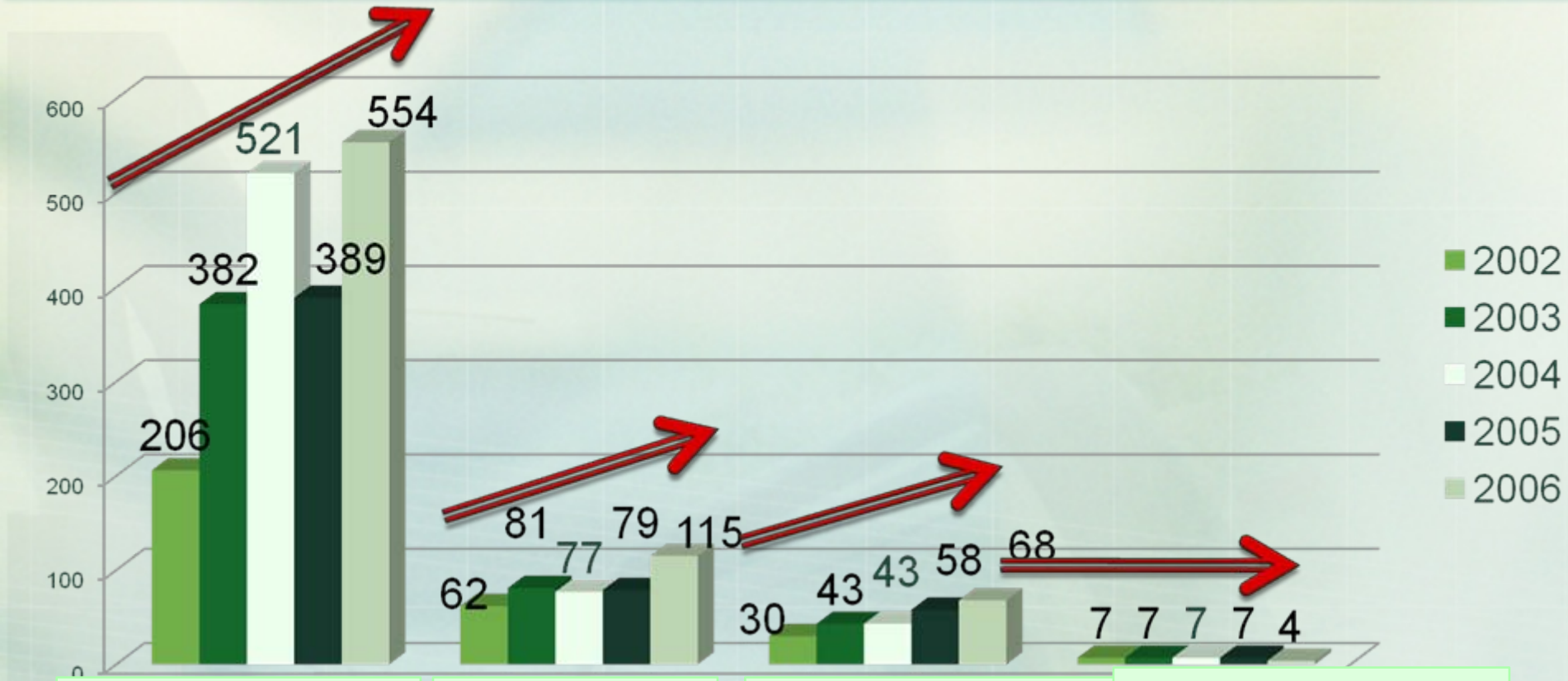


Sources: EPA statistic(2004)

Announcement of Recycling for Industrial Wastes



Industrial Waste Management, the Present Situation



Announcement of recycling

Permission of recycling

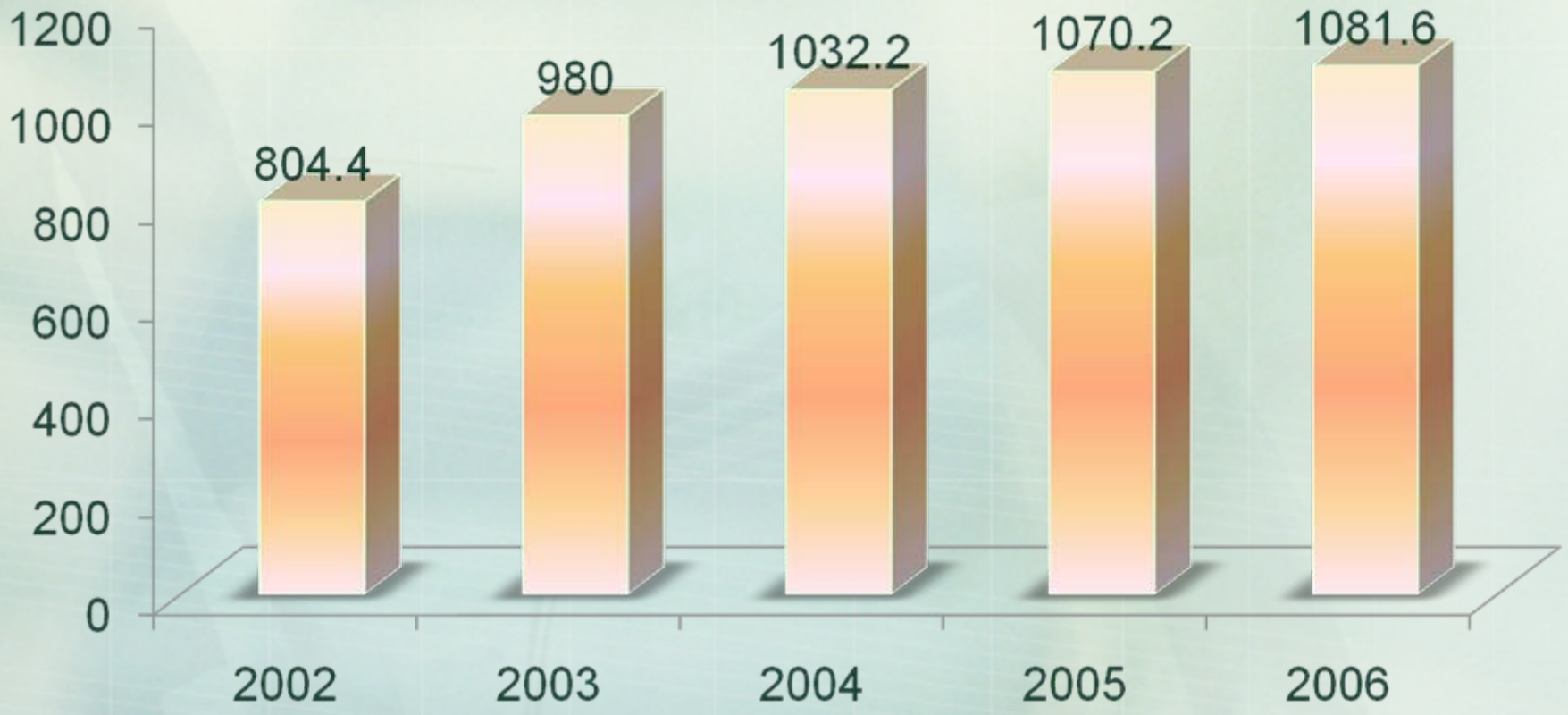
Public or private own treatment organizatic

Common treatment organization

Industrial Waste Management, the Present Situation

2002~2006

Unit: ton/yr



Sources: Industrial Development Bureau ministry of economic Affairs

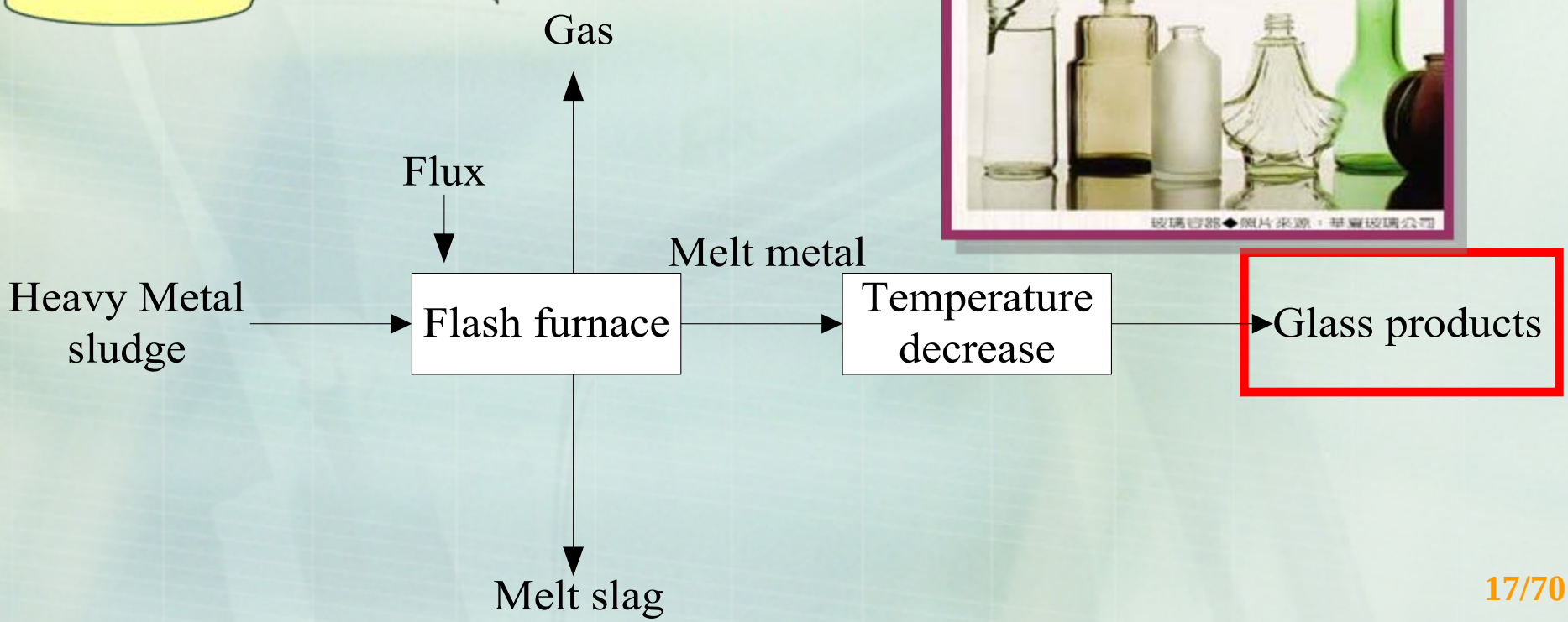
Recycling Techniques and Beneficial Commerce

Recycling techniques for Heavy metal sludge

Recycling techniques for Calcium fluoride

Recycling techniques for clean water sludge

Recycle by high Temperature melting



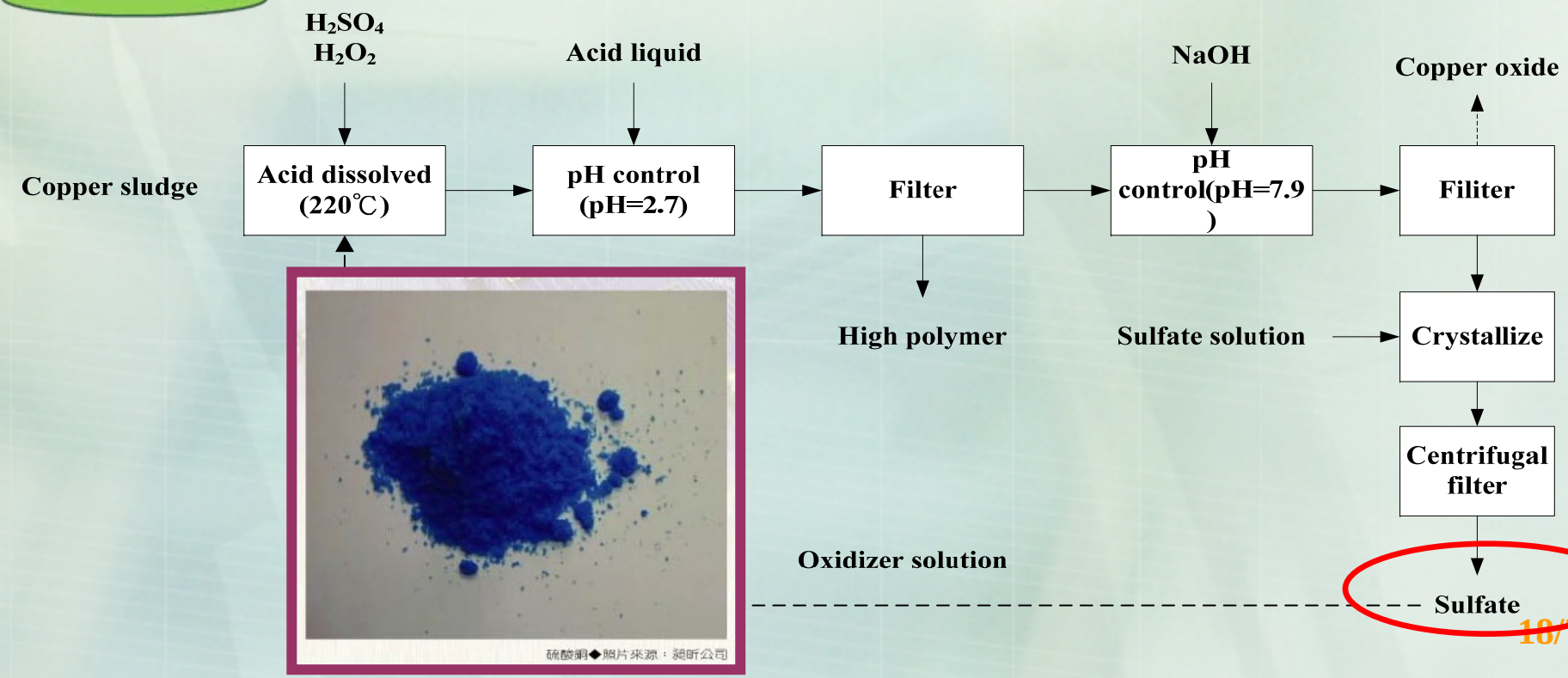
Recycling Techniques and Beneficial Commerce(2)

Recycling techniques for Heavy metal sludge

Recycling techniques for Calcium fluoride

Recycling techniques for clean water sludge

Recycle by acid dissolved to crystallize



Recycling Techniques and Beneficial Commerce(3)

Recycling techniques for Heavy metal sludge | Recycling techniques for Calcium fluoride | Recycling techniques for clean water sludge

Smelt by drying machine to recycling

Vibrate and smash put into drying machine

Heavy metal sludge → Sedimentation tank → Metal sludge dewatering → Sludge cakes

1,300~1,600℃

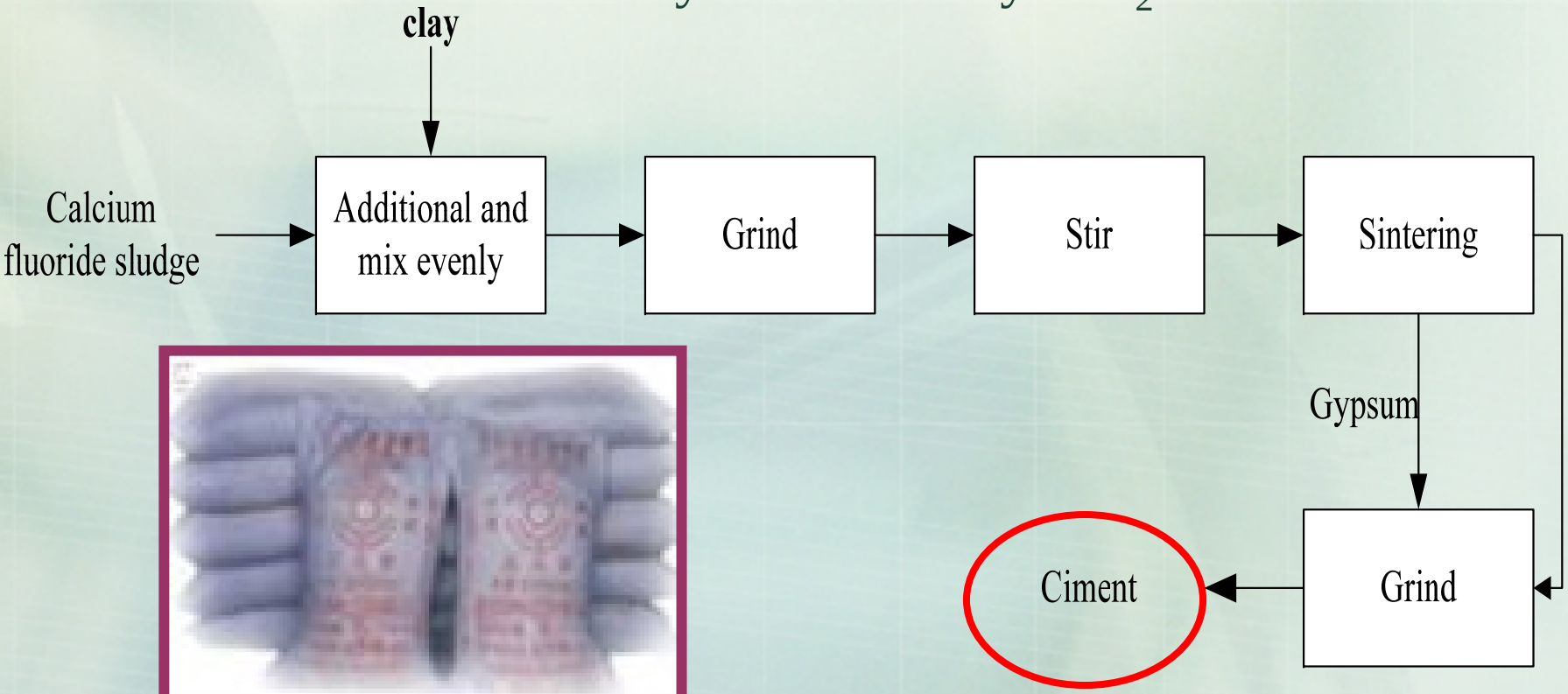
Metal oxide → Smelt → Copper

Coke and Silicide

Recycling Techniques and Beneficial Commerce(4)

Recycling techniques for Heavy metal sludge | **Recycling techniques for Calcium fluoride** | Recycling techniques for clean water sludge

One of the Cement Industry Stuff Used by CaF_2

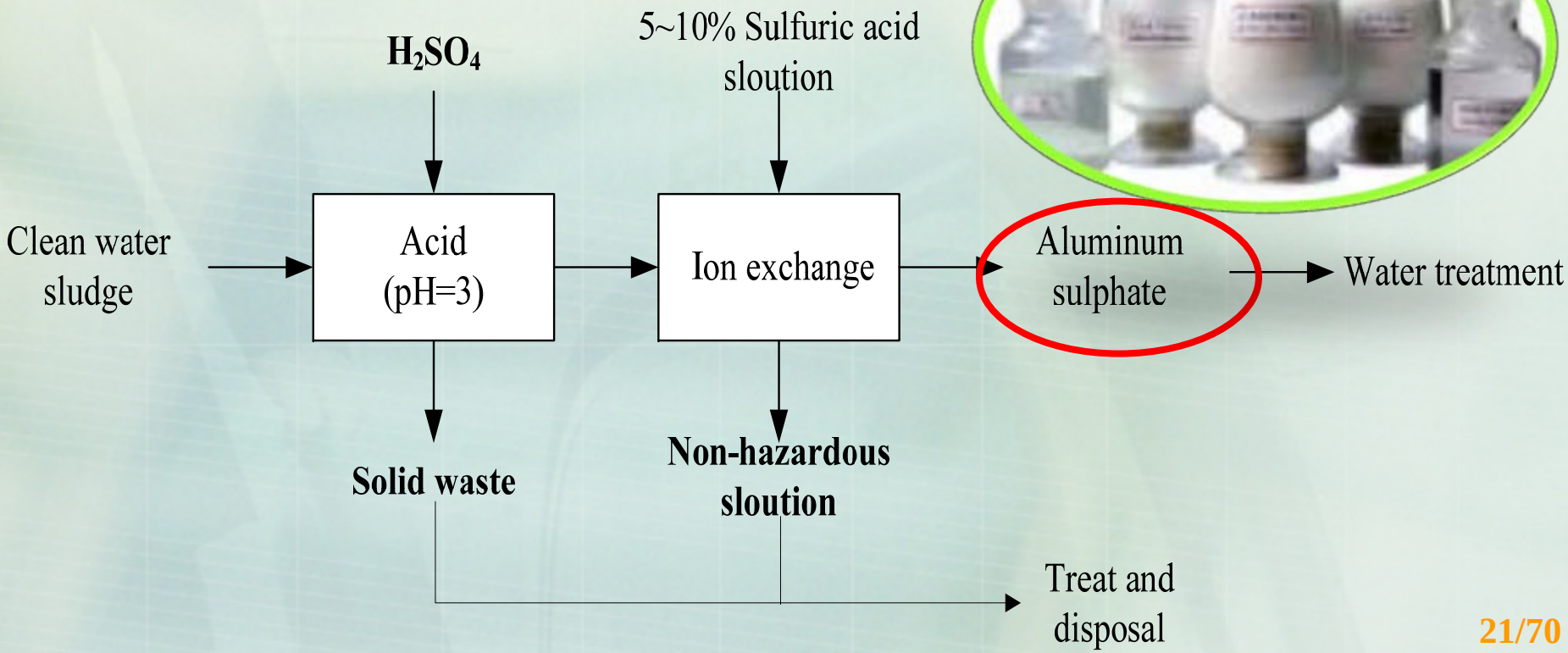


Recycling Techniques and Beneficial Commerce(5)

Recycling techniques for Heavy metal sludge

Recycling techniques for Calcium fluoride

Recycling techniques for clean water sludge



Recycling Techniques and Beneficial Commerce(6)

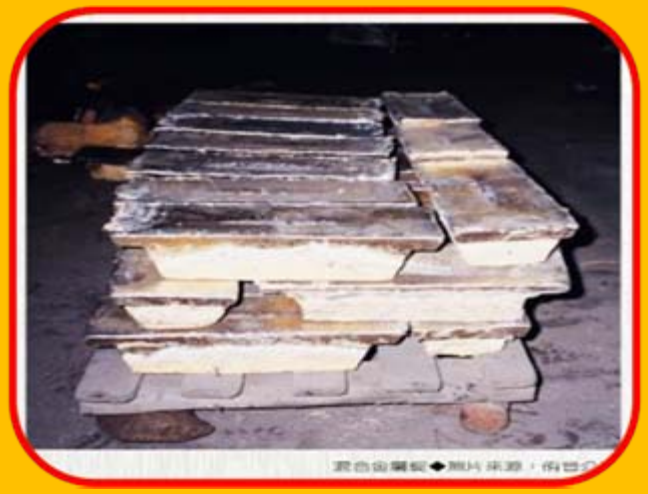
Recycling benefits result

- Recycling quantity of industrial waste 10 million ton per year
- Total value $327 hundred million.
- Recycling products include:
  1. Rubber
  2. Engineering Materials
  3. Plastic
  4. Metal

Plastic and its material

Fertilizer

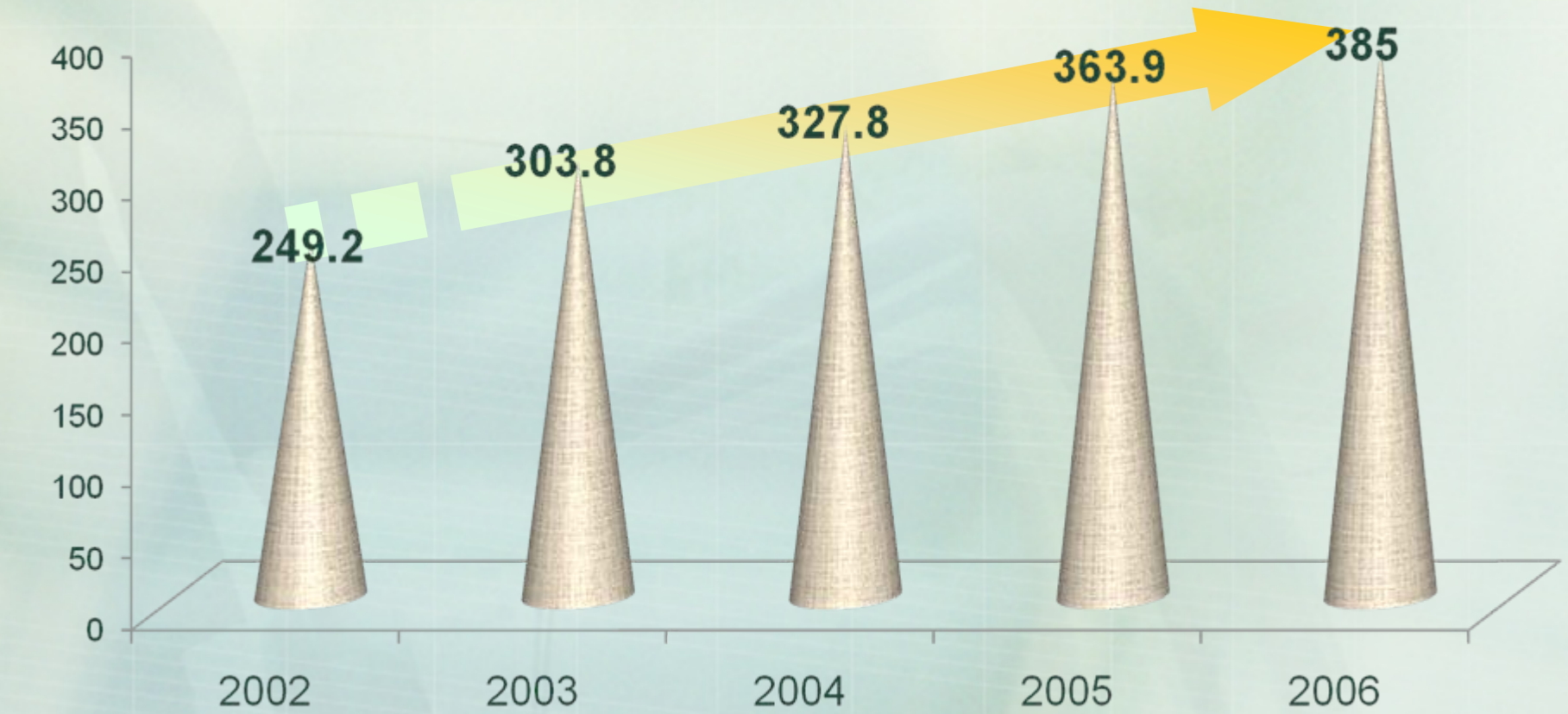
Metal



Recycling Benefits and Results

Total value of recycling industry

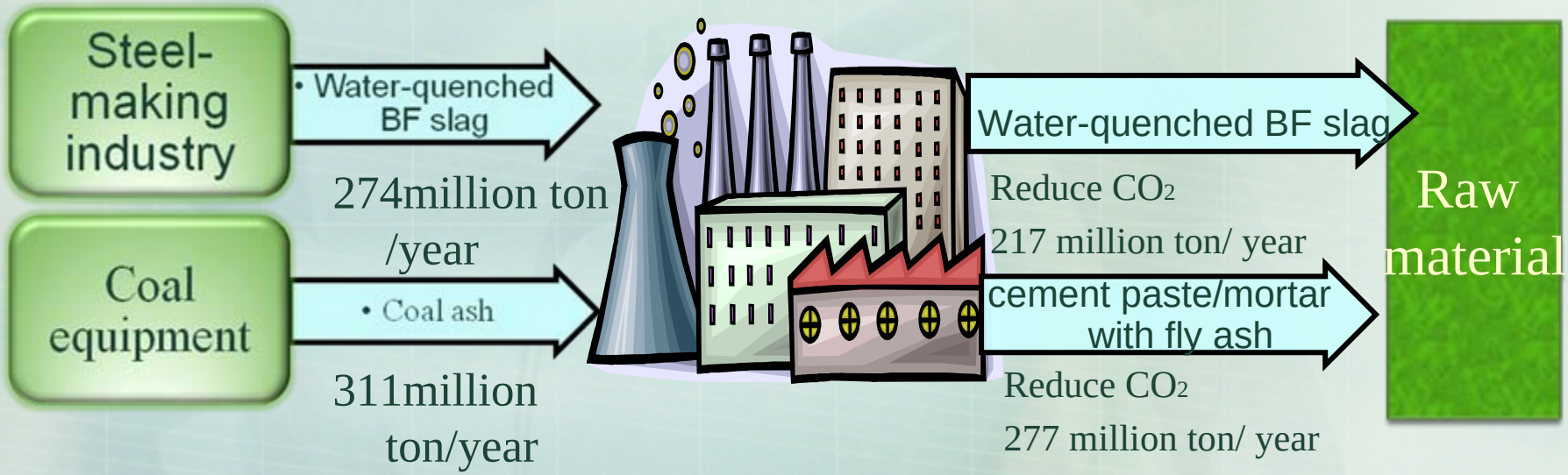
Shows an Increasing Tendency



Sources: Industrial Development Bureau ministry of economic Affairs

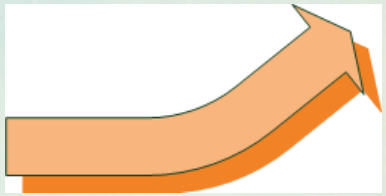
Recycling Techniques and Beneficial Commerce(8)

- Removal from the global warming potential
  - Process product decrease the greenhouse gas of 4.94 million ton by industrial recycling.
  - The contribution quantity will exceeded in number

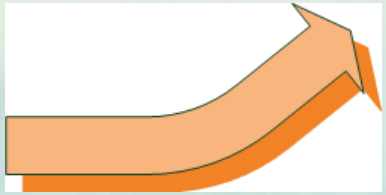


Recycling Techniques and Beneficial Commerce(8)

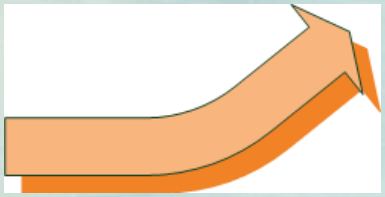
Recycling value achieve 8.5 billion/year。



CO_2 emission reduce to 940 thousand ton/year



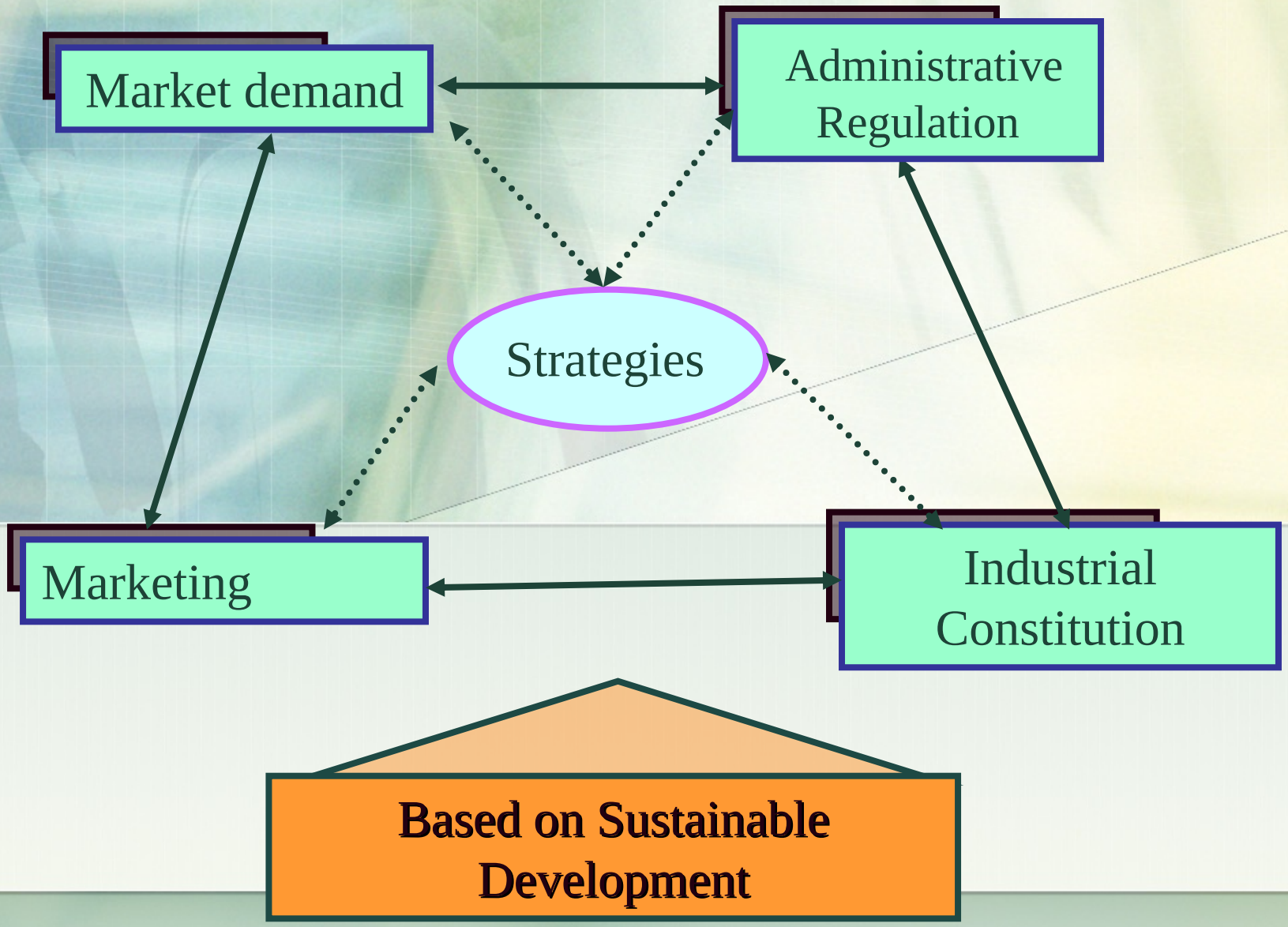
Env-quality Loss achieve 30.35 billion/year



Recycled products Quantity achieve 10,816 thousand ton/year million

3. 3R Management Framework for Industrial Waste

3R Management Framework for Industrial Waste



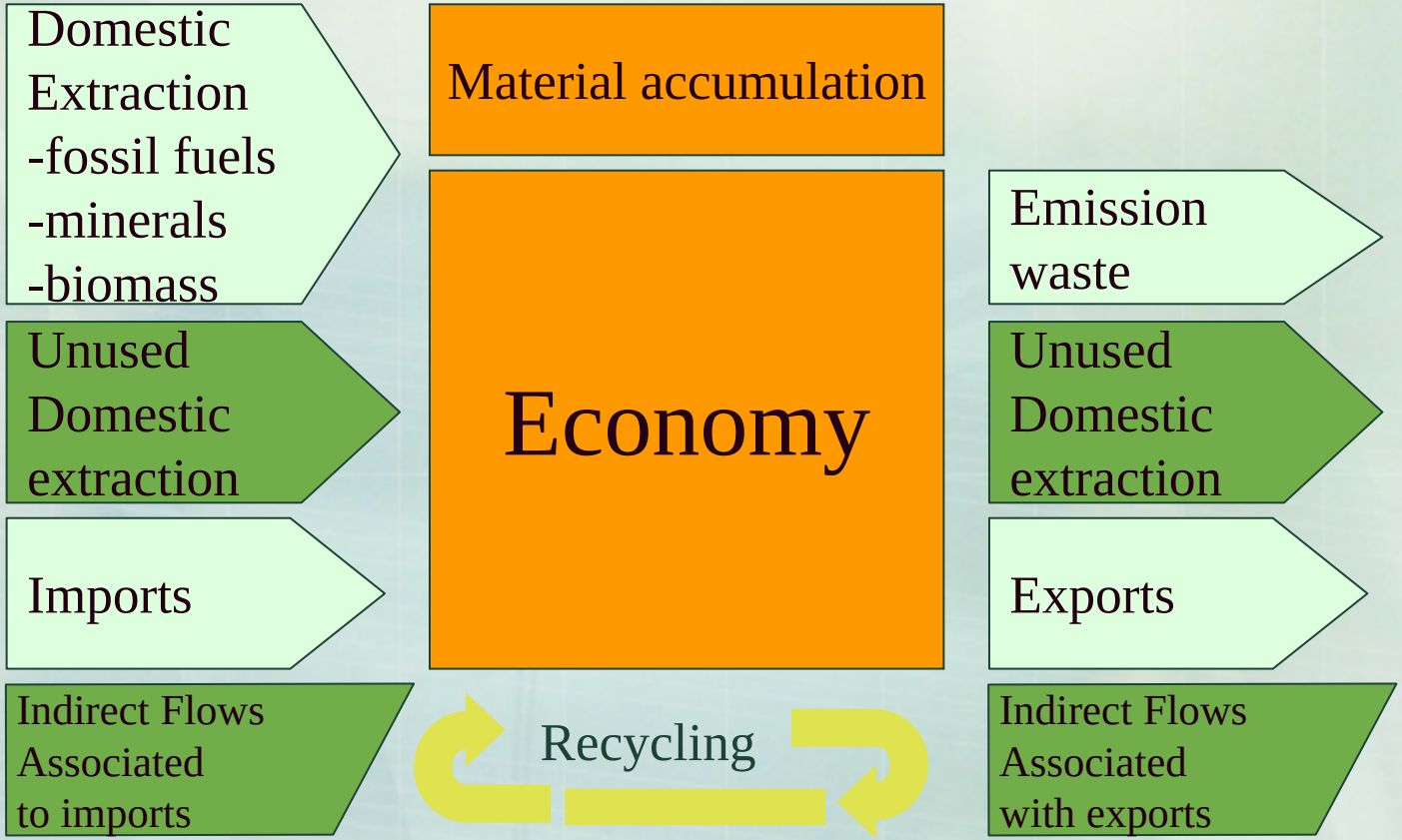
Industrial Waste Recycling SWOT Analysis

	Strength	Weakness	Opportunity	Threat
Administration	1. Policy support 2. Law standard	1.Source Reduction 2.Short of economic capacity	1.Tendency toward reduction 2. Lifecycle Management	1. Competition in laws for waste treatment
enter-prises	1. Taiwan's small and medium enterprises have maneuverability	1.Technology promotion needed 2. suit global challenges	1. Policy support	1. Training and education needed
To manage	1.Tax favorable	1.Technology and market are not into maturity 2.Hard to Large-Scale production	1.Green consumption	1.Regularly blemished 2.Hard to quality control
market	1.High quality, law, price	1.Hard to quality control 2.Hard to Large-Scale production	1.Tendency toward 3 R	1.Risk to invest abroad

Industrial Waste Management System Boundary

Material flow analysis

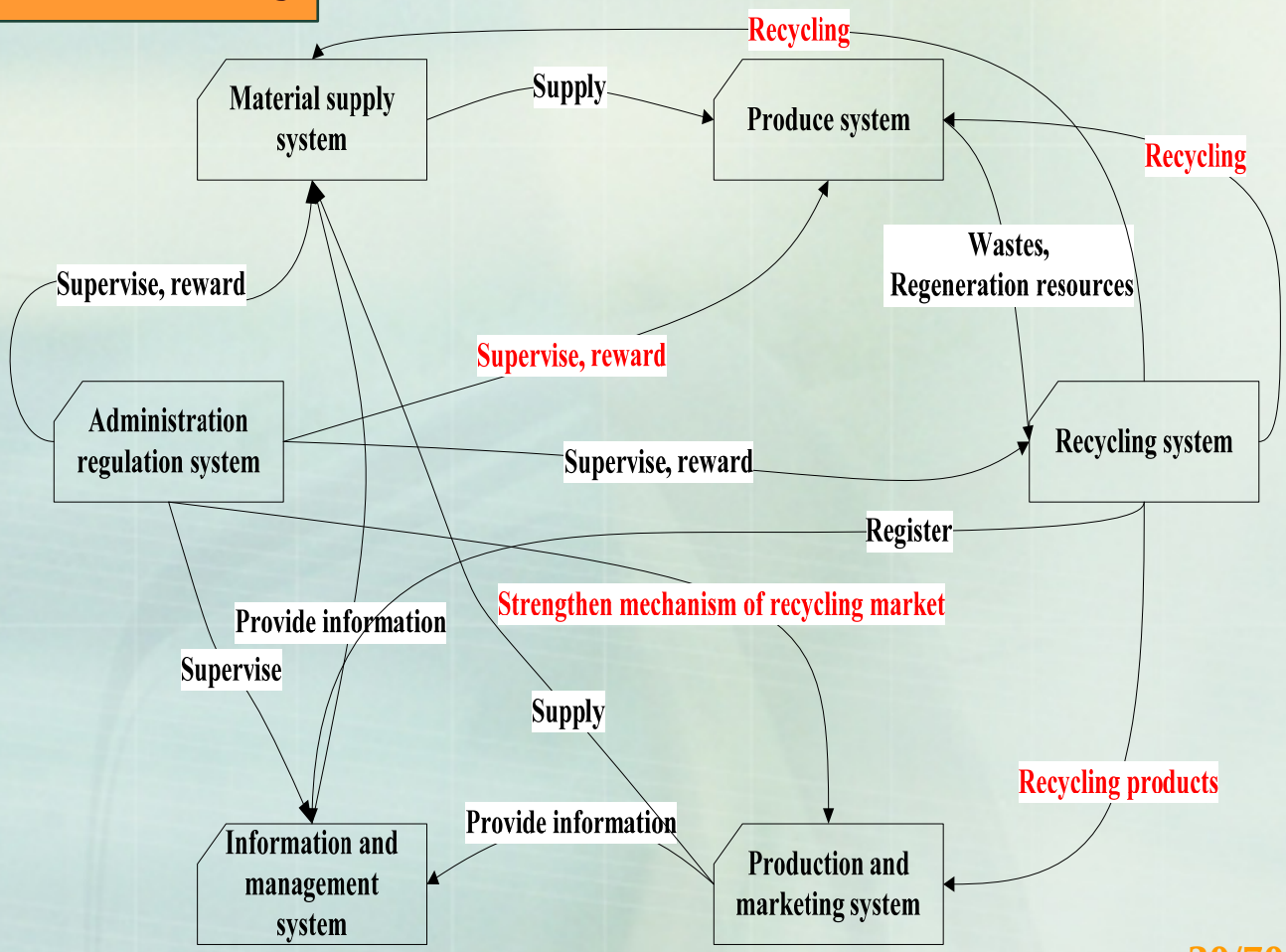
- Systematic Assessment of Resources for Input, Flow, Stock and Output.



Industrial waste management System boundary

Recycling system boundary

- Sources Reduction
- Restriction of the Use of Certain Hazardous Substances
- With High Additive Value
- Environment Benefit Maximum



Mission, Vision, Goal and Objective of Recycling for Industrial Waste

- Mission：Toward sustainable development
- Vision：ROS (Recycle-oriented Society)
- Goal：Zero Waste。
- Objective：counted and un-counted

Objective	**Integrated department organization 3R**
	Source Reduction work out
	Strength Production/Market Mechanism of 3R
	Add attraction from economy
	Information exchange needed
	Education of professionals
	the community realize 3R

Recycling Rate for Industrial Waste

Year	Industrial waste	Medical	Constr-uction	Agricul-ture	education	military	Recycling rate	Land-treatment reduce rate	Incineration treatment reduce rate
2007	75%	20%	5%	5%	15%	65%	75%	10%	85%
2011	80%	30%	10%	10%	20%	70%	80%	25%	50%
2020	85%	45%	20%	20%	70%	80%	85%	25%	50%

Source：EPA(2005)

Mission, Vision, Goal and Objective of Recycling for Industrial Wastes

Goals and strategies

2005

- Recycled products value 3.65 billion
- technology and innovative ability for equipments
- industrial wastes recycling rate achieve 73%

2010

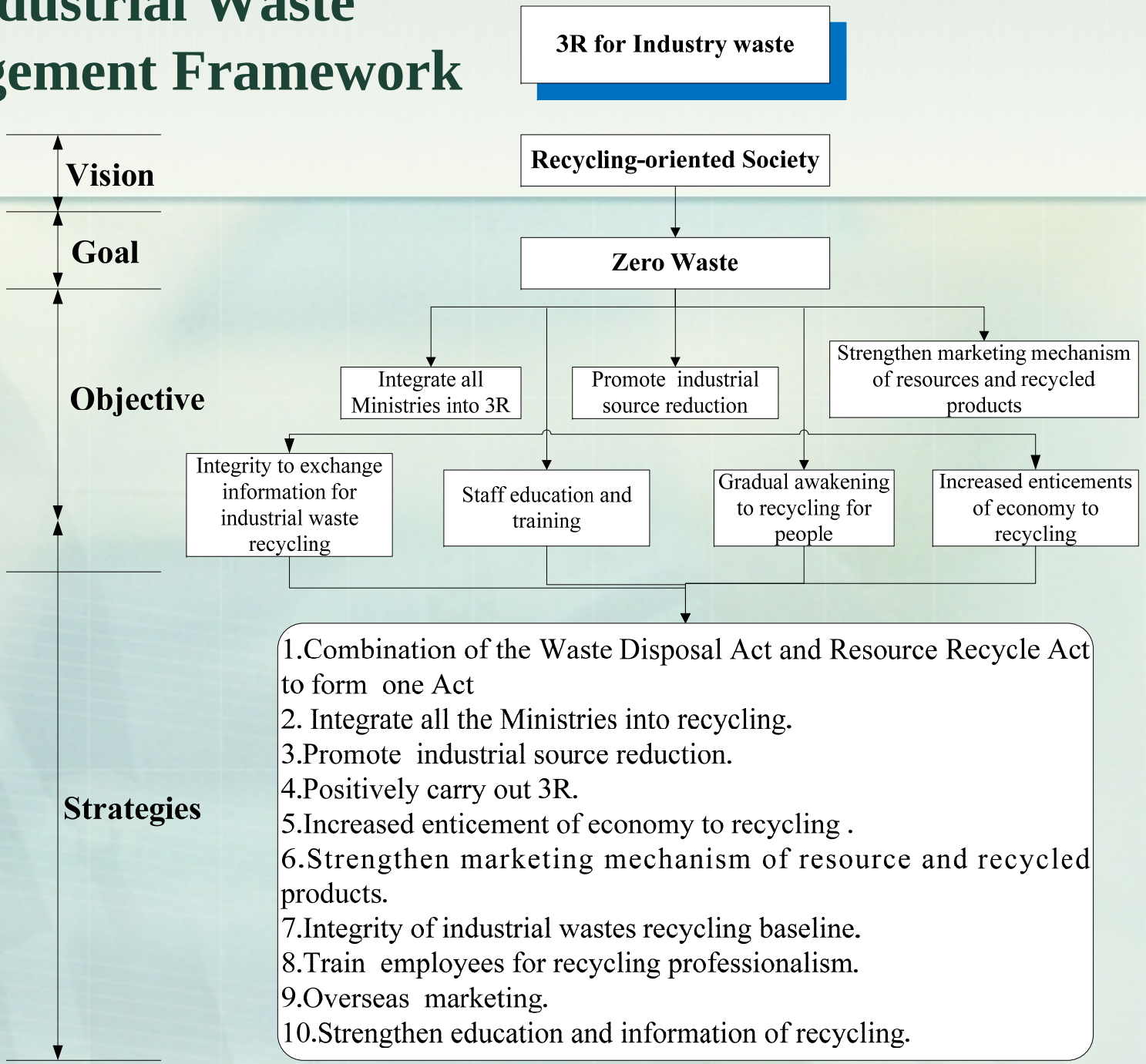
- Recycled products value 5.85 billion
- technology export achieve 2,000 million
- industrial wastes recycling rate achieve 78%

2015

- Recycled products value 9.5 billion
- technology export achieve 5,000 million
- industrial wastes recycling rate achieve 85%

- Give an impetus to product exchange abroad and to form an association
- Build national standard and self-management
- Promote high Additive value production, and new market.

Industrial Waste Management Framework



Strategies for Recycling of Industrial Waste(1)

- Implement waste management and recycling law
  - Definition of the terminologies integrated
  - Incorporate resource reduction, self-criticism, and get information flowing
- Develop framework of waste management data
  - Audit/check recycling data, report , and information from enterprises
- Integrate different departments
  - Design an inter-departmental plan to develop a 3R mechanism through a 3R commission
  - Building data collection system , such as resource reduction, design for environment, environmental management. Supply suggestions within a dateline.

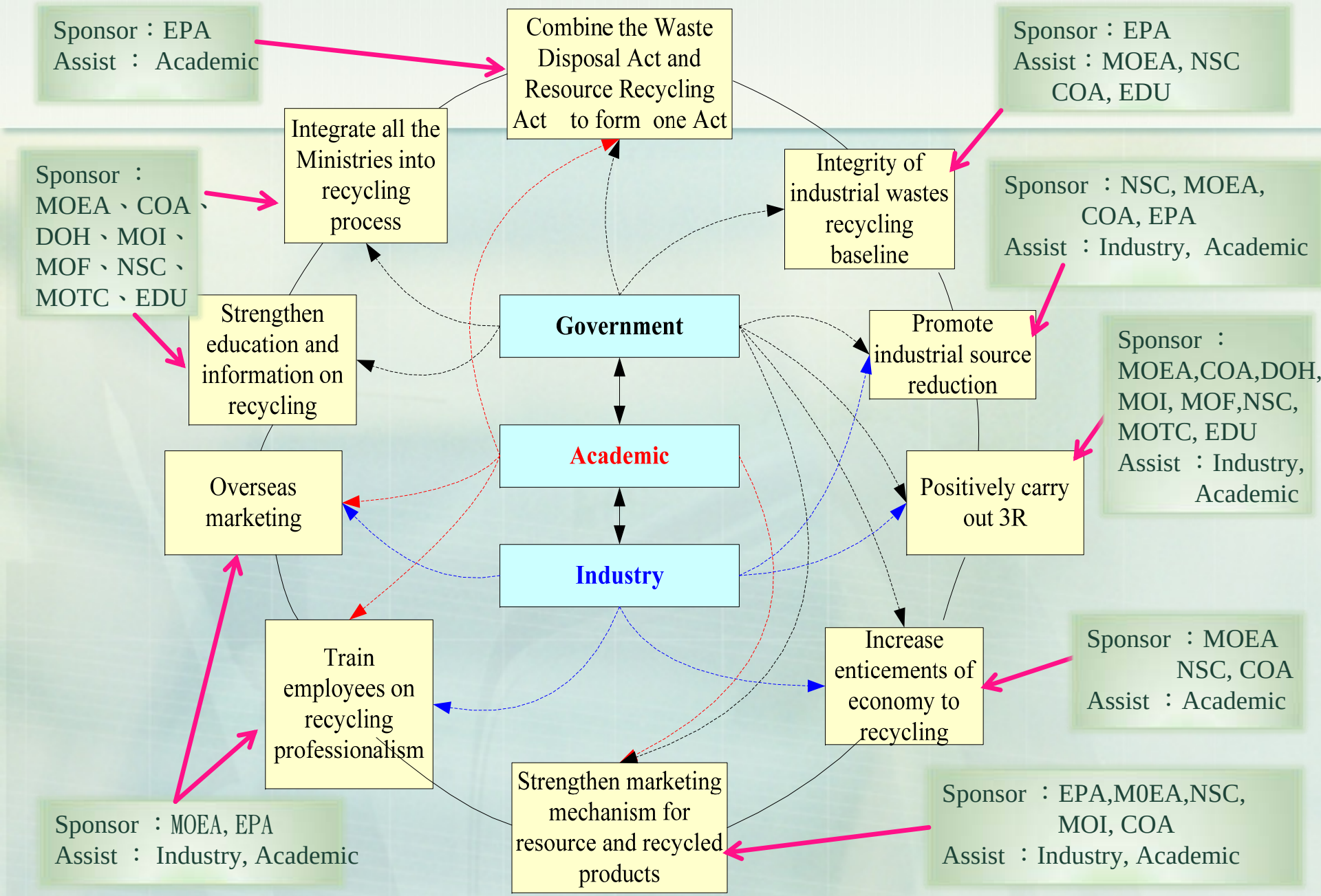
Strategies for Recycling Industrial Waste(2)

- Emphasize on source reduction
  - Include source reduction in law
  - Limit goods which use harmful substance and packaging. Should adapt WEEE (European Union)
- Promote resource recycling
  - Announce types of waste for recycling, include other items gradually
  - Build market mechanism for 3R, draw up rules and regulations
- Promote enterprises by attracting economic investment
  - Award prizes
  - Allocate land at low prices

Strategies for Recycling of Industrial Waste(3)

- Build market mechanism
  - Test and verify
  - Build national standard
  - Build self-management such as ISO14001。
  - Encourage design for environment
- Educating professionals
  - Promote technology
  - Put research findings in a high rate
  - To edit a handbook for 3R
- Overseas Marketing
  - Give an impetus for product exchange abroad and to form an association

Strategies for Recycling of Industrial Waste(4)



Industrial Waste Recycling Performance Index

Category	Indicator
Input	Waste management cost
	Invest equipment cost in DfE
	Examine the cost of testing for certain hazardous substances
	Total resource use and recycled products
	Examination expense for the quality of recycled products
	Staff education and training cost
Output	Benefit of saving energy
	Promote Product effectiveness
	Economic benefit of recycled material
Quantity	Recycled products quality rate
Outcome	Objective of achieving Industrial waste reduction
	Objective of achieving Industrial waste recycling
	Final landfill disposal rate is lessen

4.The Impact of WEEE, RoHS and EuP in Taiwan

WEEE, RoHS and EuP

Environment Load for electronic products

- **Reuse/Recycle Recovery** → WEEE
- **Restriction of the use of hazardous substance** → RoHS
- **Eco-design** → EuP

Development of WEEE, RoHS and EuP

Duration: 2003.02 → 2003.08 → 2004.08 → 2005.08 → 2006.7 → 2006.12

WEEE
- 2002/96/EC
- Member states bring into force the laws
- Extend producer responsibility
- Recycling target 4 kg/people/year

RoHS
- 2002/95/EC
- Member states bring into force the laws
- Restriction of the use hazardous substances

EuP Eco-design

2005/32/EC
- European Commission
- Number
- Resolution adoption year

Draft plan

First amendment

Second amendment

Accomplish third amendment

OJ L 191 of 22.07.2005

Twenty day

2005.8.11 effective

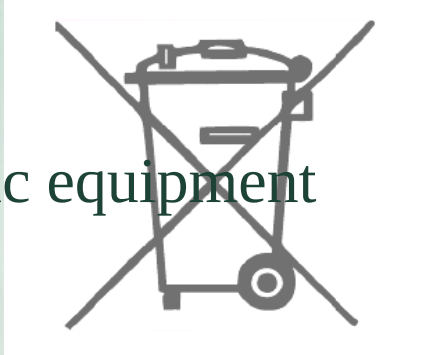
Member states Shall bring into force the laws, regulations and administrative provisions necessary before 11 August 2007

Categories of Electrical and Electronic Equipment Covered by this Directive

1. Large household appliances
2. Small household appliances
3. IT and telecommunications equipment
4. Consumer equipment
5. Lighting equipment
6. Electrical and electronic tools
7. Toys,leisure and sports equipment
8. Medical devices
9. Monitoring and control instruments
10. Automatic dispensers

WEEE DIRECTIVE

- Product Design
  - Member States shall encourage the design and production of electrical and electronic equipment which take into account and facilitate dismantling and recovery, in particular the reuse and recycling of WEEE.
- Recovery
  - Distributors to return such waste free of charge
  - Recycling rate: 4 kg per people by 31 December 2006
- Information for users
  - Symbol for the marking of electrical and electronic equipment



WEEE Reuse, Recycling and Recovery Targets

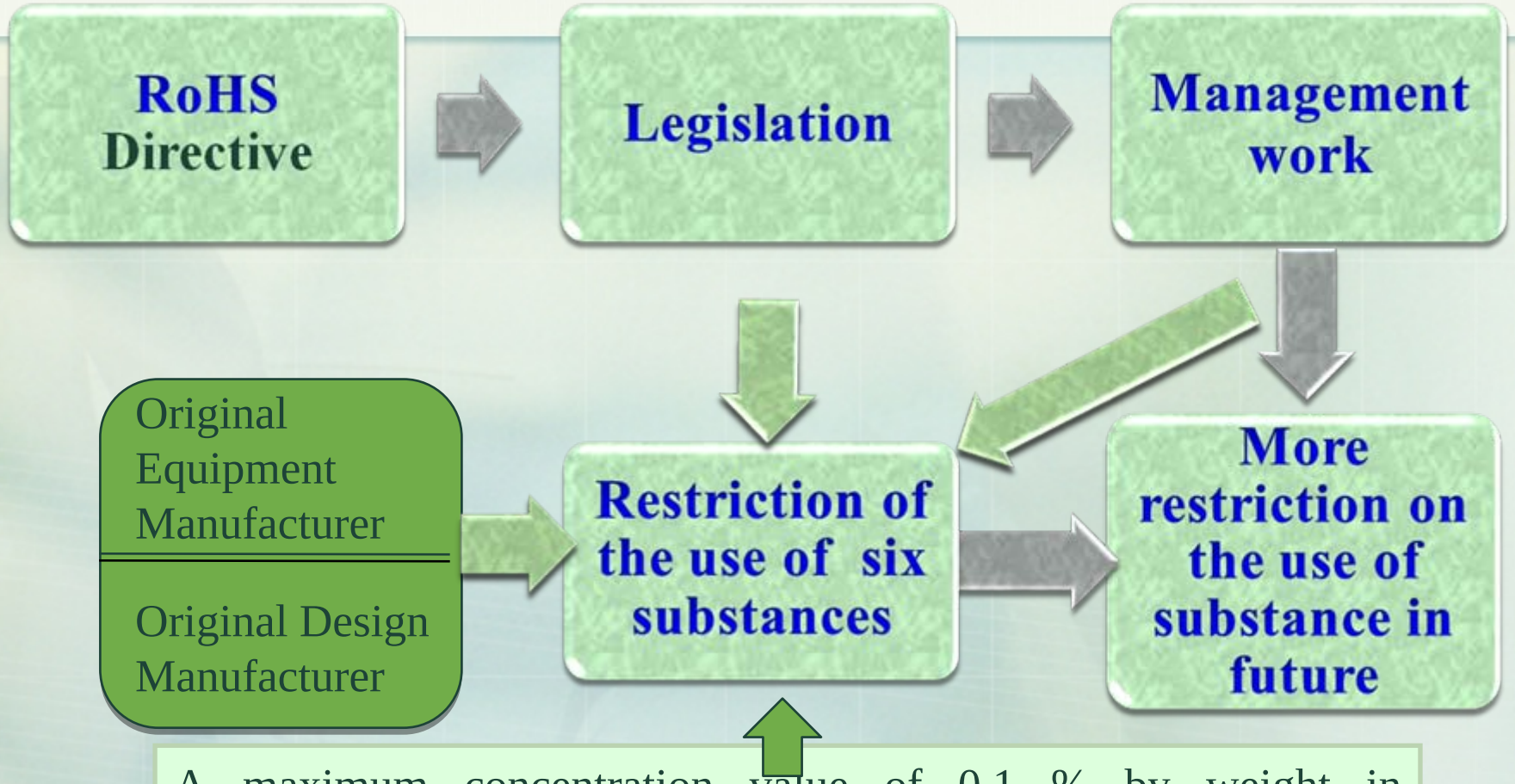
Producers meet the following targets by 31 December 2006

Recovery Item	Reuse and Recycling target	Recovery target
Large household appliances	75%	80%
Small household appliances	70%	50%
IT and telecommunications equipment	75%	65%
Consumer equipment	75%	65%
Lighting equipment	70%	50%
Electrical and electronic tools	70%	50%
Toys, leisure and sports equipment	70%	50%
Monitoring and control instruments	70%	50%
Automatic dispensers	80%	75%

Restriction of the Use of Certain Hazardous Substances Contents

- Member States shall ensure that, from 1 July 2006, new electrical and electronic equipment put on the market does not contain lead, mercury, cadmium, hexavalent chromium, polybrominatedbiphenyls (PBB) or polybrominated diphenyl ethers(PBDE).
- National measures restricting or prohibiting the use of these substances in electrical and electronic equipment which were adopted in line with Community legislation before the adoption of this Directive may be maintained until 1 July2006.

RoHS Directive and Management Framework



A maximum concentration value of 0.1 % by weight in homogeneous materials for lead, mercury, hexavalent chromium, PBB and PBDE and of 0.01 % by weight in homogeneous materials for cadmium shall be tolerated

EuP Directive Framework

Prioritize Promotion of Energy Efficiency

Eco-design for energy-using products

Based on EuP Directive Framework

Ensuring the Free Movement of those Products which Comply and Improving their Overall Environmental Impact.

- Follow Integrated Product Policy, IPP
- Lifecycle Thinking, consumer understand the energy consumption, and build Eco-profile

Restrains and objectives of EuP

Important

Source：***Energy Using Products, EuP***

Objectives

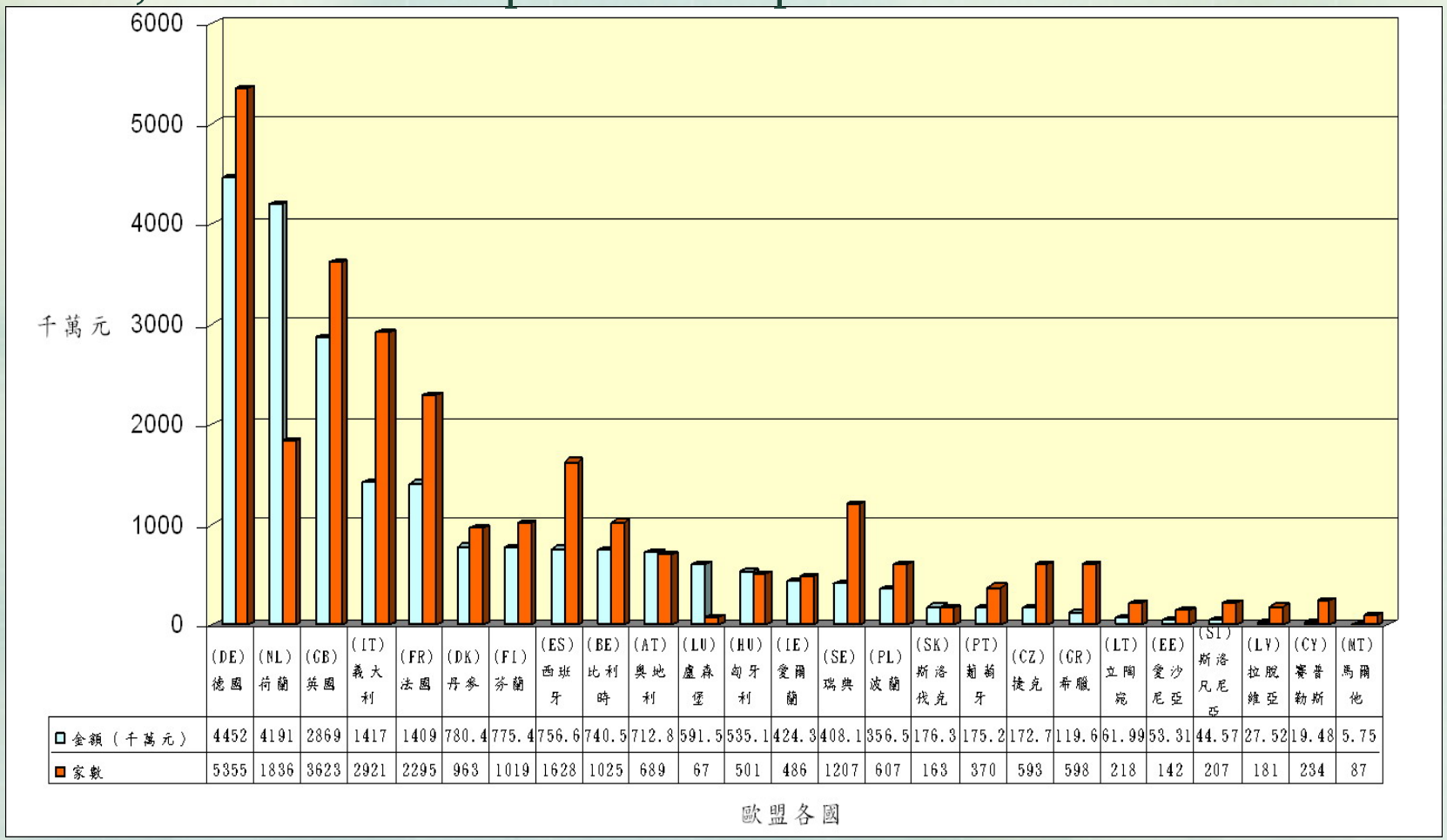
- Boiler , Heater, PC monitor, TV etc
- Not including transportation

Design for environment*：*Eco-design Requirements

- Design for environmental effects follow EuP, such as energy efficiency, lead-containing products , pollution emission, etc.
- Eco-design Requirements for Energy using Products

Industrial Impact of EuP Directive

- Total: 212.75 billion dollars
- 27,015 factories export to Europe



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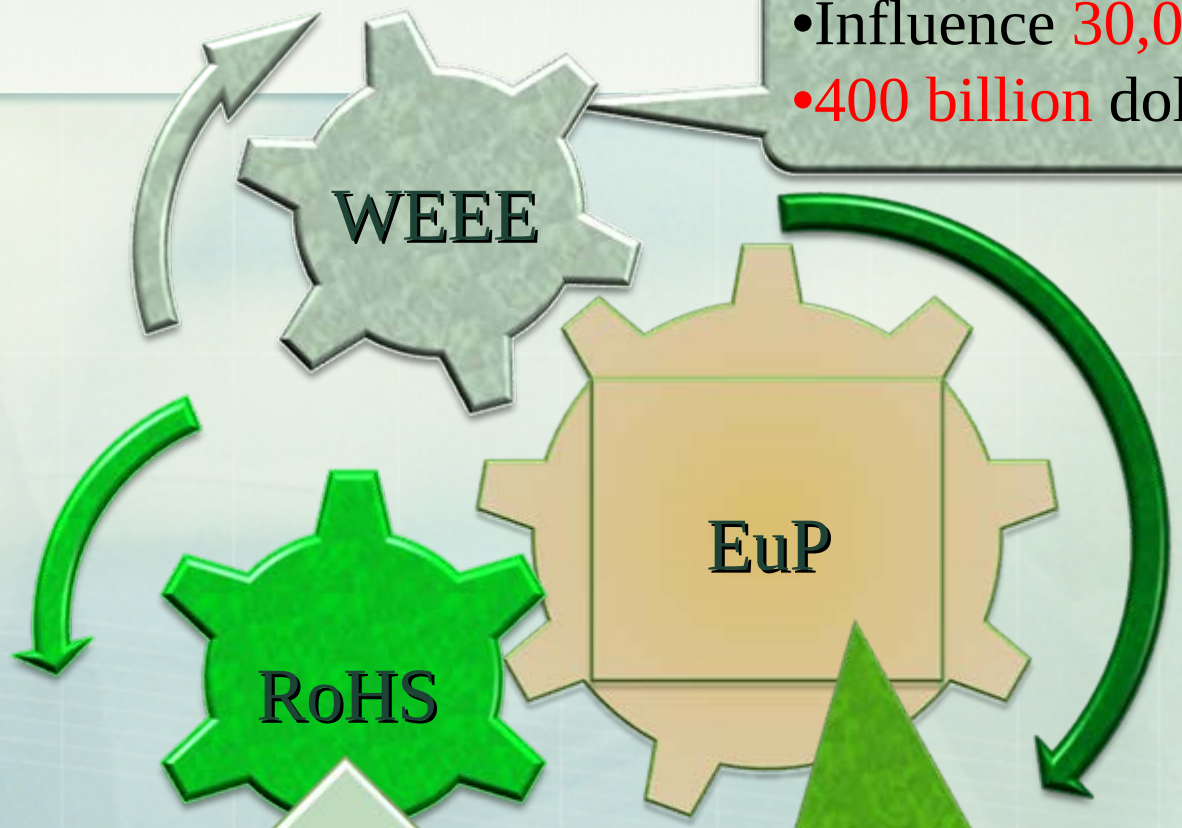
金額（千萬元）	4452	4191	2869	1417	1409	780.4	775.4	756.6	740.5	712.8	591.5	535.1	424.3	408.1	356.5	176.3	175.2	172.7	119.6	61.99	53.31	44.57	27.52	19.48	5.75
家數	5355	1836	3623	2921	2295	963	1019	1628	1025	689	67	501	486	1207	607	163	370	593	598	218	142	207	181	234	87

Impact of EuP, WEEE, and RoHS



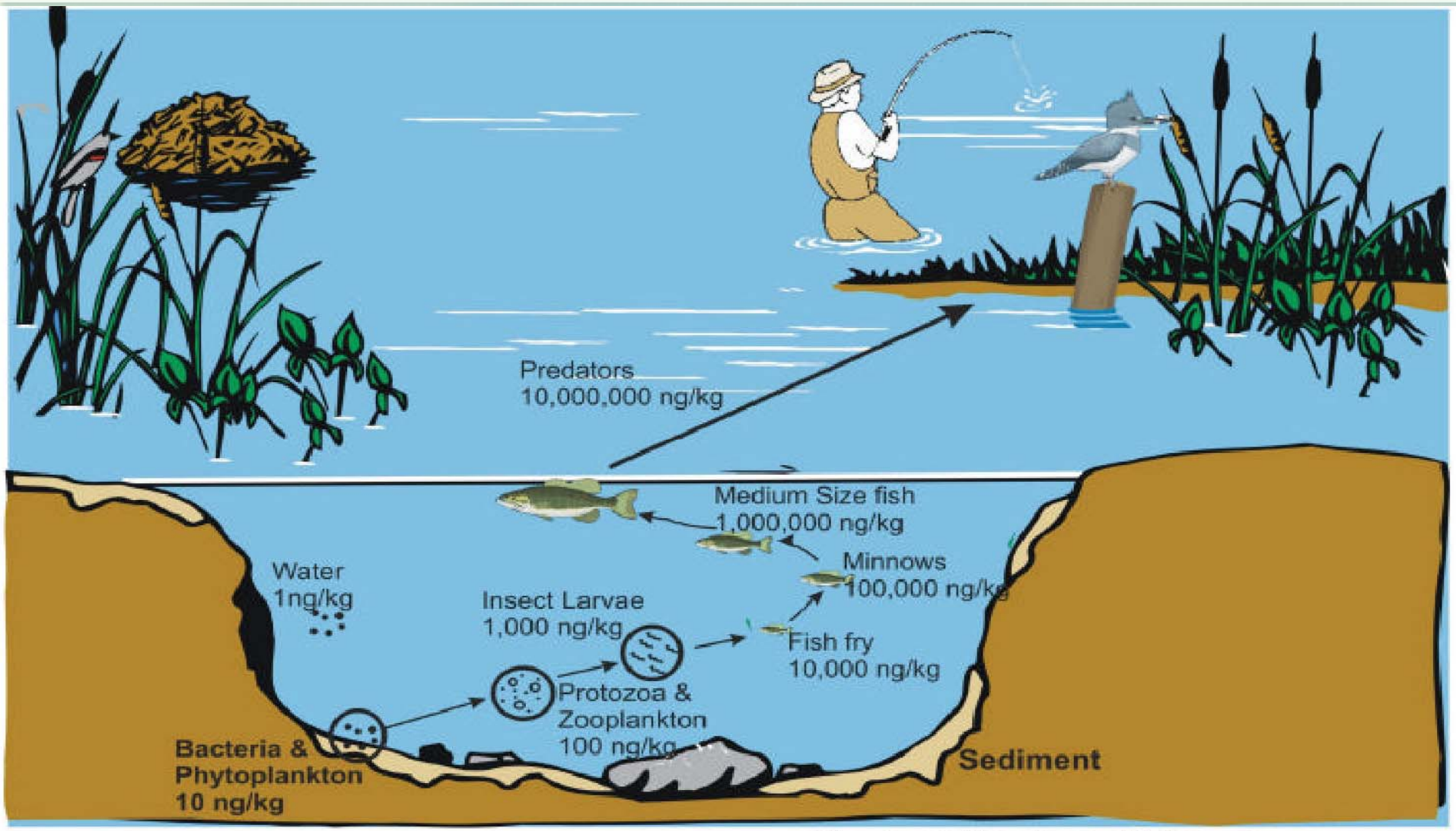
- Influence 30,000 factories
- 400 billion dollars

- Restriction of the use of hazardous substances
- Environmentally friendly materials research
- Change processes、Cost increased

- Lack of information
- Short of DfE ability
- Short of product environmental impact assessment
- Short of Eco-profile database

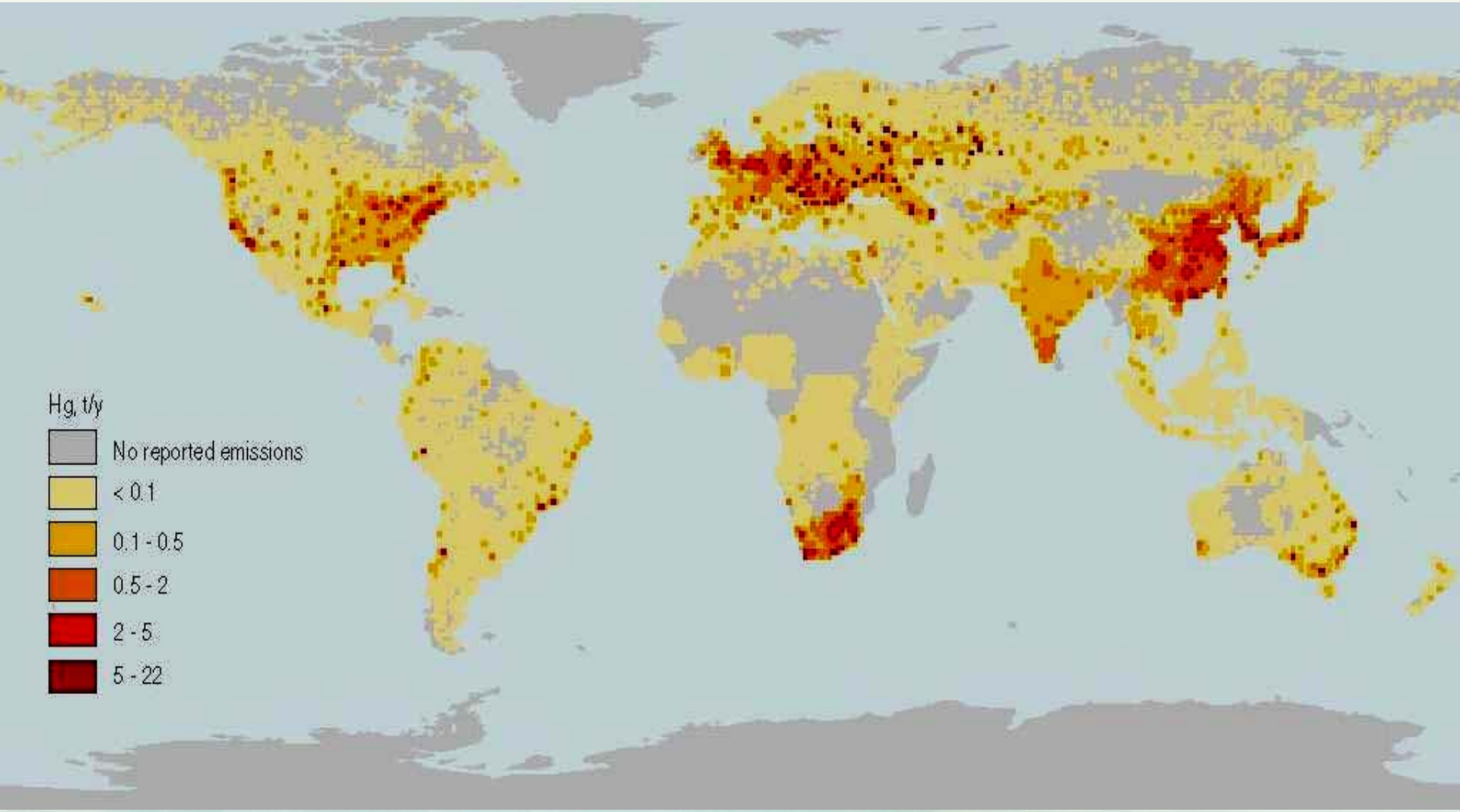
5. Feature Research Direction for 3R in Industrial Waste Management

Biomagnification



Biomagnification of Mercury

Spatial Distribution of Global Emissions of Mercury to Air



Source: UNEP Global Mercury Assessment, 2002, using J. Pacyna 1995 data, as presented by AMAP (1998).

Waste Mercury Treatment and Recycling

Rotating Rotary - Batch Vacuum

Courtesy of ETG

Continuous Rotary Thermal

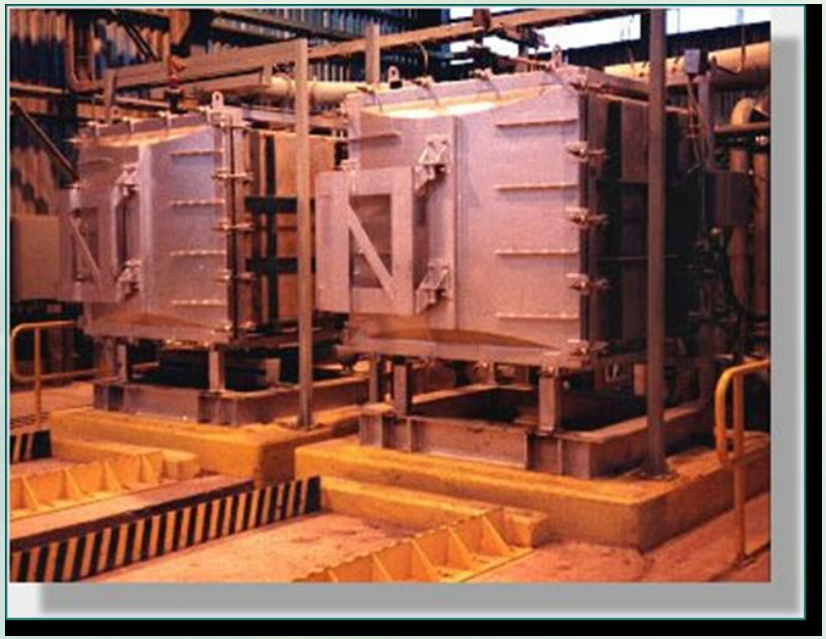
Southern Maryland Project – Performed by ETG for USACE

Waste Mercury Treatment and Recycling(2)

Stationary Rotary Retorts

Courtesy of Mercury Waste Solution

Stationary Ovens



Courtesy of Summit Valley

Waste Mercury Treatment and Recycling(3)

High potential of mercury treatment and recycling

Interior of 30 cubic foot capacity retorts shown during loading.

Courtesy of Summit Valley

Success case

- Formosa plastic Mercury sludge
- Yi-Fang chemical industry soil contaminant by mercury

Waste Mercury Treatment and Recycling(4)

Core Unit：Mercury Recycling and Solidify

Mercury concentration 90-99%

Courtesy of Summit Valley

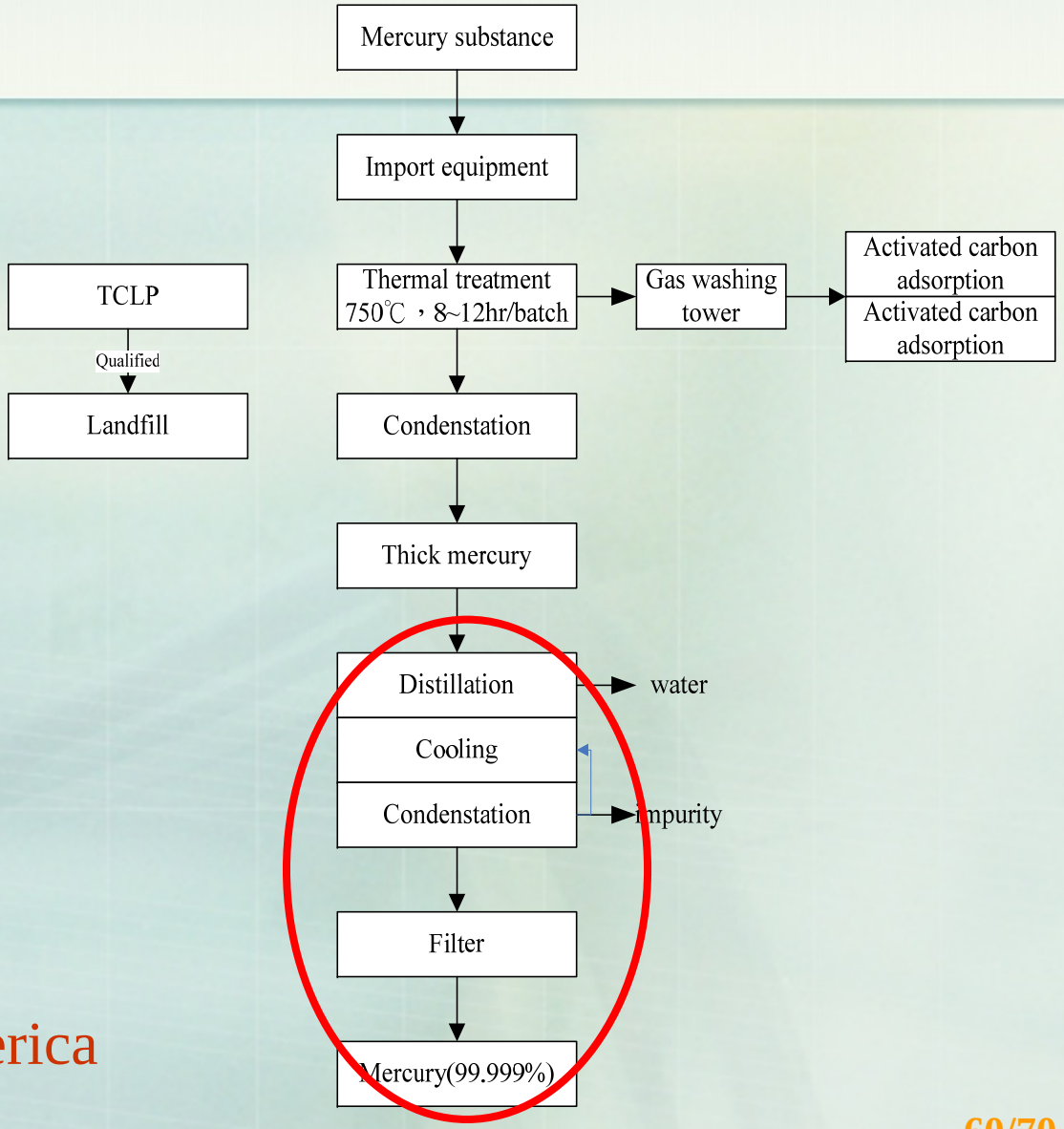
Waste Mercury Treatment and Recycling(5)

Distillation System of Mercury

Courtesy of Bethlehem Apparatus

- Triple Distillation – Technical pure mercury (99.99% purity)
- Quadruple Distillation – Virgin quality (99.9999% purity)

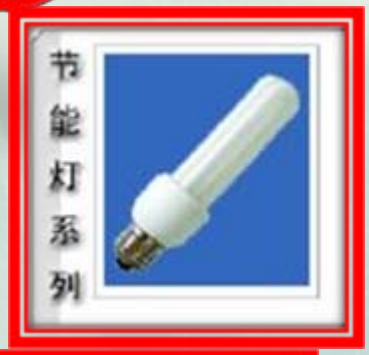
1. Mercury-Containing Lamp Recovery

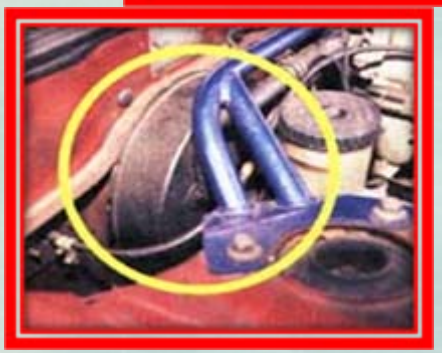


- Production：Pure mercury
- Concentration ：99.999%

AERC, and PA works treatment process in America

2. Mercury-Containing Script Recovery





(1) Thermometer

(2) Sphygmomanometer

(3) Fluorescent lamp

(4) Cosmetic

(5) Battery

(6) Tooth-filling substance

(7) Motor vehicle switch, ABS

3. Mercury-Containing Motor Vehicle Switch Recovery

- On average each car has 1.06 switch, and each one contain 0.8g mercury.
- Mercury-containing element can be recycled in recycling system. (ELVs) ◦
- To avoid 75 ton mercury-pollution emission into air.

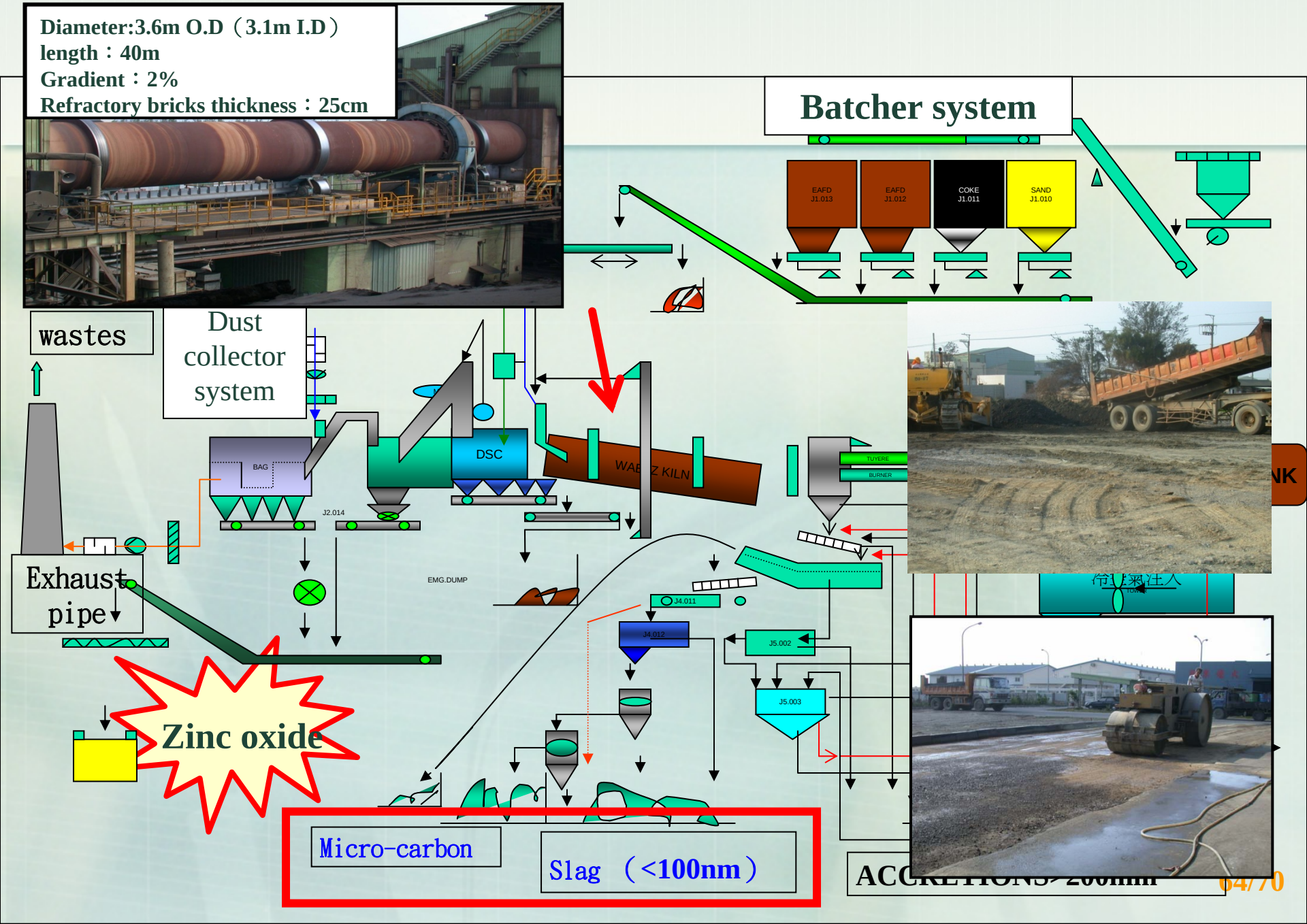
4. Electric Arc Furnace Dust Recovery

Electric arc furnace dust consist of lead, nickel, chromium, manganese, and copper.

Landfill → **Acid Rain Lead to Dissolved Contaminants**

Solidfi-cation → **Volume Increased**

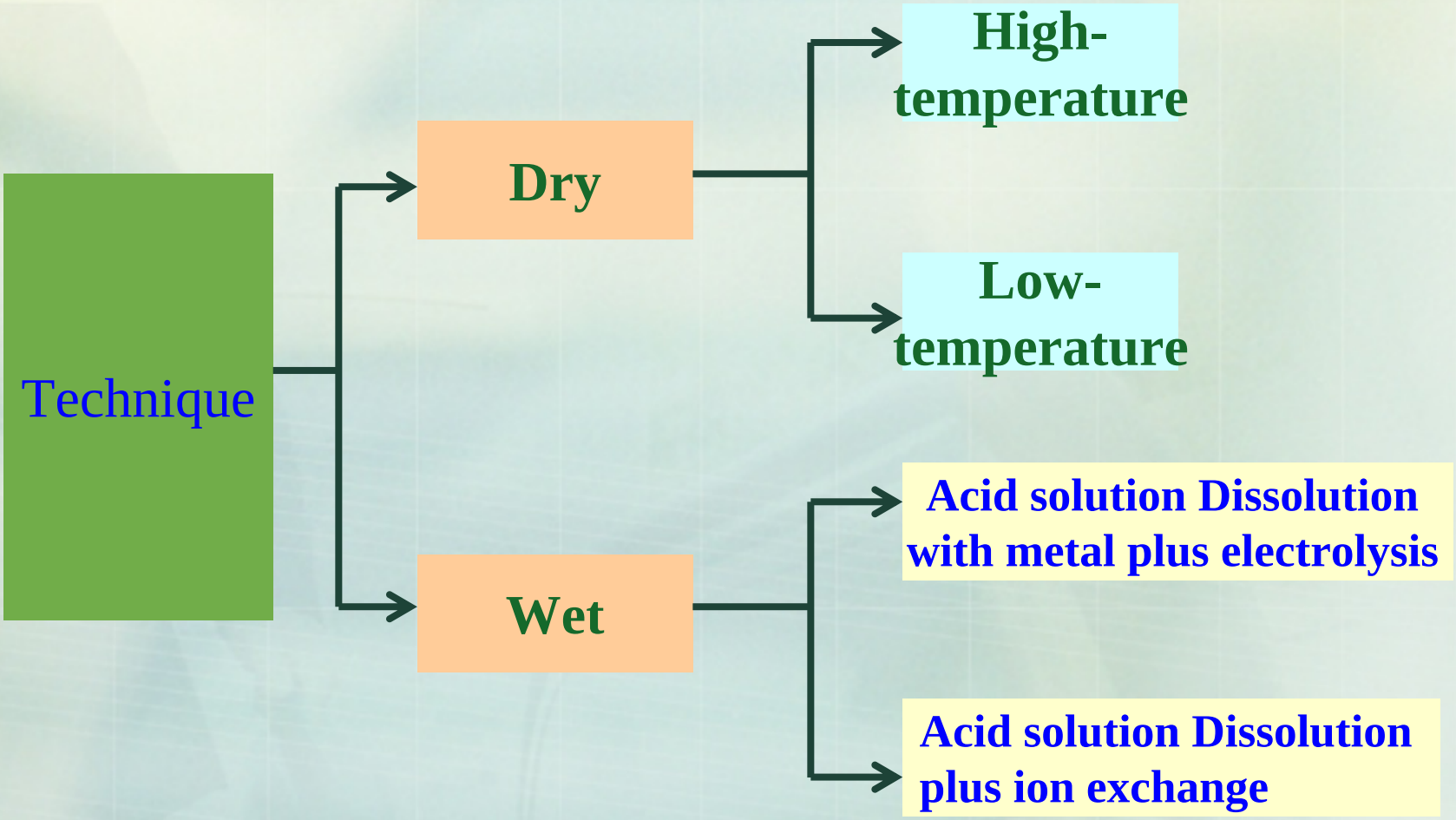
Recycling →
- **Condensation and collection**
- **Cement material**


Diameter:3.6m O.D（3.1m I.D）
length：40m
Gradient：2%
Refractory bricks thickness：25cm
Batcher system
EAFD J1.013
EAFD J1.012
COKE J1.011
SAND J1.010
wastes
Dust collector system
BAG
DSC
J2.014
EMG.DUMP
TUYERE
BURNER
J4.011
J4.012
J5.002
J5.003
Exhaust pipe
Zinc oxide
Micro-carbon
Slag （<100nm）
ACCRETIONS>200mm

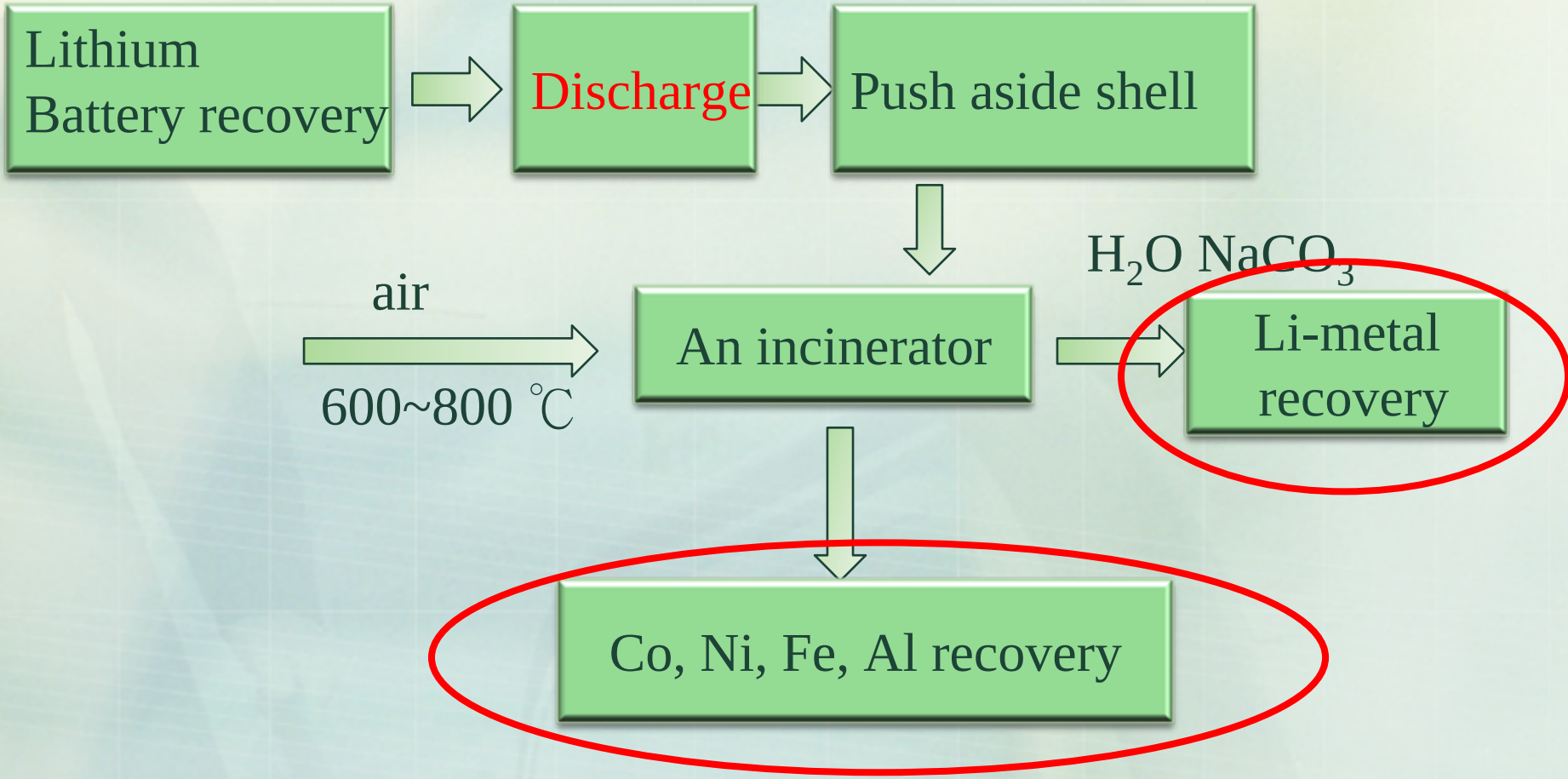
5. Lithium Battery Recovery

Material	composition	danger
The positive electrode	$LiCoO_2$	1. lung symptoms 2. Noxious air will be made
	$LiMn_2O_4$	
	$LiNiO_2$	
The negative electrode	Carbon	1. Skin allergy 2. lung symptoms 3. CO, CO_2
	Black lead	
Electrolyte	$LiPF_6$	1. HF, and P_2O_5
Dissolvent	EC、PC、DMC DEC	1. CO, and CO_2

5. Lithium Battery Recovery

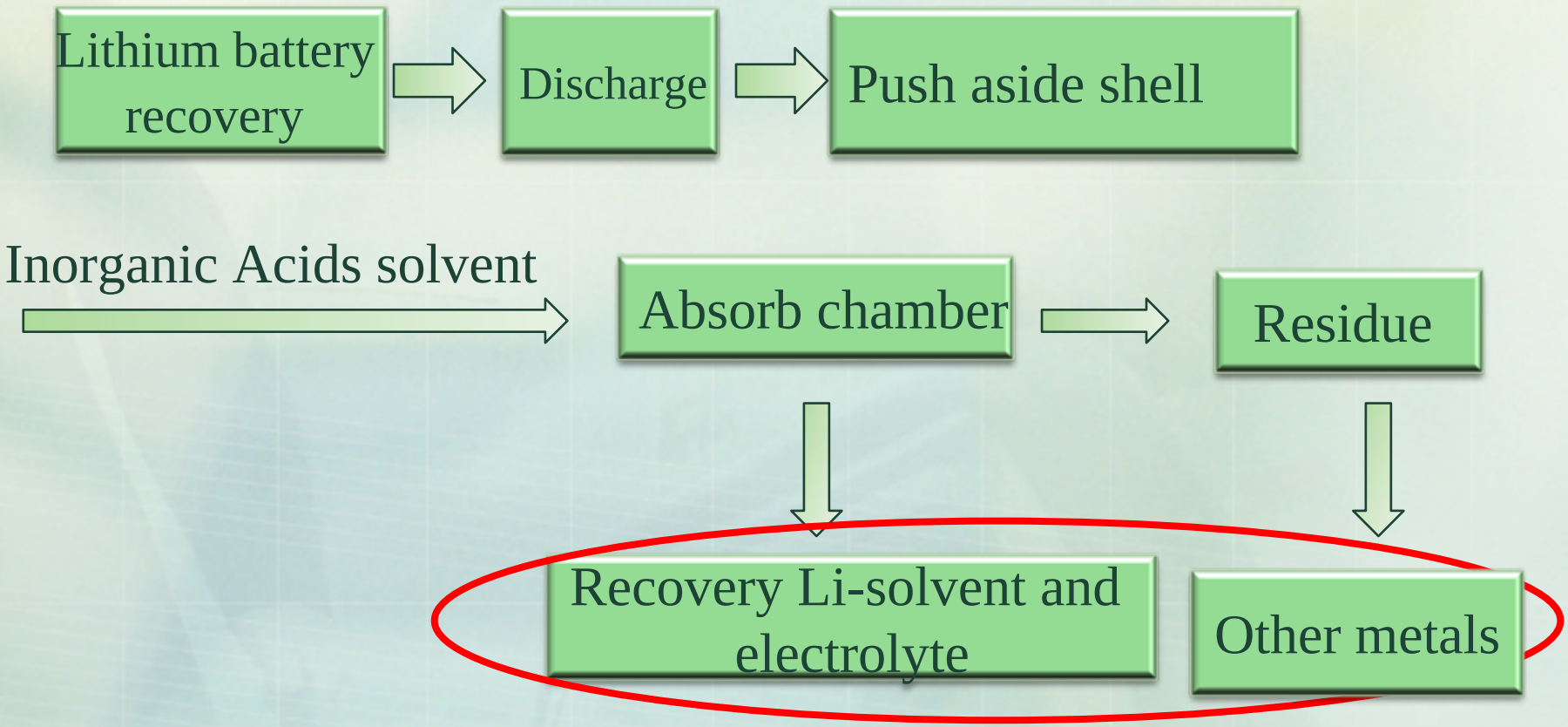


5. Lithium Battery Recovery



Dry processing for Lithium battery recovery

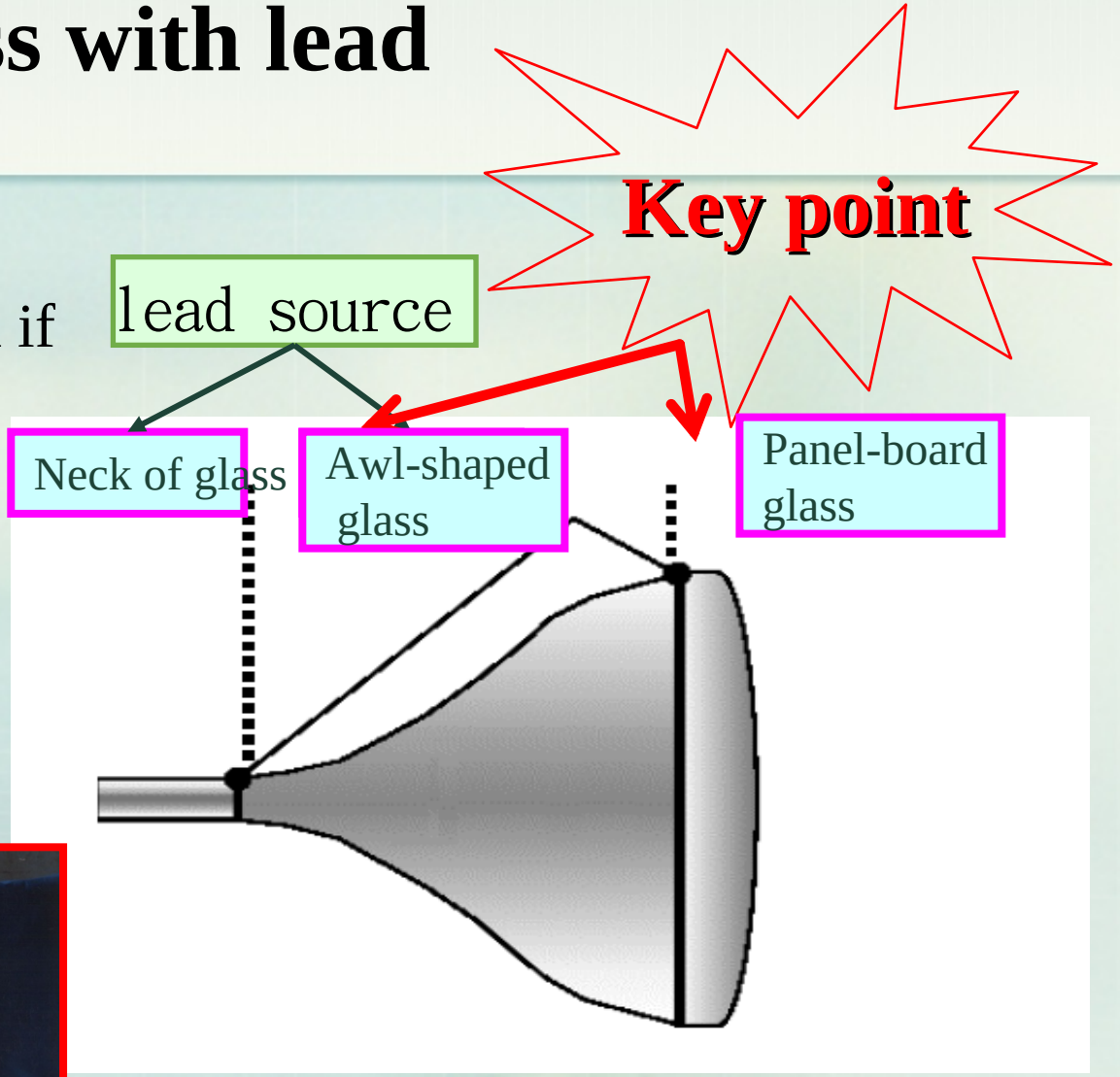
5. Lithium battery recovery



Wet processing for Lithium battery recovery

6. Recycling glass with lead

- It would lead to air pollution and acid rain if the process were incinerated.
- It would cause serious pollution if glass were buried in landfill.



CRT component

6. Recycling glass with lead

Recycling and Recovery

Waste glass from CRT

Waste CRT	Faceplate of glass	Awl-like glass
Popular kinds	1. Flux Added for bricks/ceramics 2. Used in the process of brick making	1. Flux Added for Melted 2. Used in the process of new CRT 3. recycling

Potential Products with 3R

- Ash
- Sludge
- Electrical raff
- Heavy metal
- Waste Pickling Acid

Technology used for 3R

- Recycling Waste Incinerator Ash
- Electrical raff
- Heavy metal slugging
- Technique for cement
- Recovering Waste Pickling Acid
- Recycling Heavy metal

The end

Thanks for your attention