Sustainable Resource Management Workshop
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Yen Tjing Ling Industrial Research Institute, National Taiwan University , Taipei

Course A (for Governmental Agencies)

Roles and functions of government for promoting MFA application and resource management - (A-2) Case Studies for Japan-

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Background in Japan

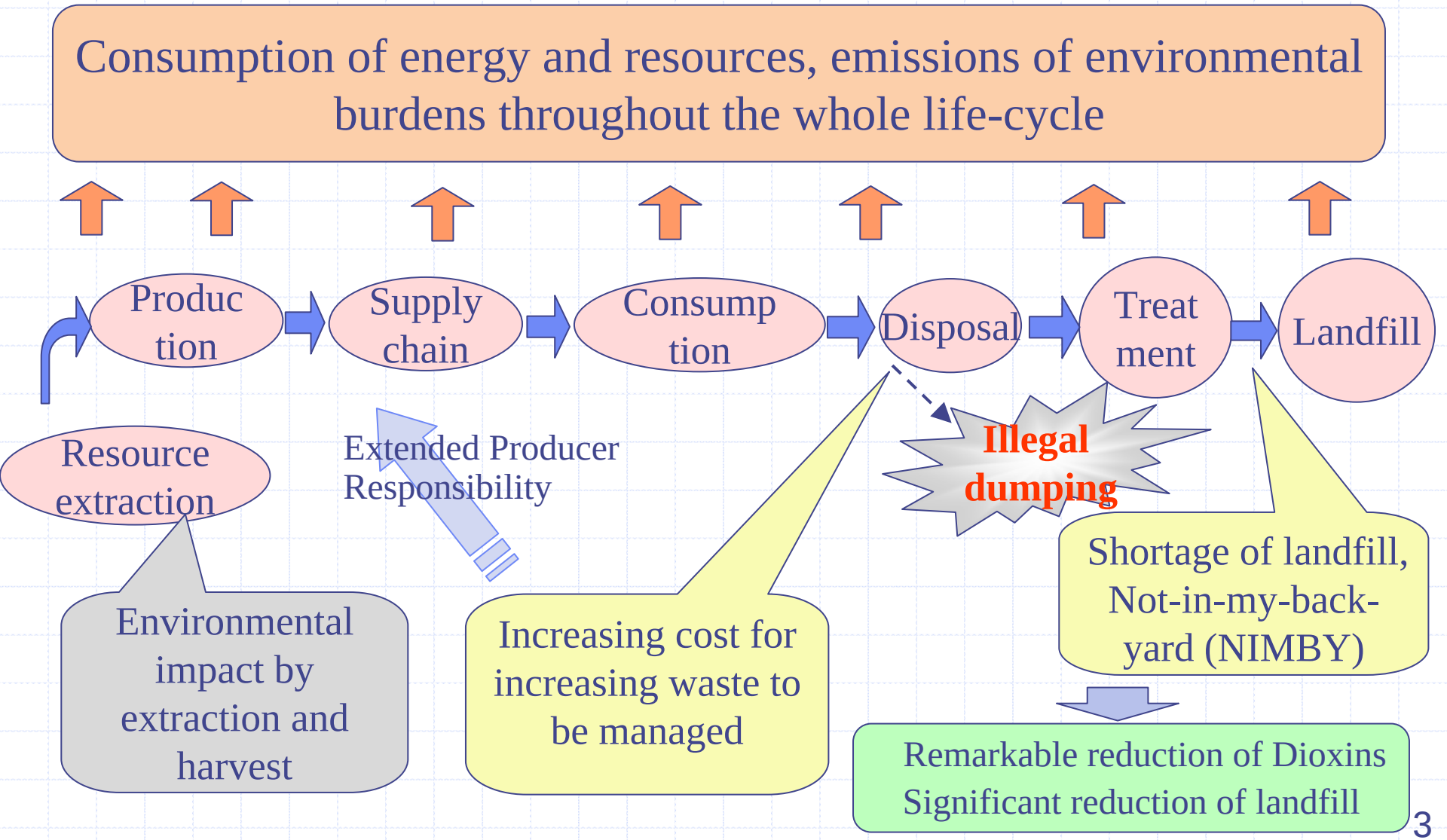
- Visible problems associated with increasing volume and diversified quality of solid wastes (shortage of disposal site, risk of environmental pollution by waste treatment facilities, illegal dumping, increasing cost, etc,)

- High dependency on imported natural resources and problems hidden behind (indicated e.g. by Ecological rucksack, ecological footprint and so on)

- The spirit of "*Mottainai*"

  Mottainai is a long-established Japanese concept meaning that it is a shame for something to go to waste without having made use of its potential in full. This expression incorporate a respect for the environment that das been handed down from ages past.

Environmental implications of mass-production and mass-consumption



Reform of waste management and recycling policy toward a Sound Material-cycle Society

1. Three main trends of waste and recycling measures

- **Responsibility of waste-generating businesses** (mainly for industrial wastes)
- Recycling measures through **Extended Producer Responsibility** (EPR)
- **Collaboration** between local and central governments, (mainly for municipal wastes)

2. Crosscutting approach

- Promotion of various **technical developments** (EcoDesign, 3R technologies, Incineration and final disposal technologies)
- New approaches toward **lifestyle change** ("Mottainai" spirit, everyday life, education, green purchasing)

Transition of socio-economic structure

Mass-production,
mass-consumption,
mass-disposal society

Sound material-cycle
society (SMCS)

大量生産･大量消費･
大量廃棄型社会

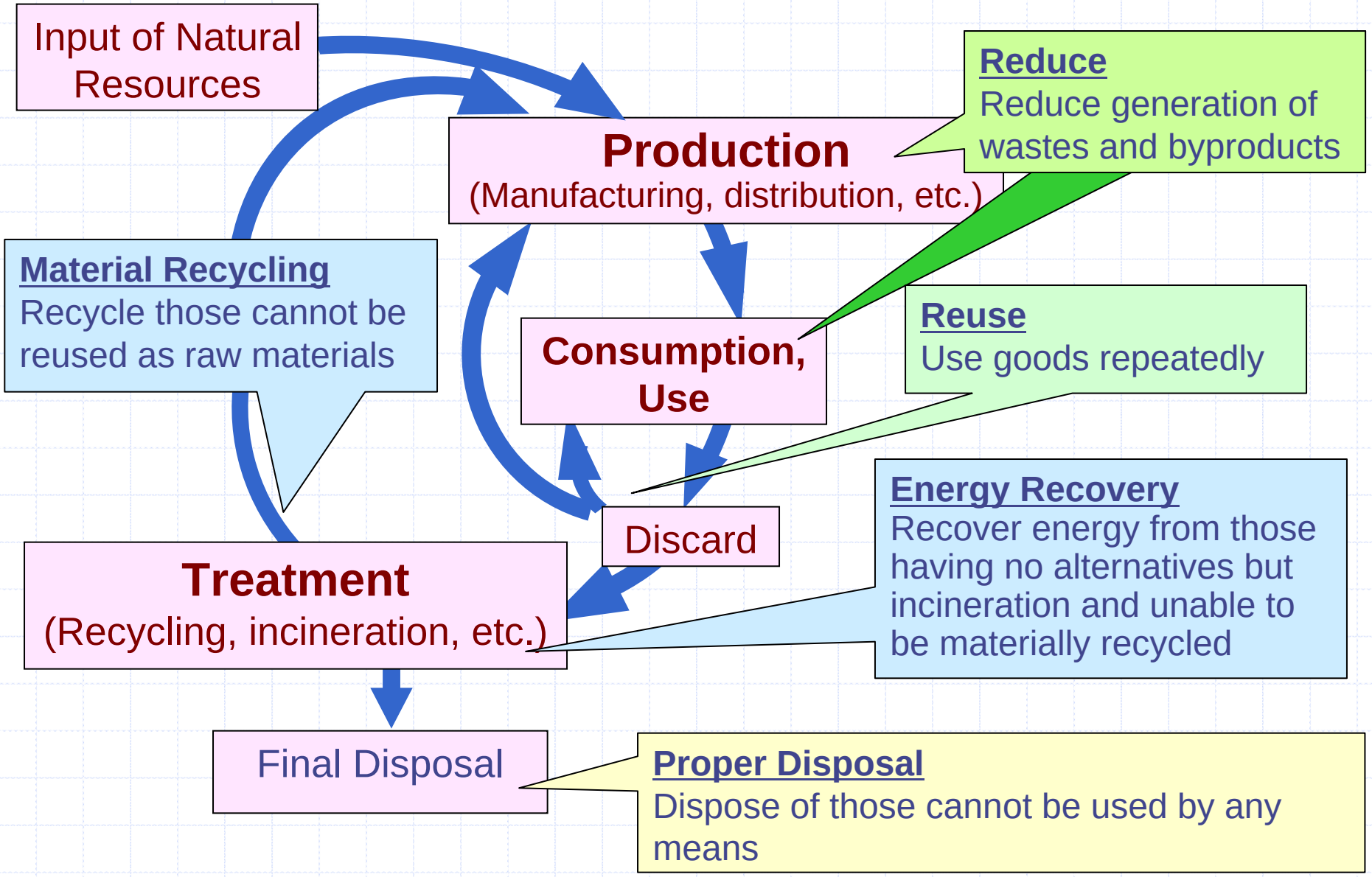
循環型社会
“Junkan”

Concept of a Sound Material-Cycle Society

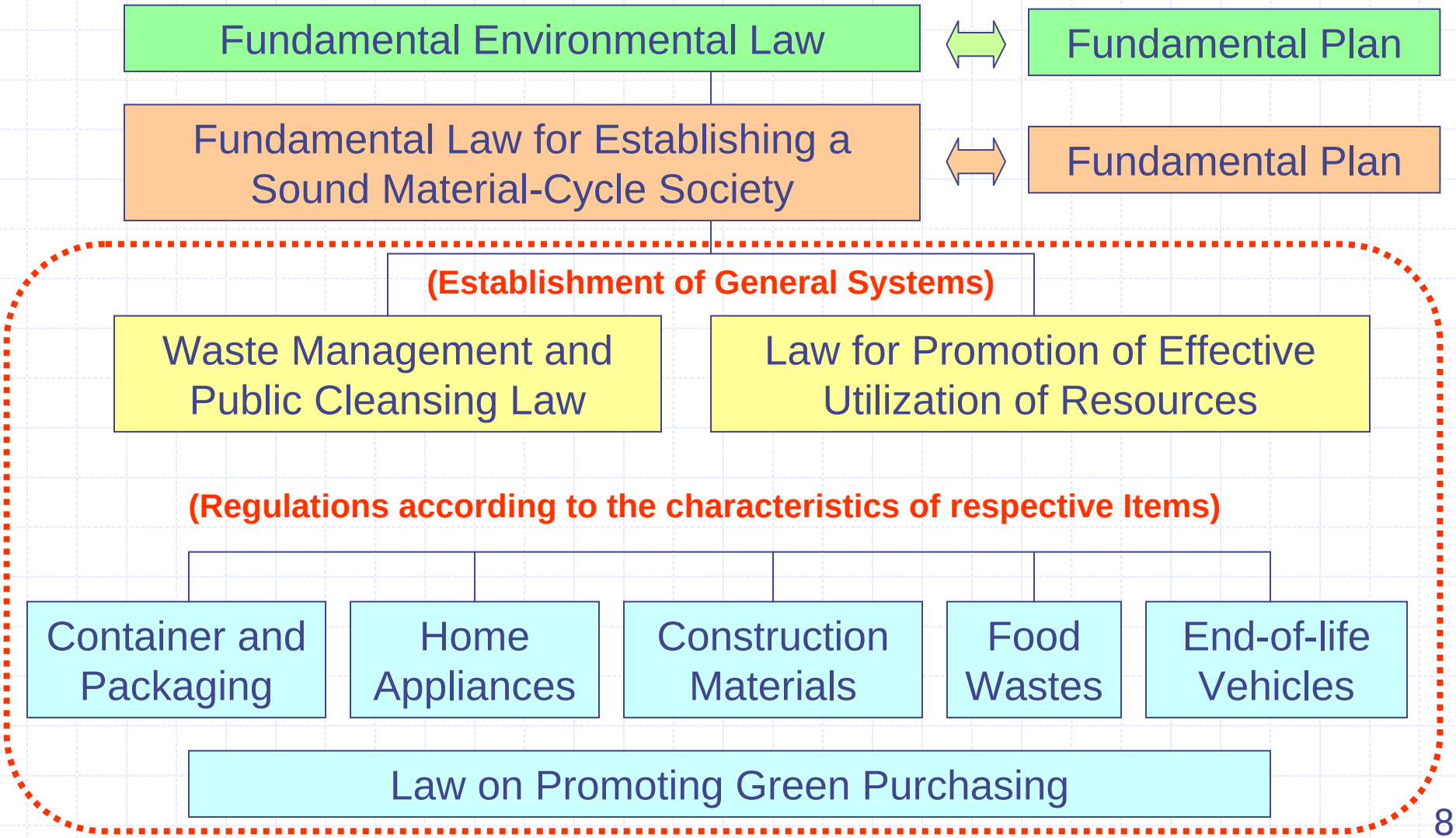
- Japan is undertaking the transition to a Sound Material-Cycle Society.

A sound material-cycle society, in which the consumption of natural resources is minimized and the environmental load is reduced as much as possible, is established by promoting reduction, reuse, recycling, energy recovery and appropriate disposal.

Scheme of a Sound Material-Cycle Society



Law and Regulation



The Fundamental Plan for Establishing a Sound Material-Cycle Society (Outline)

Present Situation and Problems

Present Situation: Unsustainable Activity Patterns of the 20th Century

Problems: ・Realization of Social and Economic Systems Based on Recycling

・Solution of Waste Problems

Image of a sound material-cycle Society

Lifestyle: Using high quality goods with care, "Slow" Lifestyle

Manufacturing: DfE (Design for Environment), Long-life products, Lease & Rental

Quantitative Targets: FY2000-2010

1 Targets for Indicators Based on Material Flow Accounts

(1) "Input": Resource Productivity **FY2010: About 390 thousand yen/ton** (About 40% improvement from FY 2000)

(2) "Recycling": Rate of Reuse and Recycling **FY2010: About 14%** (About 40% improvement from FY 2000)

(3)"Output": Final Disposal Amount **FY2010: About 28 million tons** (Almost 50% reduction from FY2000)

2 Targets for Effort Indicators

・Reducing the quantity of municipal solid waste: reducing the amount of garbage discharged from households per person per day by 20% from FY2000

・Expanding the sound material-cycle business market

Efforts of Entities

The State: Fostering partnerships among social stakeholders, leading activities for establishing a sound material-cycle society, etc.

Citizens: Changing their lifestyle to establish a sound material-cycle society, etc.

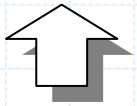
Business organizations: Promoting appropriate reuse, recycling and disposal of wastes based on EPR, etc.

NPOs/NGOs: Promoting activities that contribute to establishing a sound material-cycle society, etc.

Local governments: Enforcing laws and regulations, acting as a coordinator among various local entities, etc.

Fundamental Plan for Establishing a Sound Material-Cycle Society

Quantitative Targets: FY2000-2010



Efforts Required of Entities

- National Government
  Fostering partnerships among stakeholders
- Citizens
  Changing their lifestyle
- NPOs and NGOs
  Promotion of their activities
- Business Organizations
  Promoting the "3Rs" based on EPR (Extended Producer Responsibility)
- Local Governments
  Enforcing laws and regulations; acting as coordinators

Fundamental Plan for Establishing a Sound Material-Cycle Society

Image of a Sound Material-Cycle Society

Manufacturing: DfE (Design for Environment), long-life products, lease & rental
Waste management: cyclical use, appropriate disposal system

Quantitative Targets: FY2000-2010

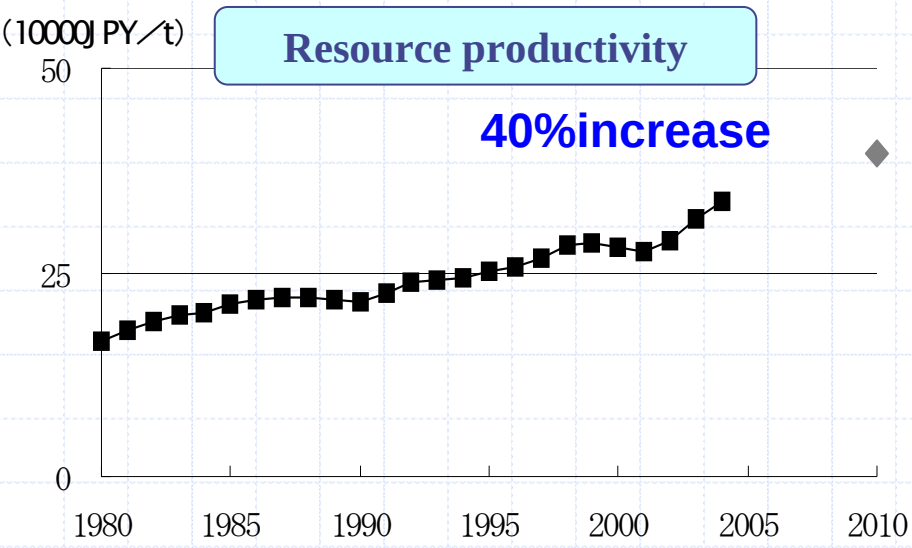
1 Targets for Indicators Based on Material Flow Accounts

a) Resource Productivity
b) Cyclical Use Rate
c) Final Disposal Amount

2 Targets for Indices Related to Efforts

- Reducing the quantity of municipal solid waste
  20% reduction of garbage discharged from households per person per day compared with FY2000
- Promoting sound material-cycle related businesses
  Doubling the size of the related market and the number of related jobs compared with FY 1997

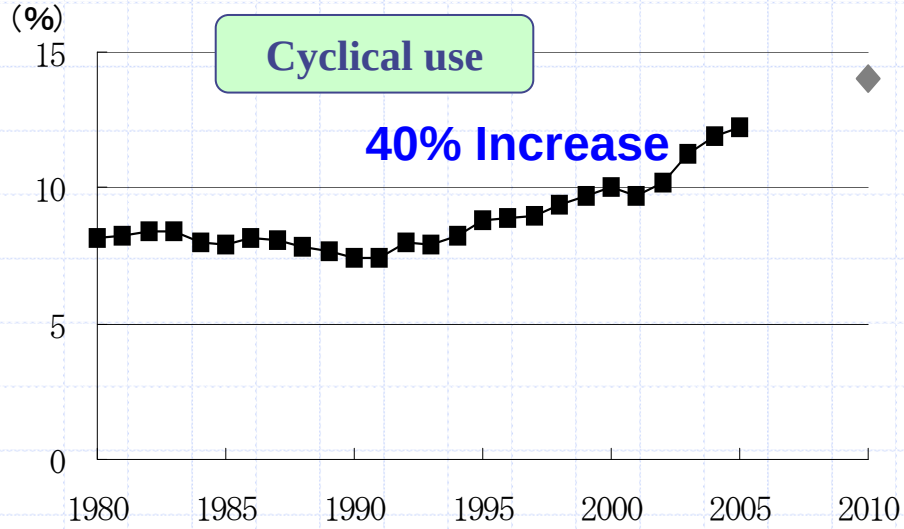
Trend of 3 material flow indicators

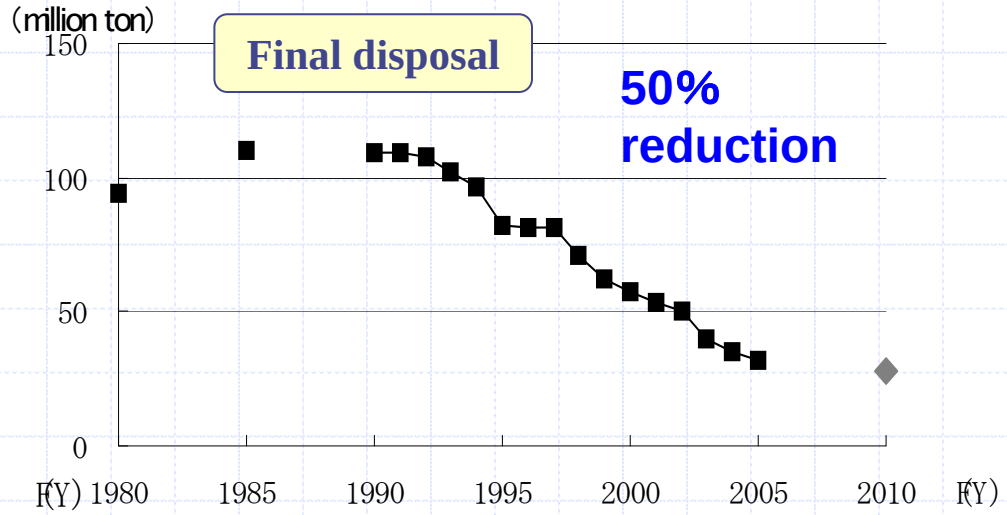


Resource productivity = GDP / Direct Material Input（DMI)

Cyclical use = Cyclically used amount / DMI＋Cyclically used amount

Final disposal = Final disposal of solid wastes





Decomposition of resource productivity

$$\frac{DMI}{GDP} = \sum_k \sum_i \frac{DMI_k}{DMI_k + R_k} \cdot \frac{DMI_{k,i} + R_{k,i}}{F_i} \cdot \frac{F_i}{F} \cdot \frac{F}{GDP}$$

To increase the use of recycled materials out of total input of resources

To reduce direct & indirect material required by the production of each commodity（by technology improvement）

Changing the pattern of consumption and investment（transition to less material-intensive demands）

Reduction of dependence on imports

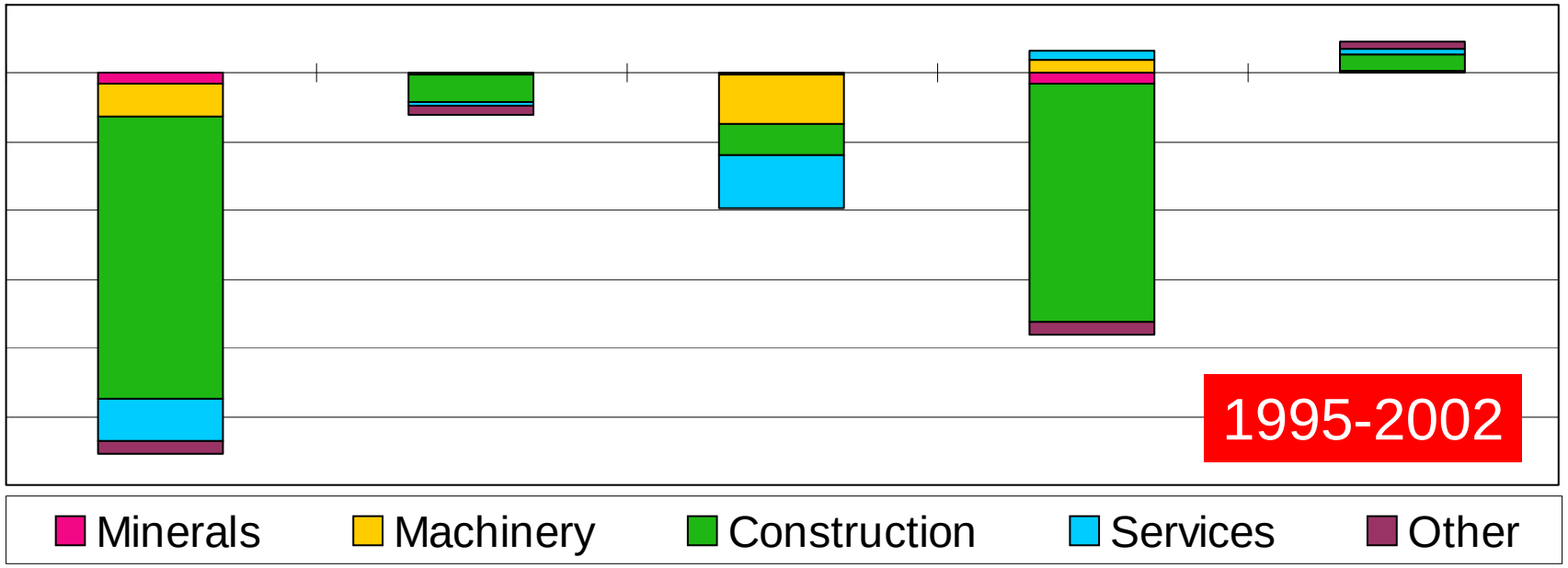
DMI:Direct Material Input

R: Amount of recycled materials

Decomposition analysis of resource productivity (by materials)

$$\frac{DMI}{GDP} = \sum_k \sum_i \frac{DMI_k}{\left(DMI_k + R_k\right)} \times \frac{\left(DMI_{k,i} + R_{k,i}\right)}{F_i} \times \frac{F_i}{F} \times \frac{F}{GDP}$$

Material Use Intensity (Inverse of RP)	=	1 – Cyclical Use Rate	×	Induced Material Use Intensity	×	Structure of Final Demand	×	1 + Average Propensity To Import



Hashimoto S. et al., *Journal of Industrial Ecology*, 12(5-6), 657 – 668, 2008

The Extension of Indicators under the 2nd Fundamental Plan for Establishing a Sound Material Cycle Society (Mar. 2008)
(material flow based indicators)

1 Indicators with target setting (as compared with 2000)

1)	"Input": Resource Productivity	increase	2010	40%	2015	60%
2)	"Recycle": Cyclical use Rate	increase	2010	40%	2015	40-50%
3)	"Output": Final Disposal Amount	reduction	2010	50%	2015	60%

2 Supplementary indicators with target setting

1) Resource productivity not including resource input of construction minerals
2) Collaboration with the action for low carbon society
   - the amount of reduction by the measures of waste sector to reduce GHGs emission
   - GHGs emission associated with waste sector and fossil fuels to be substituted by waste power generation (monitoring)

3 Indicators to monitor progress

1) Resource productivity related to fossil fuels
2) Input rate of biomass resources
3) Hidden Flow and TMR (Total Material Requirement) (the example of estimation: about 21 times larger than the import of metal resources)
4) Indicators considering international resource circulation
5) Resource productivity of each industrial sector

Examples of progress in recycling

- Aluminum Cans
- Recovery rate > 90%
- Can-to-can recycling is practiced
- Recycling of Aluminum avoids energy intensive smelting process and accompanied CO_2

- Recycling of waste packaging plastics
- e.g. Chemical feedstock recycling such as substitute to coking coal for steel making
- 2kg CO_2 avoided per 1kg waste plastics, compared with incinerator with power generator of 10% efficiency

Opportunities and limitation of recycling

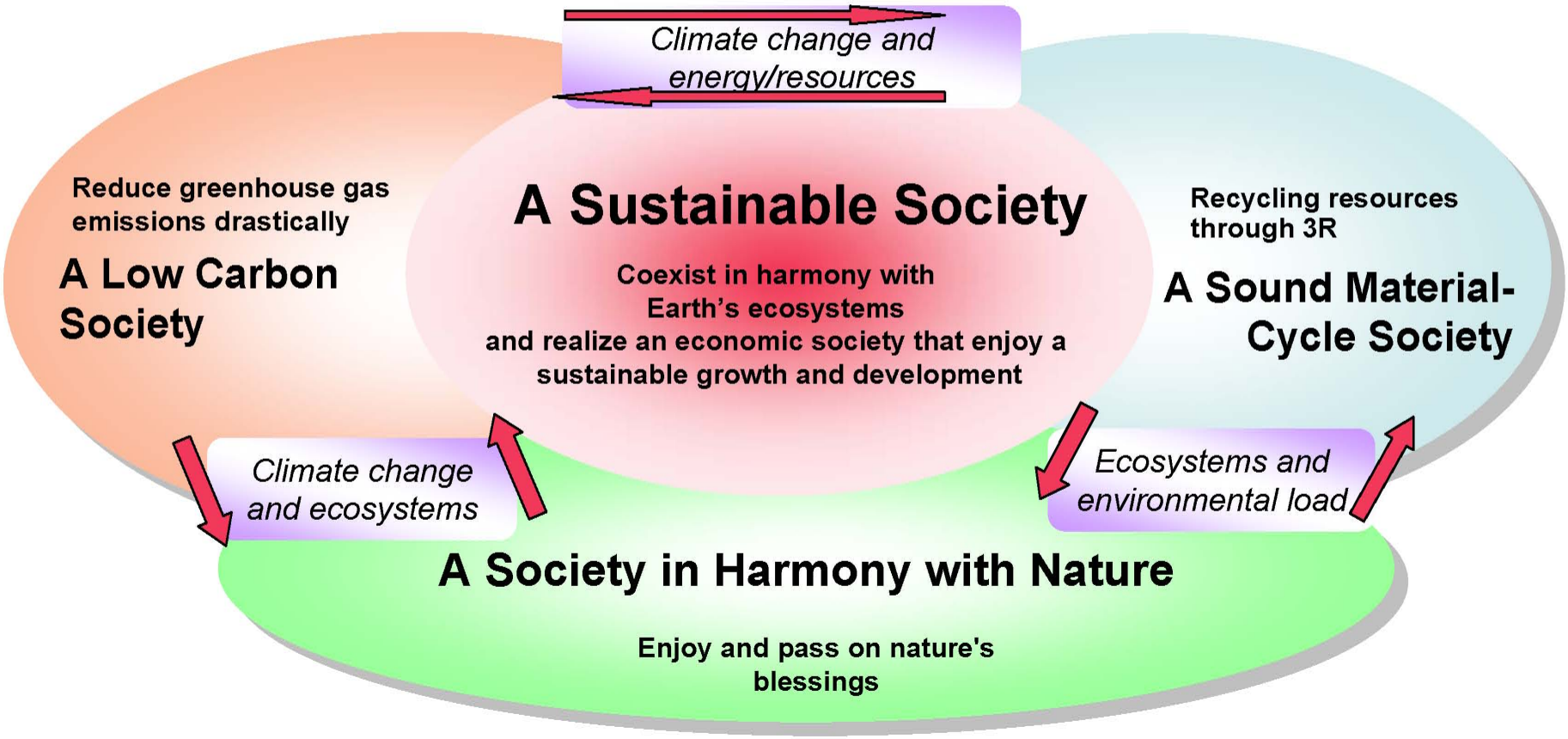
- Opportunities
  - Reducing primary resource requirement and associated environmental impacts of mining (e.g. of Copper)
  - Reducing energy consumption and carbon emission of material production (e.g. of Iron and Aluminum)

- Limitations
  - Negative environmental impacts by application of immature recycling process
  - Imbalance between supply and demand of secondary resources (e.g. Steel scrap availability from developed economies are not sufficient for meeting demand from developing economies)

Japan's strategy for a Sustainable Society

(Cabinet Meeting Decision on June 1, 2007)

Integrating 3 Aspects of a Sustainable Society



http://www.env.go.jp/en/focus/070606.html

Energy vs. Material resources

Possibilities for Win-win relations

- A common framework of material and energy flow analysis can describe both material flows and energy flows.

- Majority of raw material industries are energy-intensive and carbon intensive, so the reduction of raw material consumption through 3Rs will contribute to mitigate GHG emissions.

Needs for integrated understanding and management

- When is the best timing for consumers to replace less-energy efficient durables (cars, refrigerators, air-conditioners, etc.) with up-to-date efficient models ?

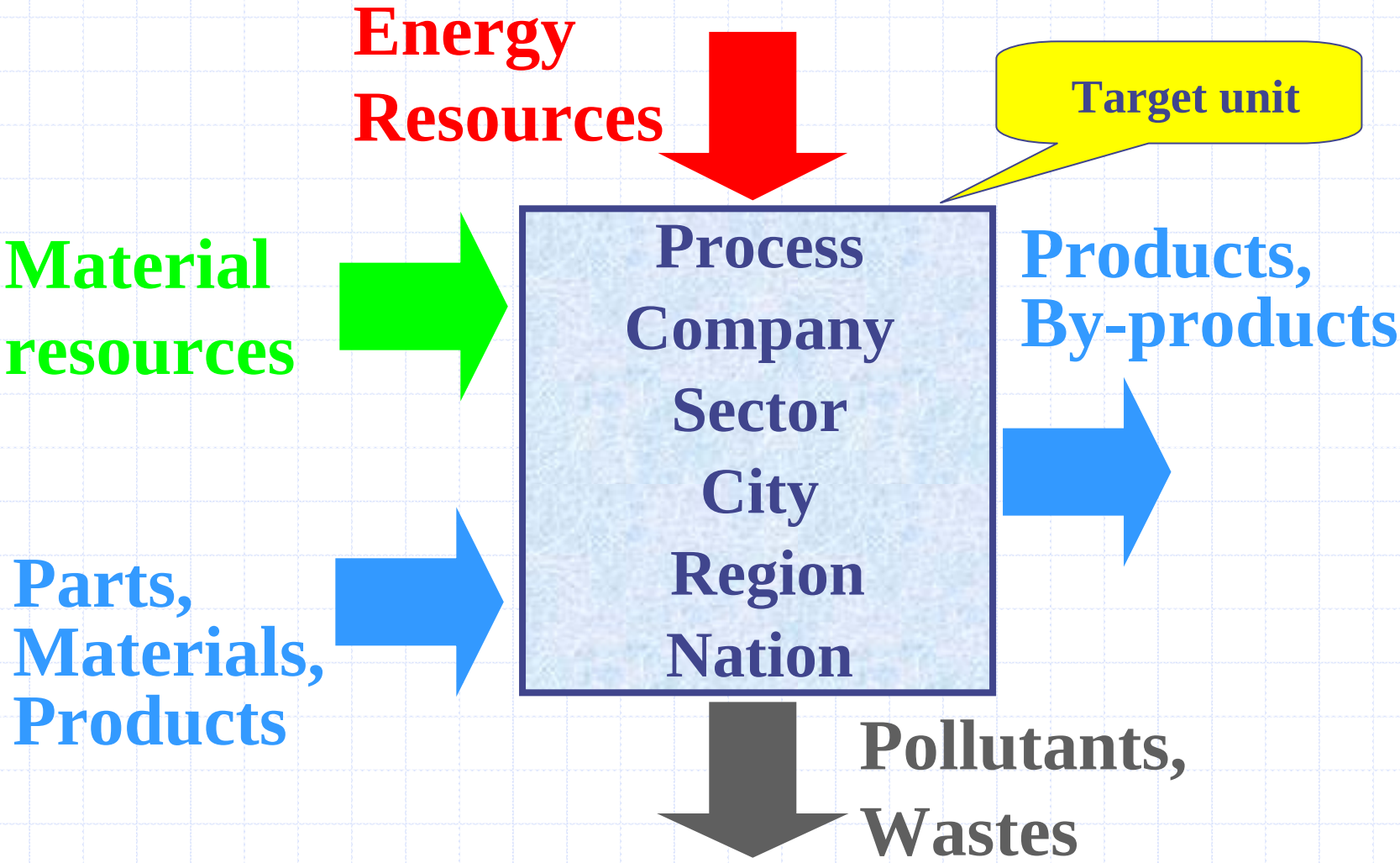
- Isn't it "*Mottainai*" to discard equipments still durable ? Is it adequate to export 2nd hand electric equipment to developing countries ?

- Energy pay-back time considers only trade-off between increasing energy requirement in initial stage and reduction in later stages, and additional non-energy mineral use is usually not taken into account.

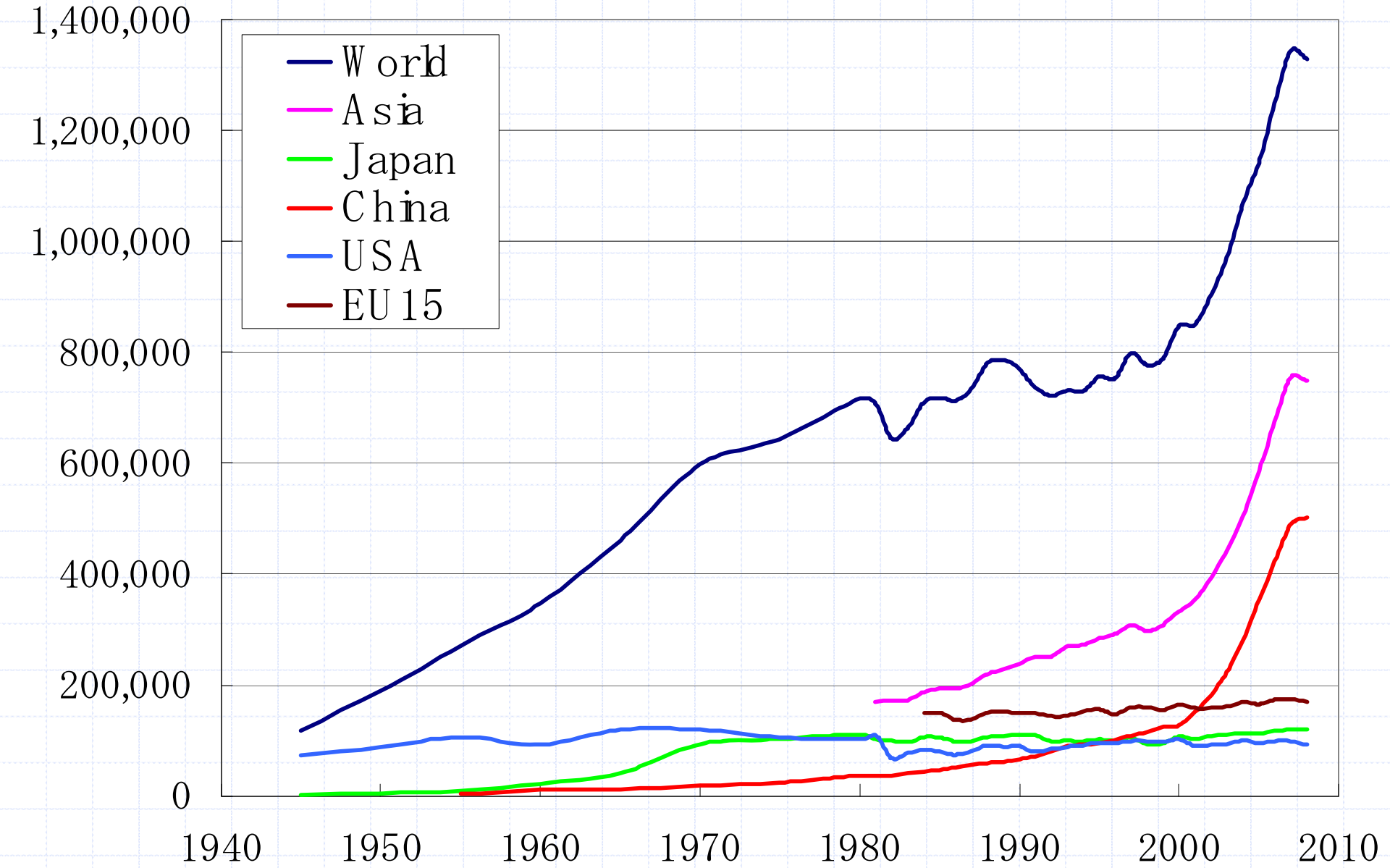
Trade-off and substitution between energy and material resources

- Both fossil fuels and non-energy minerals (e.g. metals) are non-renewable.
- More energy is sometimes required to reduce material requirement, and more materials are required to reduce energy requirement.
- Additional use of non-energy resource may lead to the increase of future energy consumption for lower-grade ore processing.
- How should we account for increasing use of precious/rare metals for photovoltaic, fuel cell vehicle ?
- Methodology of life-cycle impact assessment for this kind of trade-off should be elaborated.

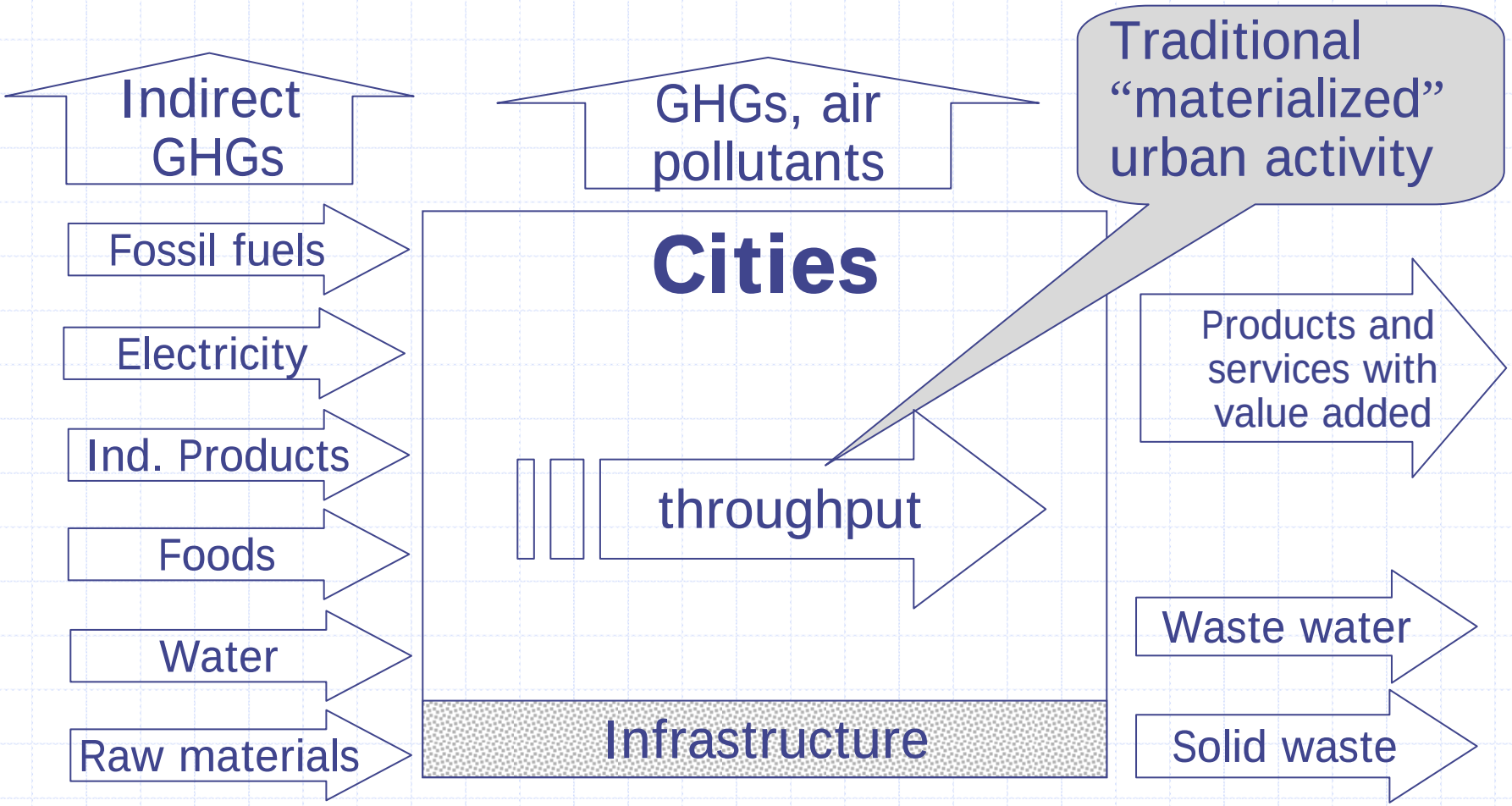
General framework of Material Flow Analysis



Trends of Crude Steel Production by Region



Metabolism of Cities



Urbanization is carbon & energy intensive

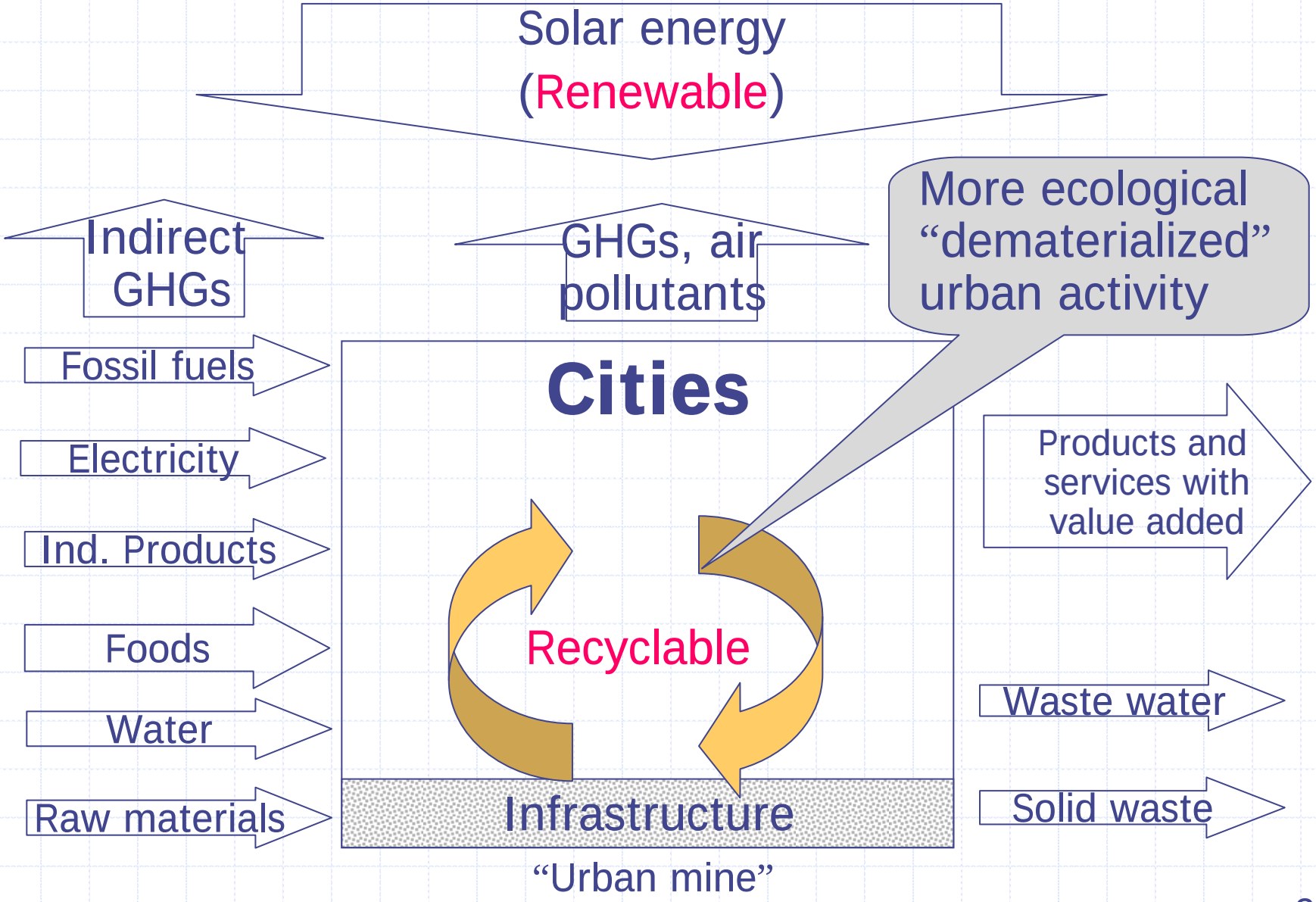
- Steel and cement, key materials for building urban infrastructure, are carbon-intensive.

  ca. 0.8t-CO_2/t-cement production

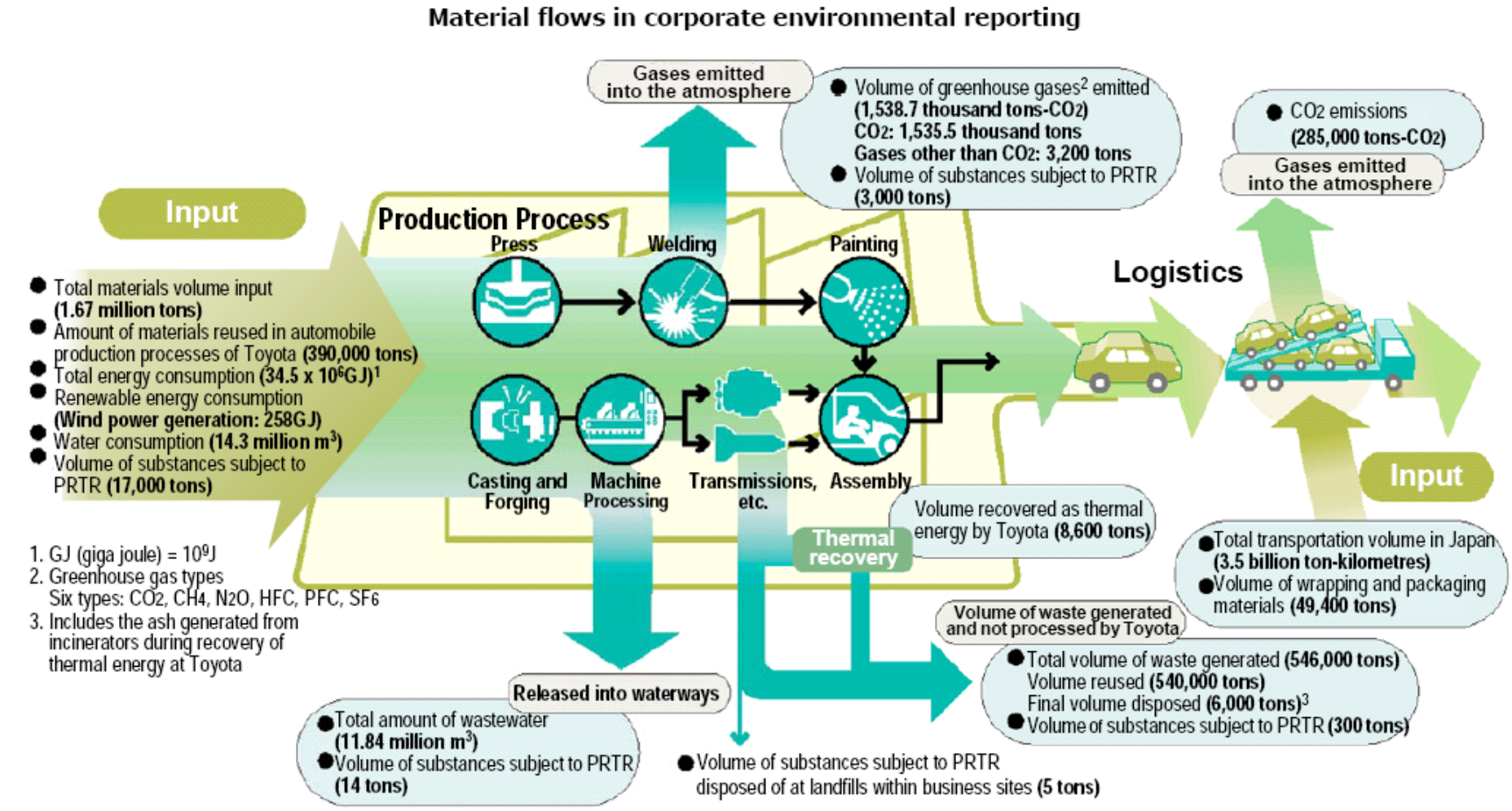
  ca. 1.5t-CO_2/t-steel production

- Once urban infrastructure is built, it prompts energy consumption through operation, e.g., heating/cooling space, driving on road, pumping sewage, etc.

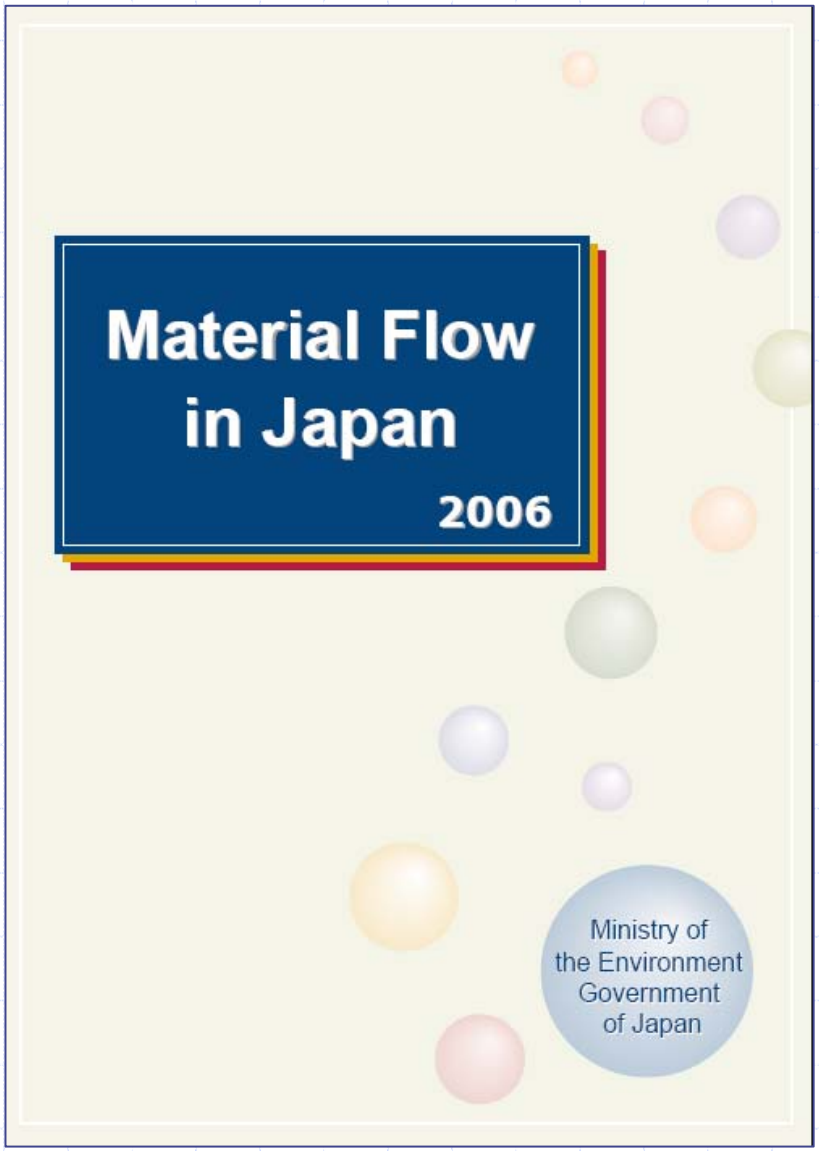
Metabolism of Cities



MFA in a corporate environmental reporting



Source: Toyota Motor Corporation, Environmental and Social Report, 2005



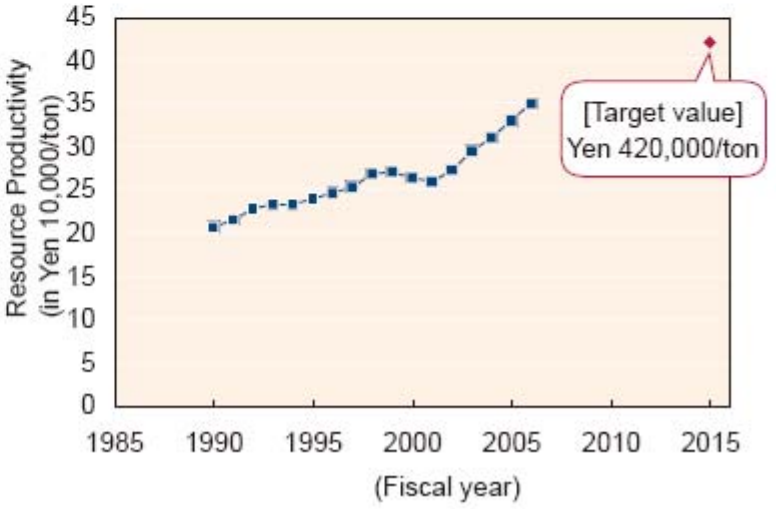
http://www.env.go.jp/en/recycle/smcs/material_flow/2006_en.pdf

Three Targets in the Fundamental Plan for a Sound Material-Cycle

The Fundamental Plan for Establishing a Sound Material-Cycle Society, which was decided by the Cabinet in accordance with the Fundamental Law for Establishing a Sound Material-Cycle Society (2000), has set numerical targets concerning "material flow indexes" for identifying the overall flow of materials in the economic sector in order to form a sound material-cycle society. Specifically, the plan has set an index for each of the three aspects of the material flows.

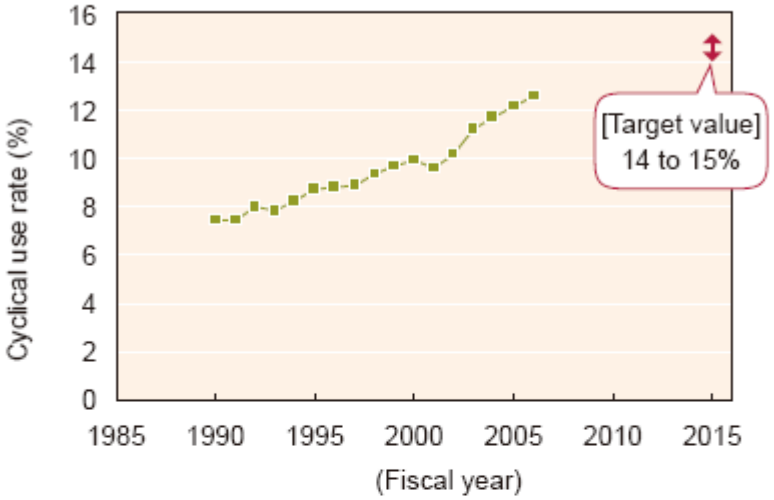
Inlet : resource productivity (= GDP/natural resources, etc. input).

"Resource Productivity" is the index to comprehensively represent how effectively materials are used by industries and in people's lives. Natural resources are limited in quantity, cause environmental loads when extracted, and finally become waste. Therefore, it is desirable that the GDP is effectively generated with a lower input of natural resources. That is, an improvement of resource productivity is desired.



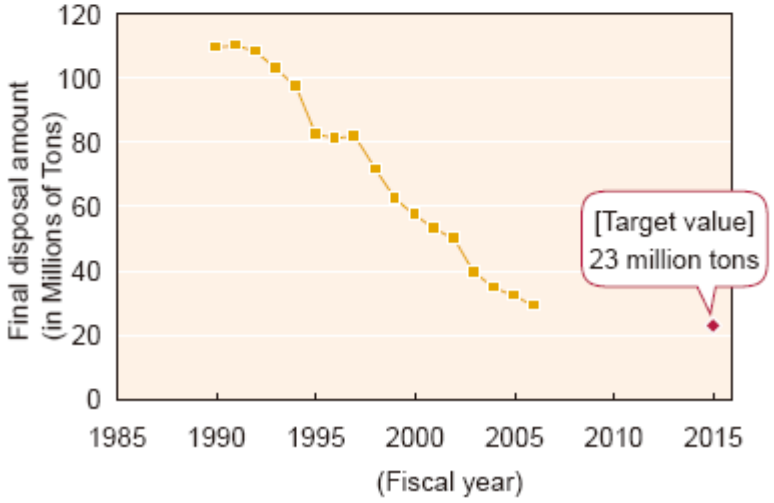
Cycle : cyclical use rate (= cyclical use amount/(natural resources, etc. input + cyclical use amount))

"Cyclical use Rate" is the index to represent the percentage of the amount of cyclical use in the total amount of things input into an economic society. It is desirable, in principle, that this rate is increased, which means correct cyclical use is promoted to reduce the final disposal amount. The "total amount of things input into an economic society" is the sum of the natural resources input and the amount of cyclical use.

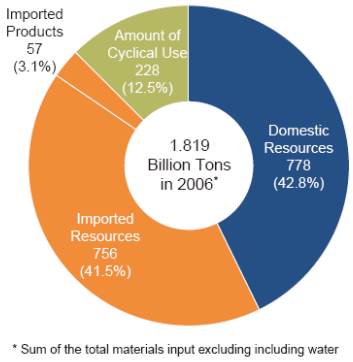


Outlet : final disposal amount

"Final disposal amount" is an index that directly concerns the urgent issue to face the shortage of landfill capacity at final disposal sites. Since the index is expressed as the sum of general wastes and industrial waste. That is, a decrease of final disposal amount is desired.



Material Flow in Japan (in Fiscal Year 2006)



* Sum of the total materials input excluding including water

(Unit: Millions of Tons)

Imported Products (57)

Imported Resources (756)

Import (813)

Domestic Resources (778)

Natural Resources, etc. Input (1,591)

Total Materials Input (1,819)

Including Water (See Note) (290)

Export (170)

Net Additions to Stock (754)

Energy Consumption and Emissions from Industrial Processes (494)

Food Consumption (91)

Returned to Nature (85)

Fertilizer (15)

Generation of Waste, etc. (583)

Reduction (241)

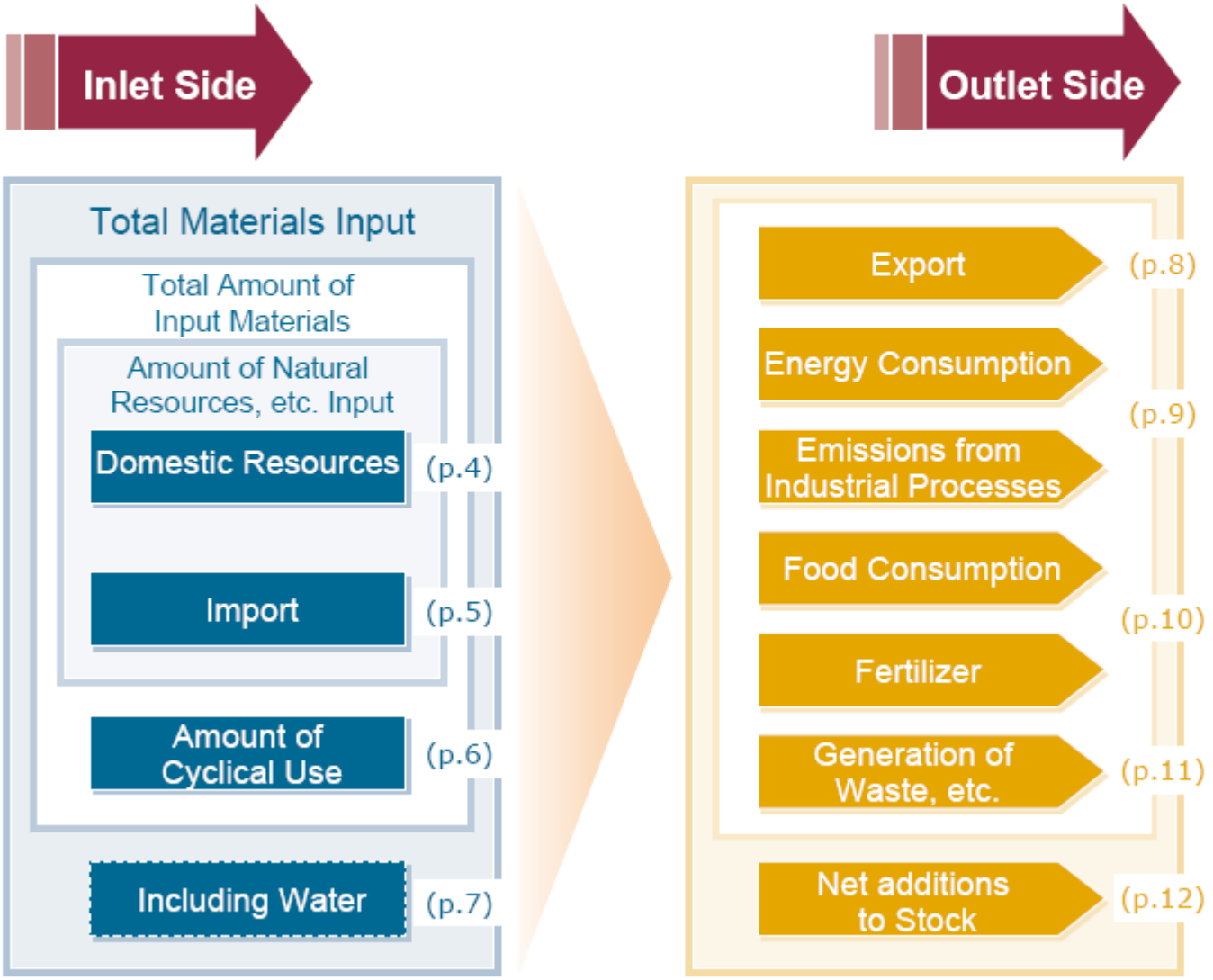
Final Disposal (29)

Amount of Cyclical Use (228)

(Note) Including water: Input of water included in waste and the like (sludge, animal manure, human waste, waste acid, and waste alkali) and sediment and the like associated with economic activities (sludge from mining, building and water works and tailing from mining).

Details of the Material Flow in Our Country

In this section, the material flow is divided into “Inlet” and “Outlet,” and the details are organized according to item.



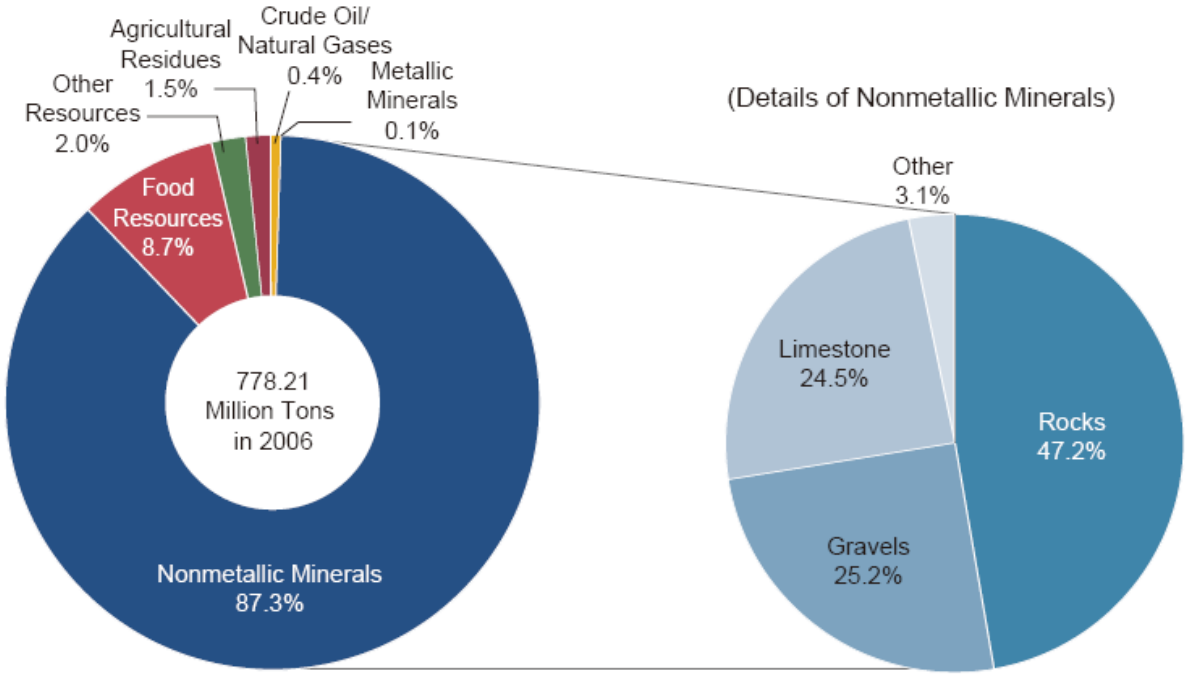


Fig.1 Component ratios of the amount of input domestic resources

Fig.2 Component ratios of nonmetallic minerals

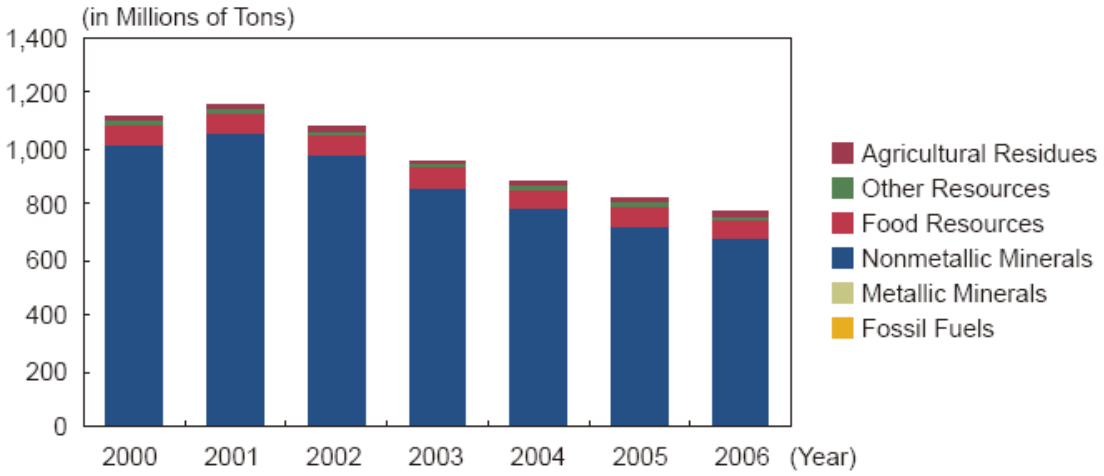


Fig.3 Changes in the amount of input domestic resources

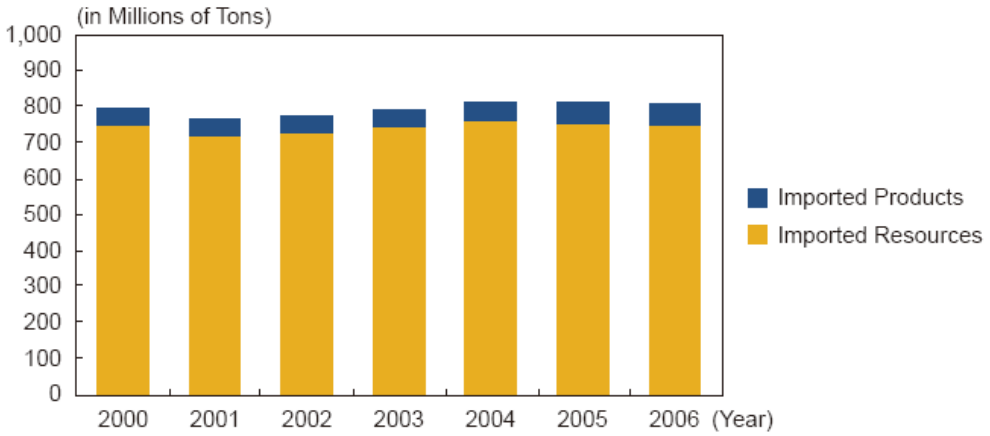


Fig. 4 Change in the amount of import

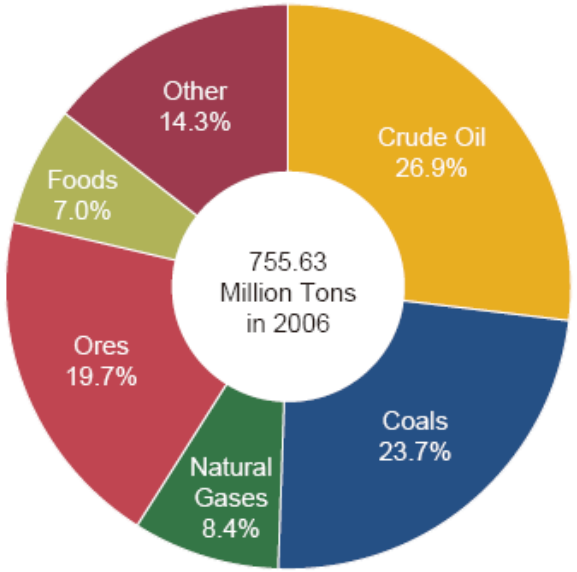


Fig. 5 Details of the amount of imported resources

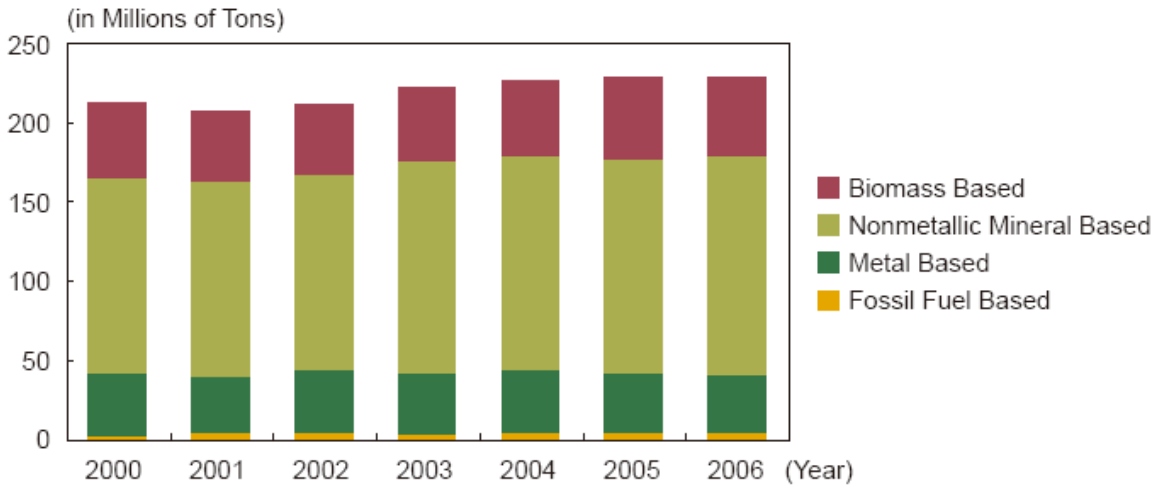


Fig. 6 Changes in the amount of cyclical use

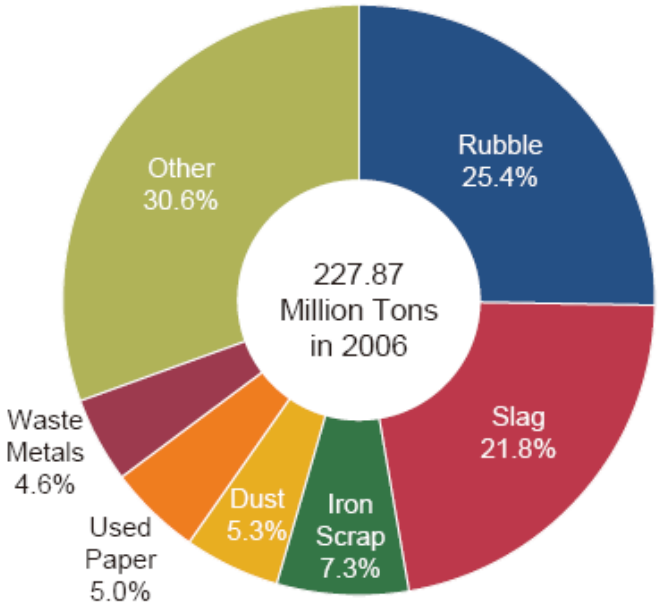
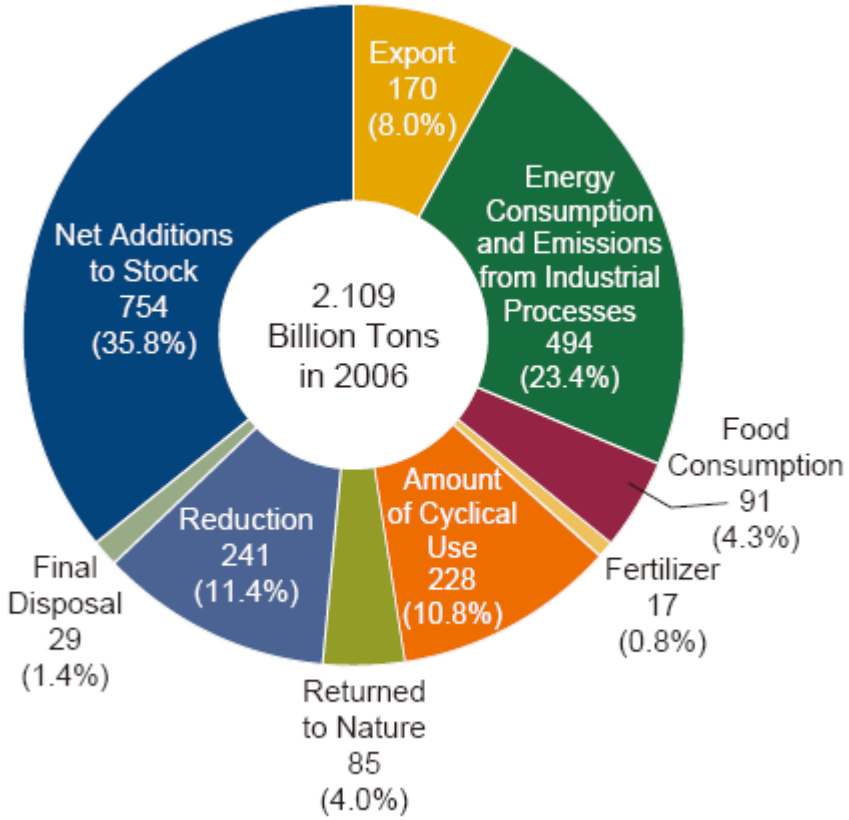


Fig. 7 Details of the amount of cyclical use

Outlet Side



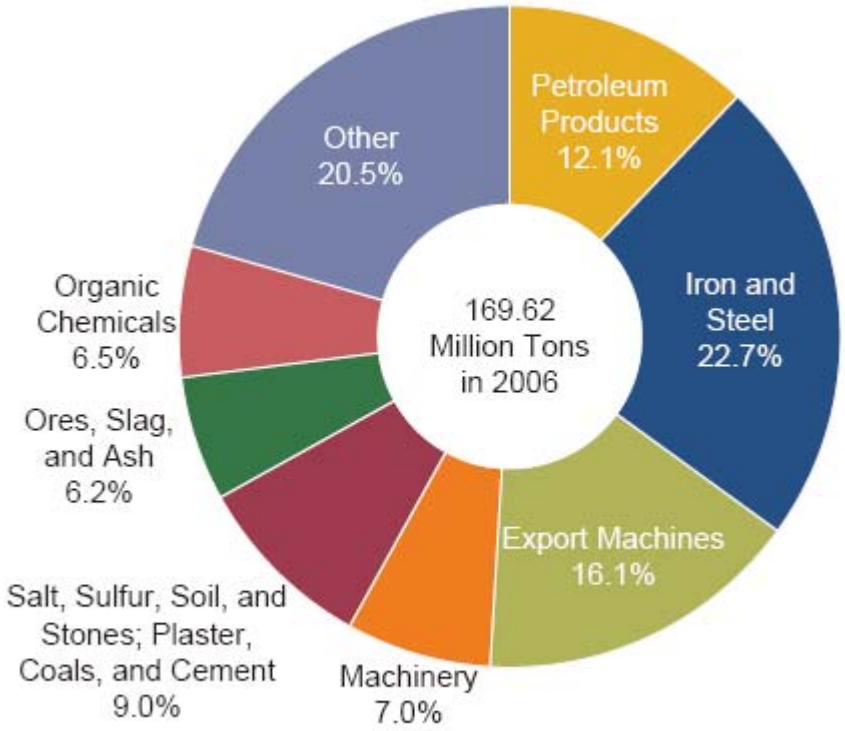
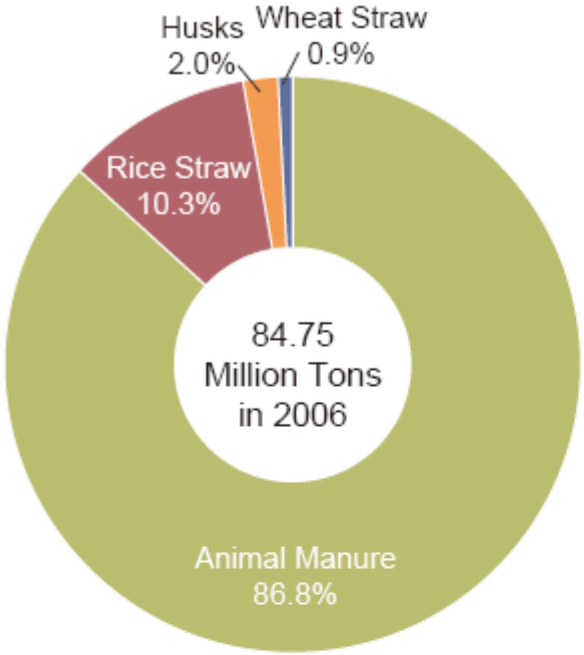
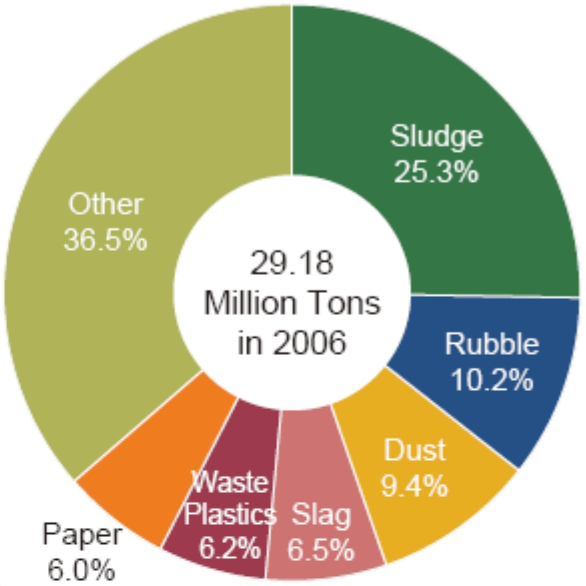


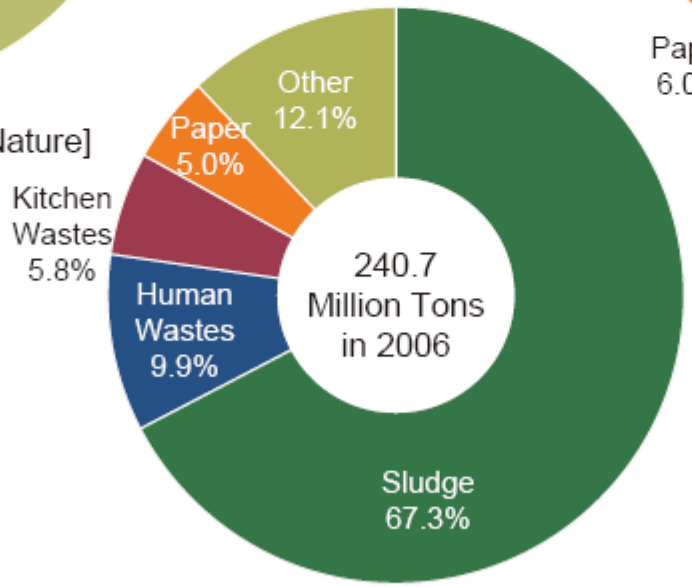
Fig. 9 Details of the amount of export



[Amount of Returned to Nature]



[Final Disposal Amount]



[Amount of Reduction]

* For [Amount of Cyclical Use], see page 6.

Fig. 15 Details of the amount of returned to nature, amount of reduction, and final disposal amount