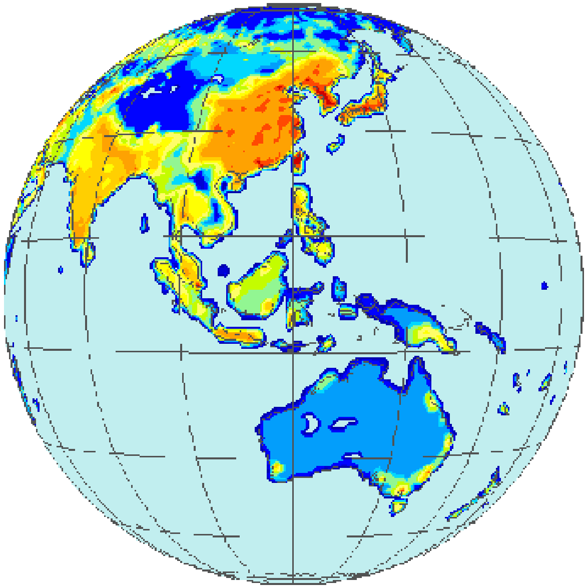
Introduction of waste management in AIM/CGE



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National Institute for Environmental Studies

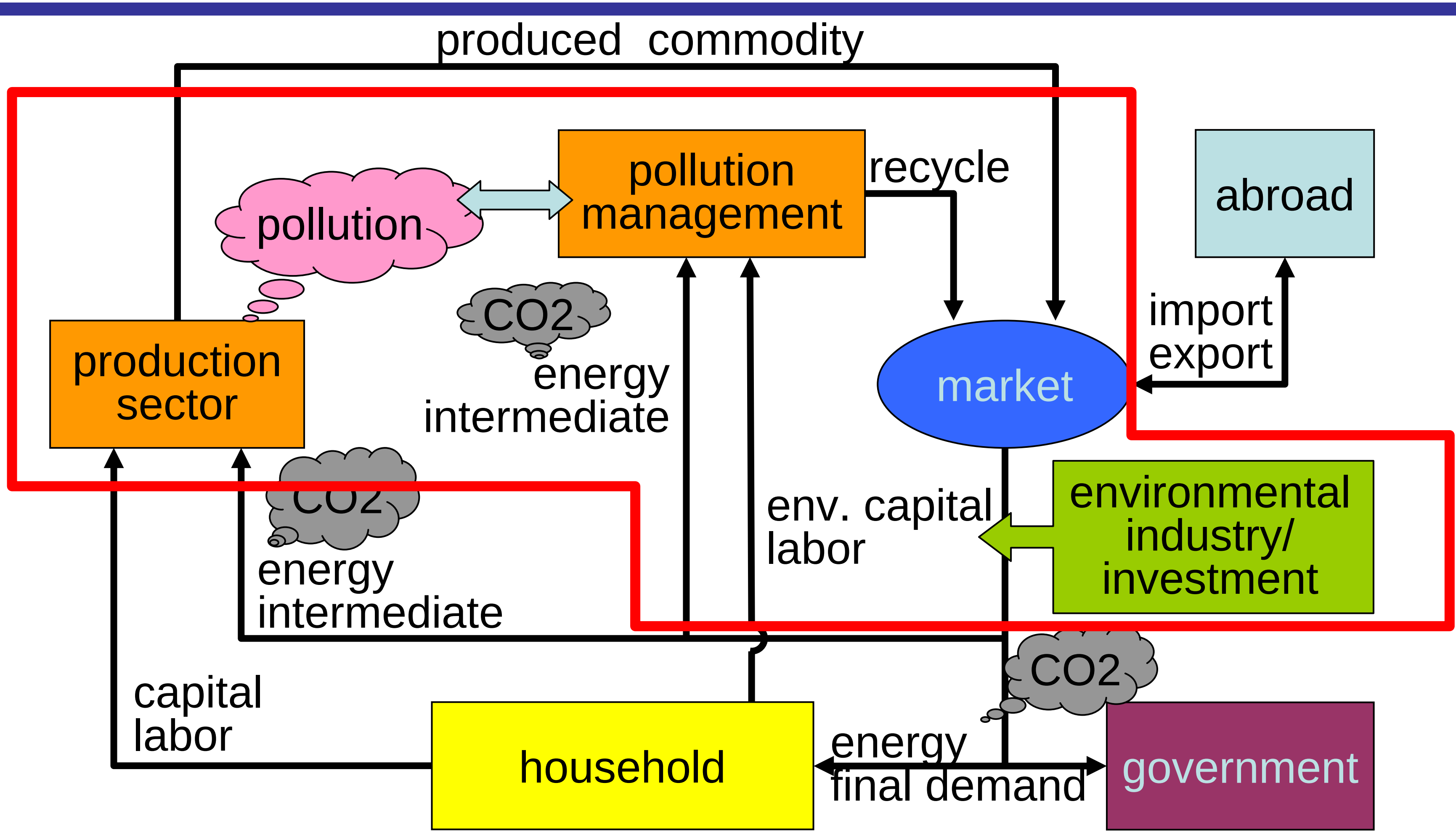
APEIS Training Workshop

NIES, 8 December 2004

How to introduce waste in AIM/CGE

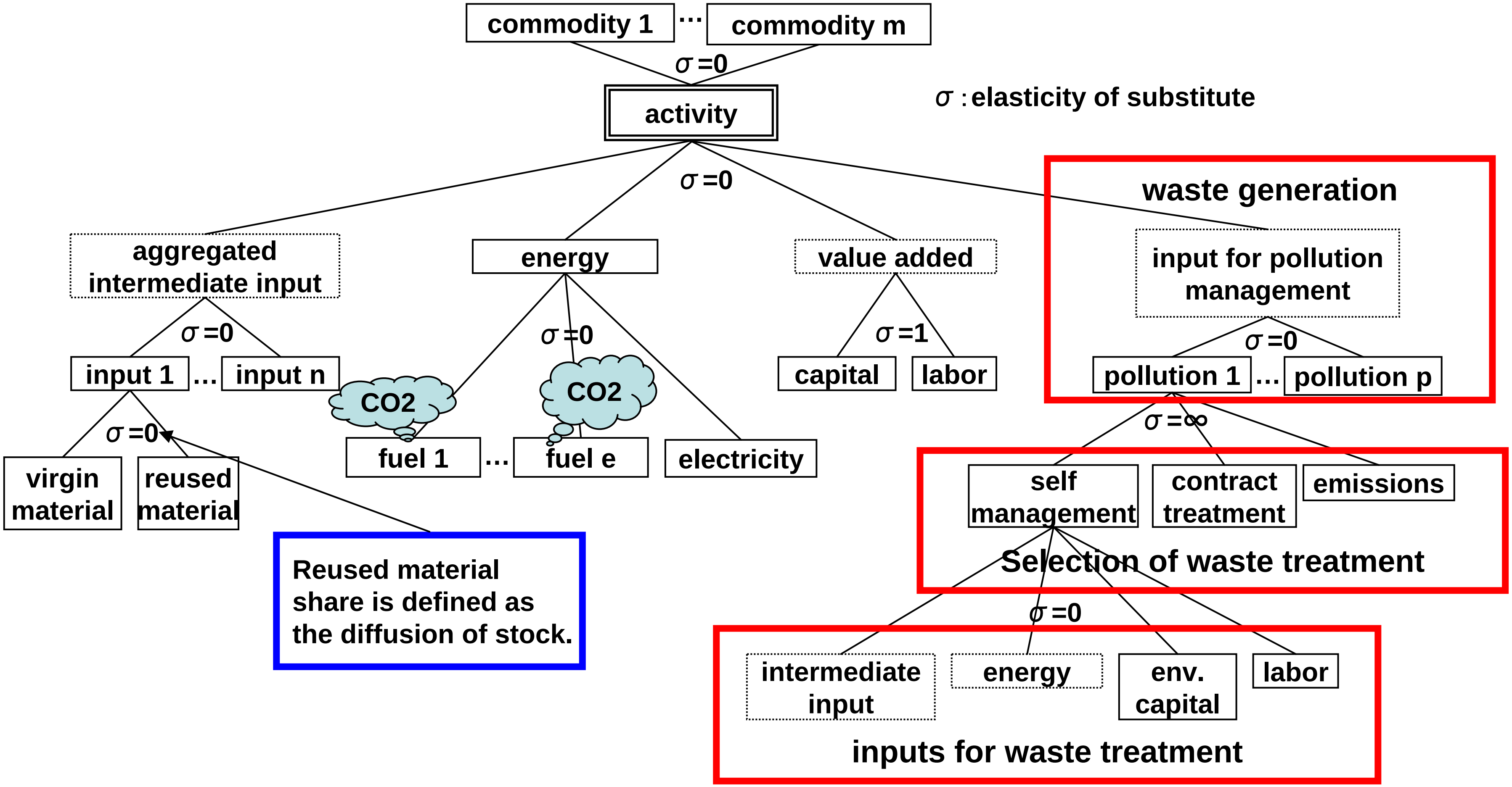
- Waste generation
  - by activity: agriculture, manufacture, household
  - by waste type: scrap metal, waste paper, ...
- Waste treatment
  - input for treatment (capital, labor, energy, ..)
  - output after treatment (recycling, reuse, ...)
- Recycle demand
  - by activity: steel production sector, power sector, ...
  - by recycling goods: paper, biomass, ...

Additional inputs for waste analysis

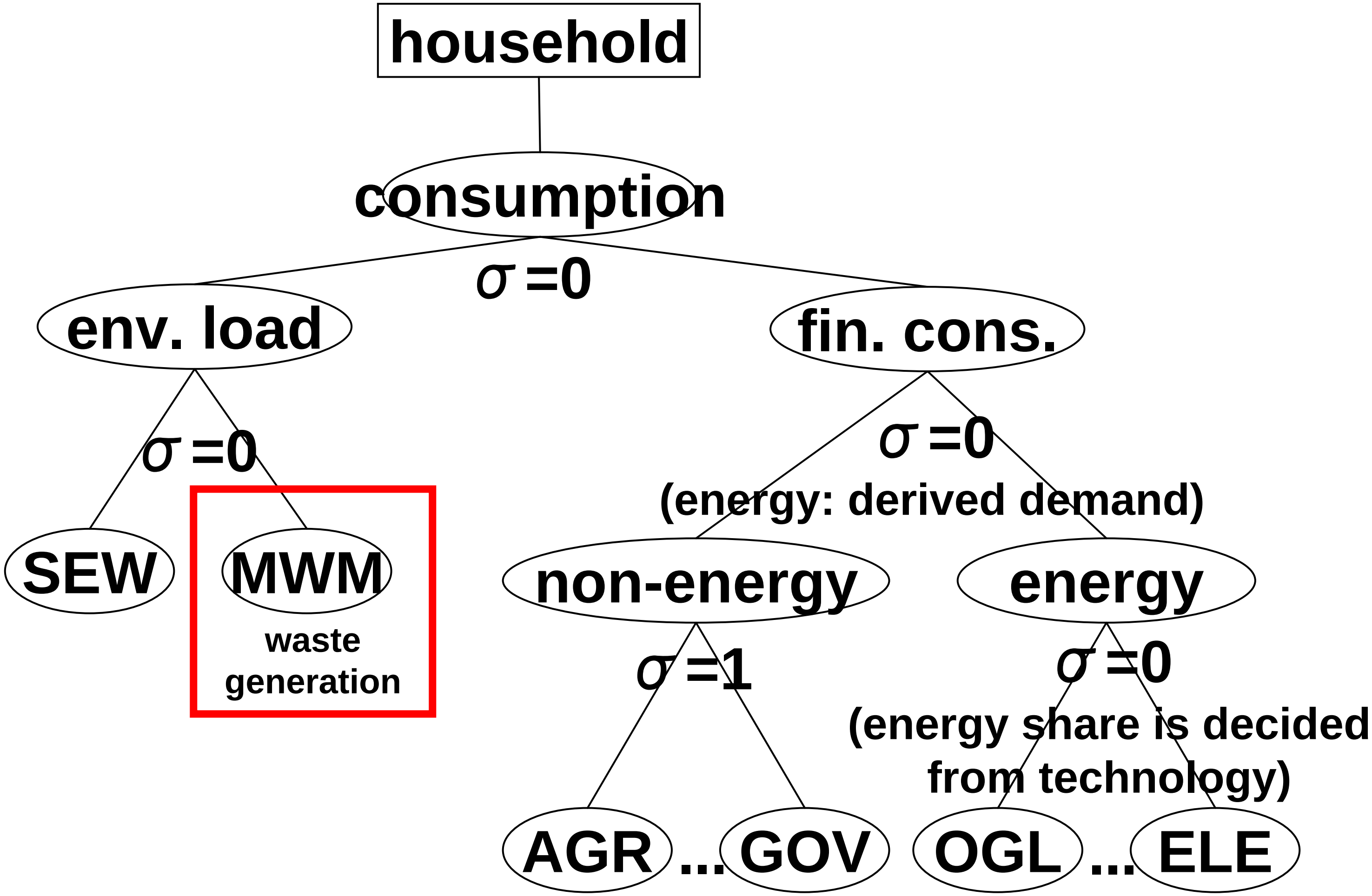


Structure of AIM/Material

Production of AIM/Material



Demand structure in AIM/Material

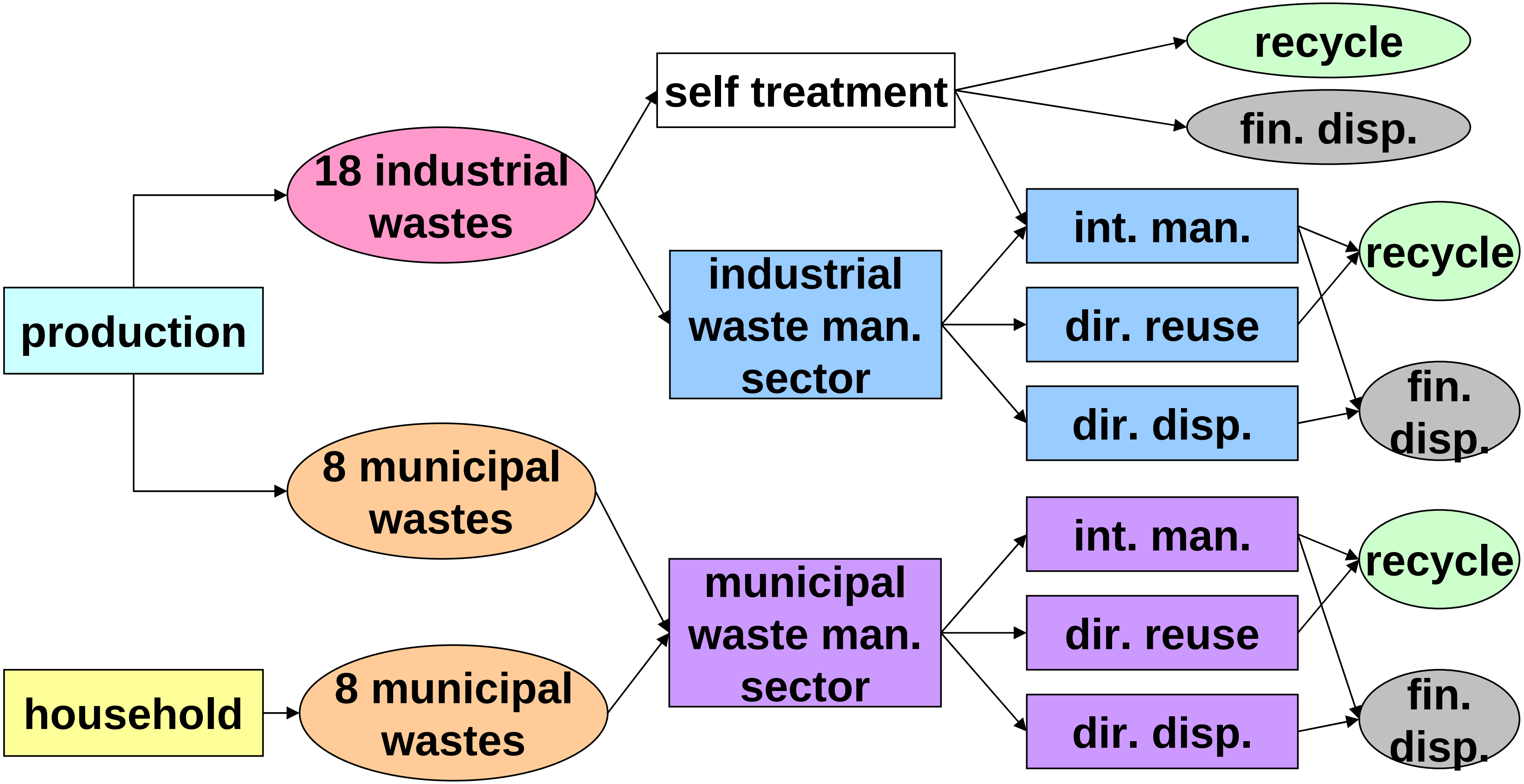


Classification of solid wastes

ash	animal and plants wastes
sludge	waste rubber
slush, waste oil	metal trash, scrap metal
waste acid	waste glass
waste alkali	slag
waste plastics	construction and demolition waste
waste paper	dust, soot
waste wood	animal excrement
waste fiber and textile	animal carcass

- Yellow cells represent both industrial waste and municipal waste classification.
- White cells represent industrial waste classification.

Progress in structure :
(2) Reproduction of detailed waste flow



Progress in structure: (1) Waste from stock and reuse

Purpose

- **Direct reuse of waste is effective environmental policy or not?**
  - **It seems to be effective to solve waste issues.**
  - **But, it seems to delay energy efficiency improvement.**
- **In order to answer this question, following module is developed and integrated with AIM/Material**

  production/consumption (AIM/Material)

  → stock (durable goods)

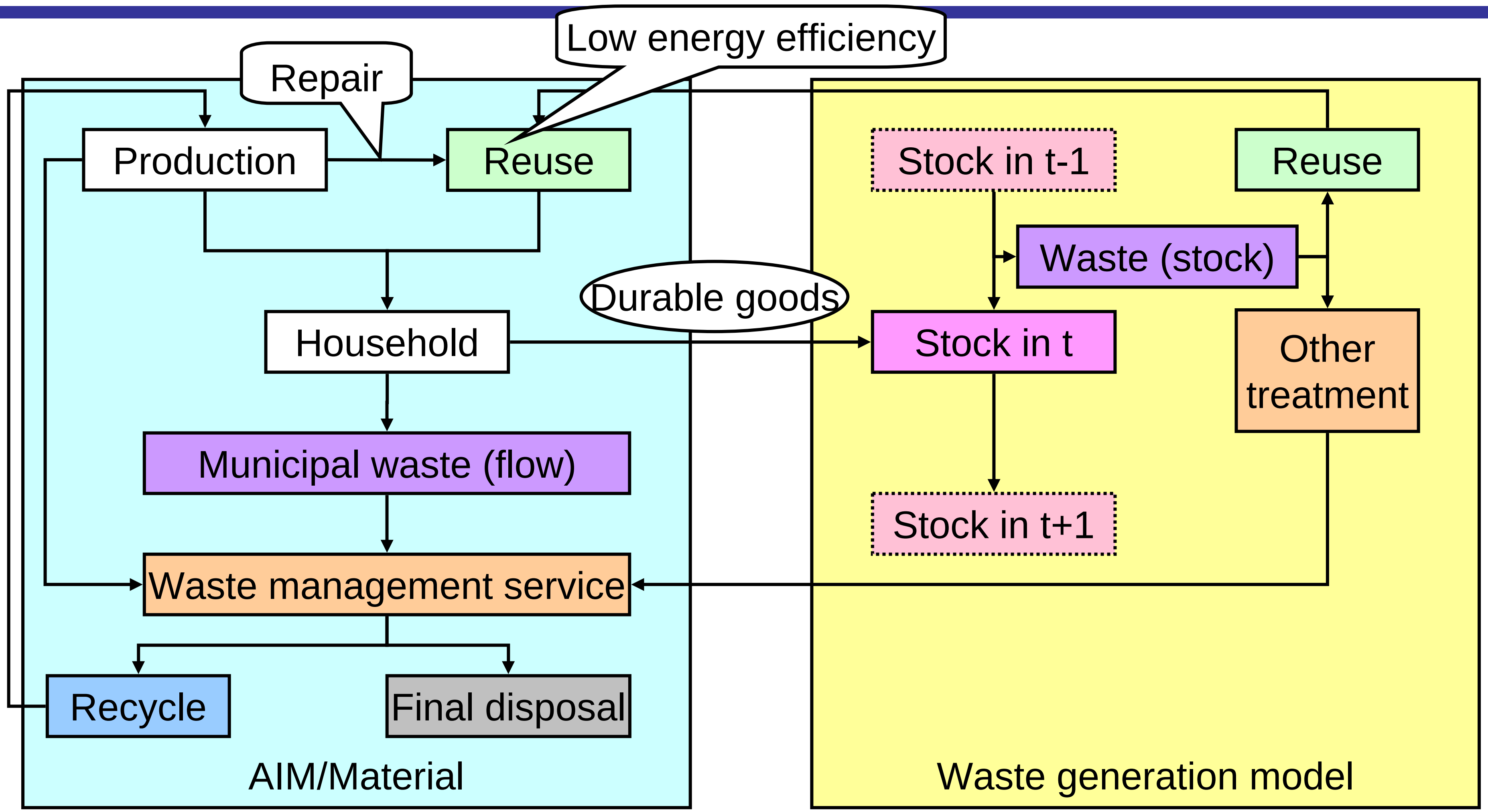
  → waste (Weibull distribution)

  → reuse / treatment

Sample 1

Progress in structure: (1) Waste from stock and reuse

Model



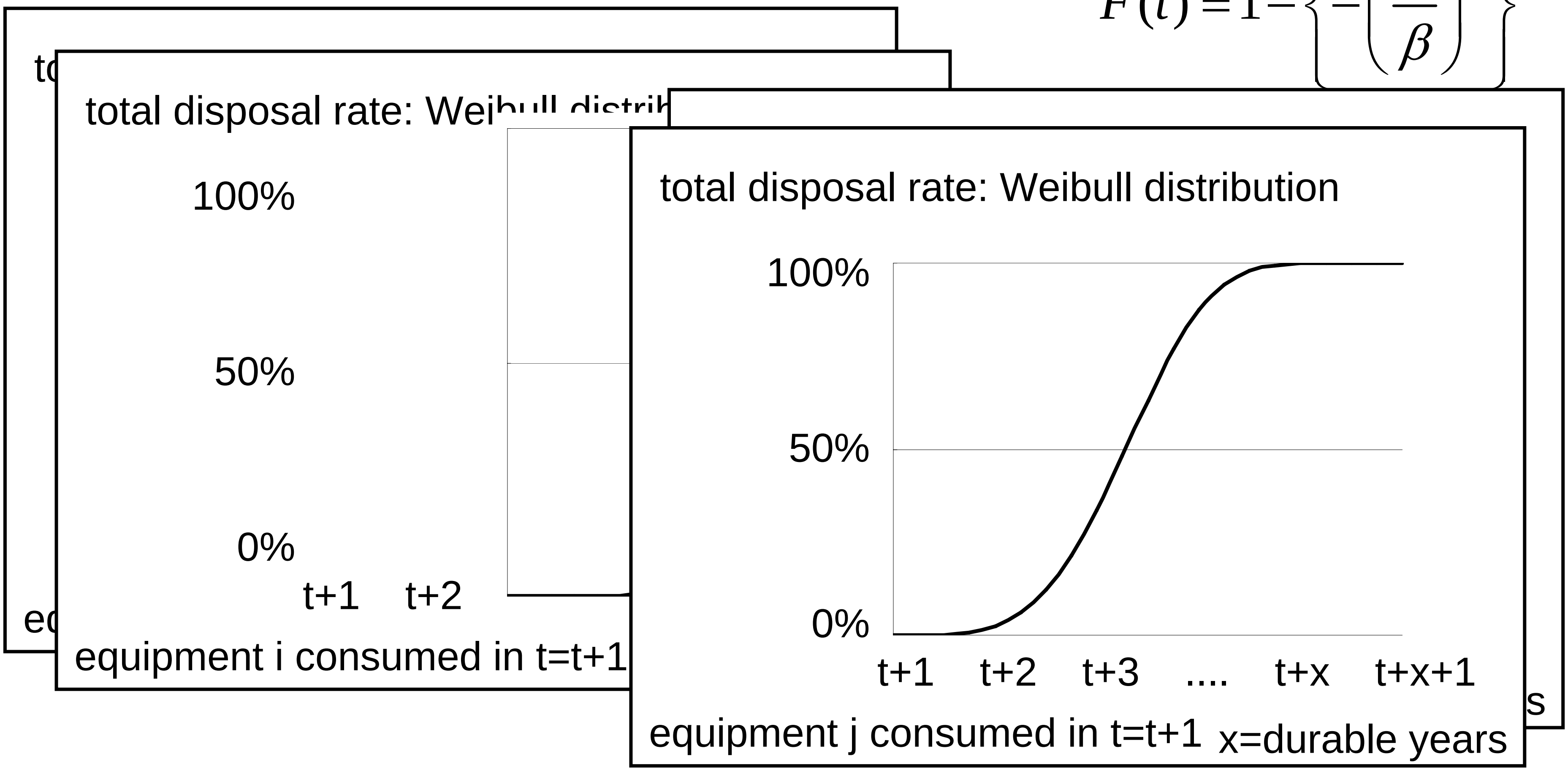
Sample 1

Progress in structure: (1) Waste from stock and reuse

Waste generation model

Total disposal rate:

$$F(t)=1-\left\{-\left(\frac{t}{\beta}\right)^{\alpha}\right\}$$



Sample 1

Progress in structure: (1) Waste from stock and reuse

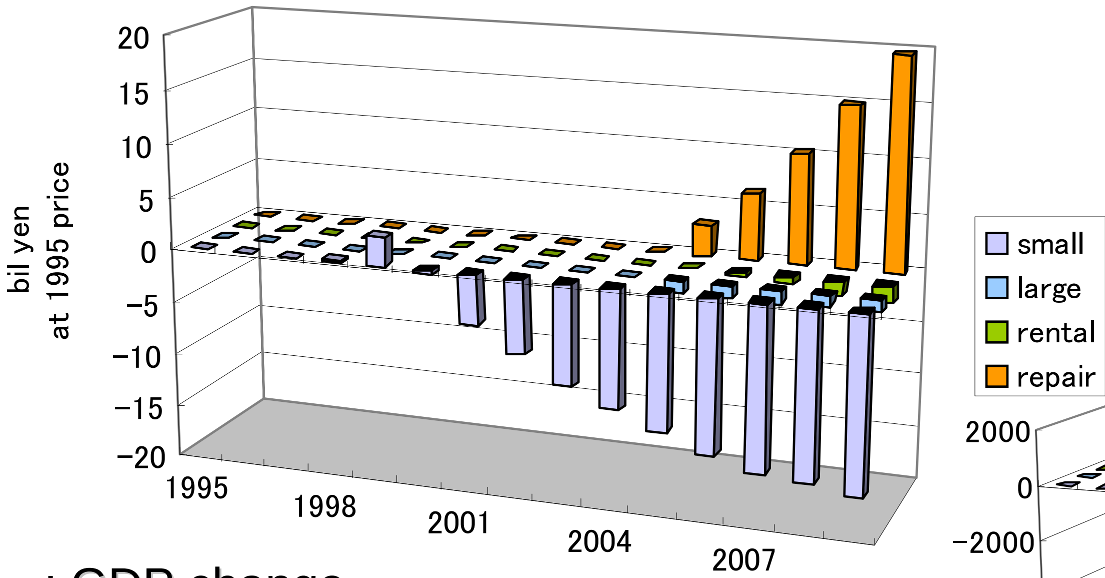
Scenarios

- Reference case
- Reuse promotion scenarios
  - promotion of reuse in household
    small scale expansion of reuse
  - expansion of reuse in government
    large scale expansion of reuse
  - expansion of rental service
  - reduction of repair cost

Sample 1

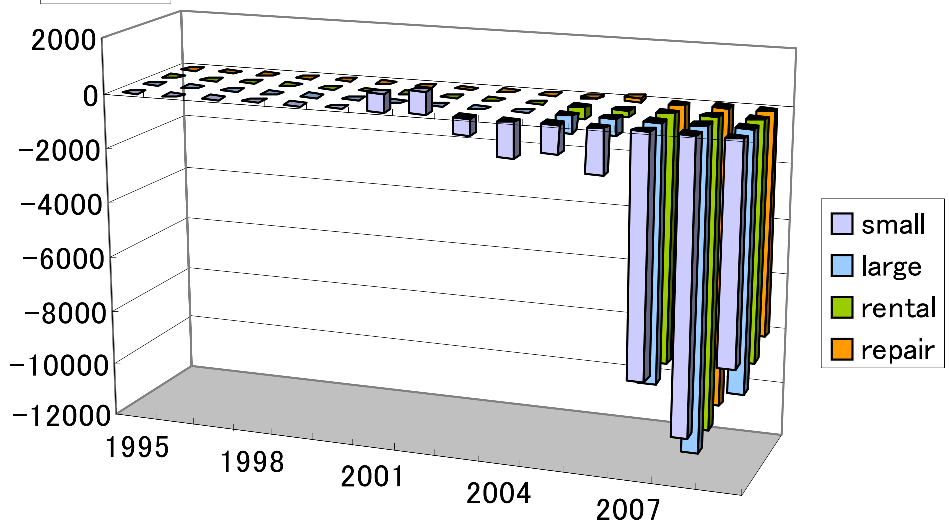
Progress in structure: (1) Waste from stock and reuse

Simulation results



: GDP change

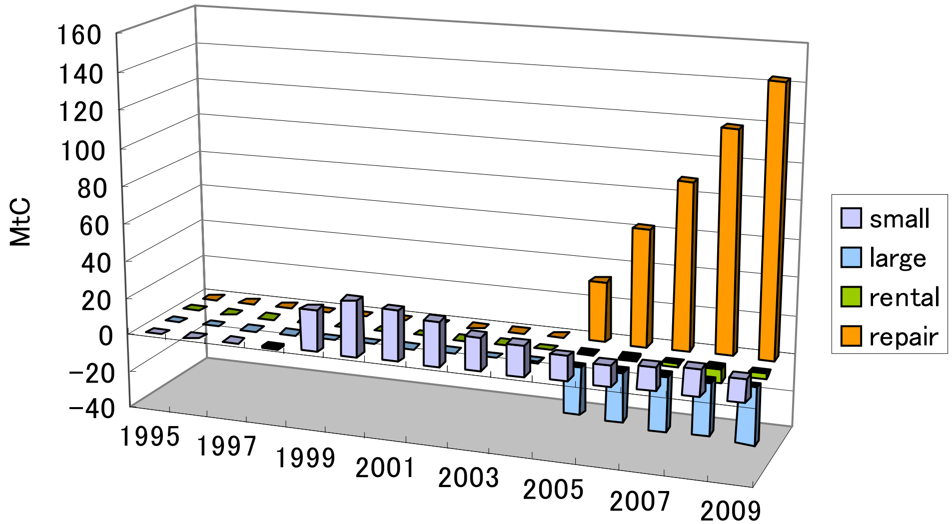
Municipal waste disposal change



Sample 1

Progress in structure: (1) Waste from stock and reuse

Simulation results



CO2 emission change

Sample 1

Progress in structure: (1) Waste from stock and reuse

Messages from simulation

- **Expansion of reuse will make quantity of municipal final disposal decrease.**
- **CO_2 will increase in small expansion of reuse, because reuse delay energy efficiency improvement.**
- **On the other hand, CO_2 will decrease in large amount of reuse, because economic structure itself will shift from manufacture to service industry such as repair.**
- **Please contact Ms. Miyashita (MHIR) for more detail!**

Direct link of top-down and bottom-up

- Elasticity of substitution in AIM/Material

  = 0 or ∞

  ← to keep material balance

  ex. produced pulp and waste pulp → 0

  produced energy and by-product energy → ∞

→Need scenarios on structural change

→For support scenarios, bottom-up model to represent the technology change has been constructed.

Sample 2

Overview of bottom-up model

Simple linear model (Sewage sludge treatment);

Minimizing Total Cost =

initial cost + running cost + final disposal cost

s.t. $D \leqq \Sigma_i X_i$: service demand of sewage sludge

$X_i \leqq A_i \cdot I_i$: treated sewage sludge

$R_j = X_i \cdot r_{ij} = rd_j$: Recycle demand

$\Sigma_i D_i = X_i \cdot d_i$: final disposal

i: technologies,

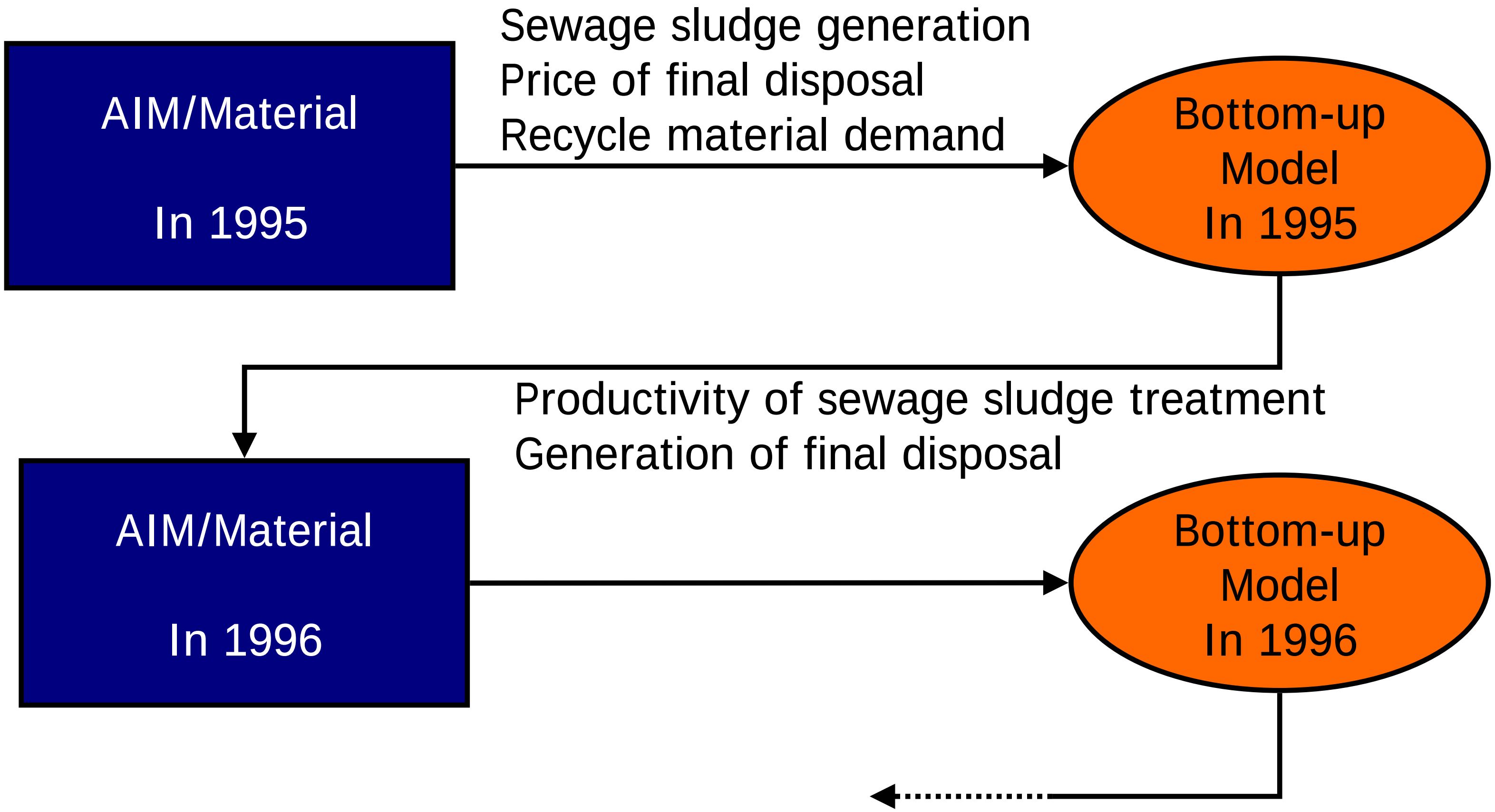
X: treated sludge, A: capacity of sludge treatment,

R: recycled products, D: other residual

I, r, rd, d: parameters

Sample 2

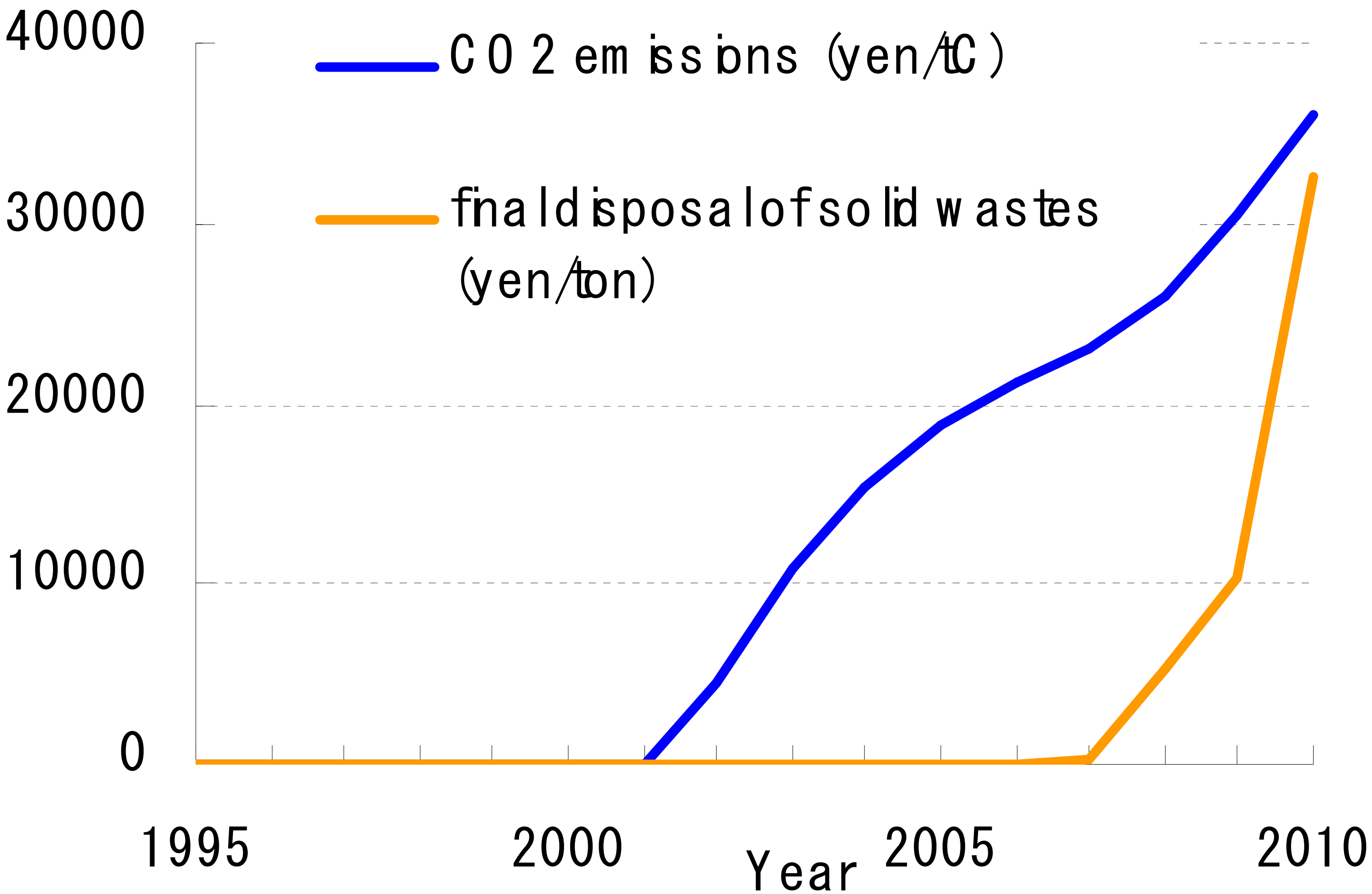
Linkage of 2 models
- sewage sludge treatment -



Sample 2

Results of 2 models

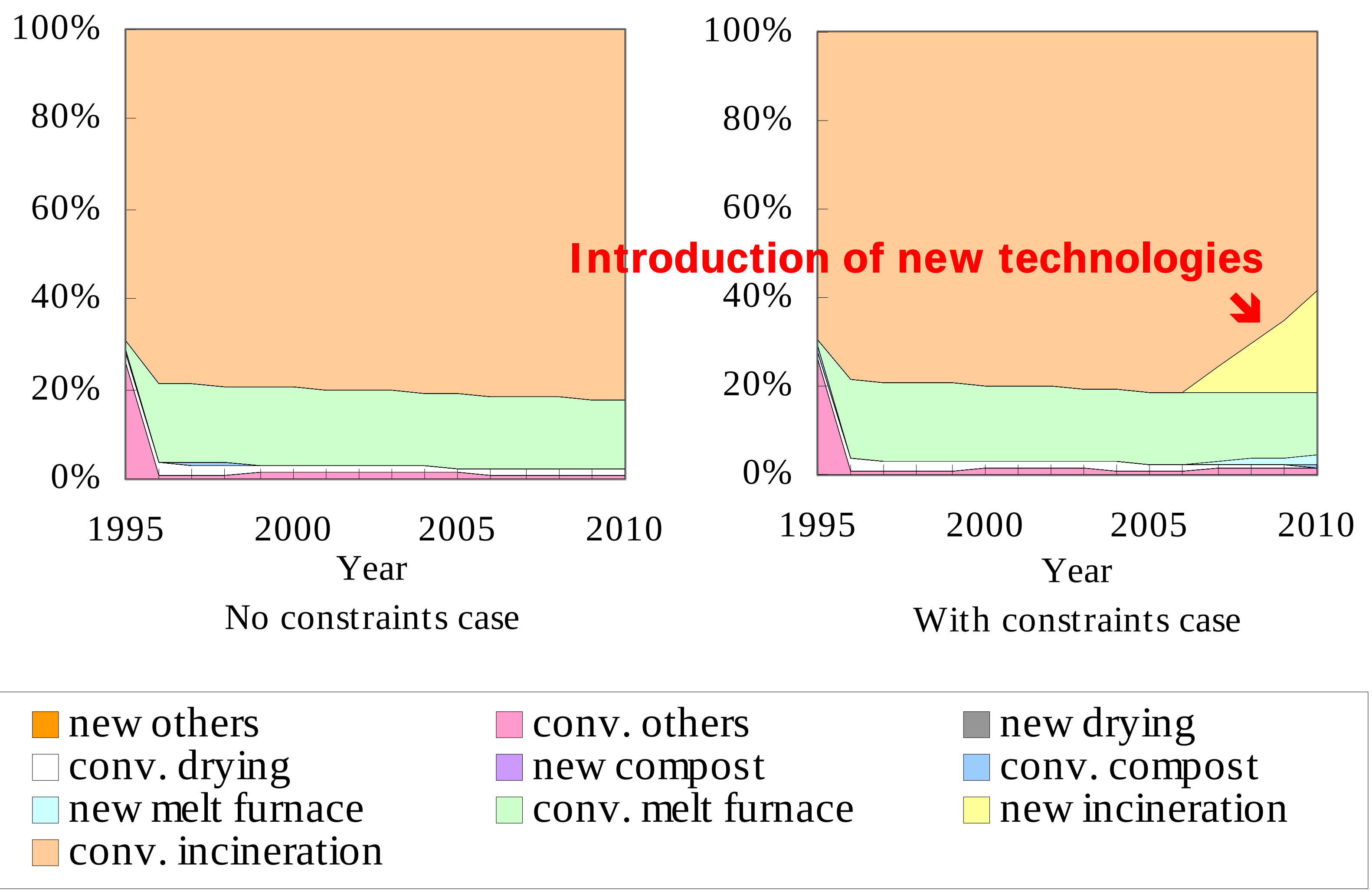
- Marginal cost of pollutants -



Sample 2

Results of 2 models

- technology change -



Results of 2 models

- Economic impact of constraints & technologies -

- In 2010
  - **Environmental constraints on CO2 emissions and final disposal of solid waste will bring 1.8 trillion yen of GDP loss.**

    In case of no constraints, GDP in 2010 will be 638 trillion yen.
  - **By introducing new technologies (systems) in sewage sludge management, 10 billion yen of GDP will be recovered.**
  - **Both increase of recycle material demand and introduction of new technologies will make GDP loss will be mitigated by 200 billion yen.**

Soft link of top-down & bottom-up

Necessary dataset

- Consistent dataset: relationship between input and output

  Investment of new technology

  ➜Technology improvement in stock in the next year

  ➜Modification of production function

Procedure for assessing carbon tax in Japan

- Reference scenario is baseline
  - Autonomous energy efficiency improvement will achieve without additional cost.
  - From enduse model, energy demand per output in stock is calculated every year.
  - Technology improvement in new investment is estimated from stock average. ➜Scenario.xls
- Policy scenario
  - From enduse model, energy demand per output in stock and additional cost compared to reference case to introduce new technologies are calculated every year.
  - Convert of technology efficiency in each sector from stock average to new investment

Inputs data from AIM/Enduse

reference		2000	2001	2009	2010	2011	2012
Agriculture	coal	0	0	0	0	0	0
	oil	10,448	10,312	9,222	9,085	8,949	8,813
	town gas	0	0	0	0	0	0
	electricity	334	330	295	291	286	282
	new energy	0	0	0	0	0	0
Mining	coal	0	0	0	0	0	0
	oil	733	724	652	643	634	625
	town gas	0	0	0	0	0	0
	electricity	167	165	149	147	145	143
	new energy	0	0	0	0	0	0
Construction	coal	0	0	0	0	0	0
	oil	3,909					
	town gas	0					
	electricity	96					
	new energy	0					

policy case		2000	2001	2009	2010	2011	2012
Agriculture	coal	0	0	0	0	0	0
	oil	10,448	10,312	9,222	9,085	8,949	8,813
	town gas	0	0	0	0	0	0
	electricity	334	330	283	275	268	260
	new energy	0	0	0	0	0	0
Mining	coal	0	0	0	0	0	0
	oil	733	724	646	635	625	614
	town gas	0	0	0	0	0	0
	electricity	167	165	142	139	135	131
	new energy	0	0	0	0	0	0
Construction	coal	0	0	0	0	0	0
	oil	3,909	3,914	3,961	3,967	3,972	3,978
	town gas	0	0	0	0	0	0
	electricity	96	96	92	91	89	88
	new energy	0	0	0	0	0	0

Sample 3

Inputs data from AIM/Enduse

sector	process	technology	total subsidy in 1st commitment period (100M¥)	annual subsidy (100M¥/year)
steel	production	waste plastic injection	1,174	235
		high efficient kiln cooler	9	2
cement	production	waste power system	22	4
agricult ure	boiler conversion control	coal boiler	0	0
		oil boiler	0	0
		gas boiler	0	0

Additional cost to introduce options

➜ It is regarded that this type of investment only contributes to improve the energy efficiency, not enhancement of production capital.

➜ In the process of capital accumulation, this additional investment is excluded.