

# **Recent Results from AIM (Asian-Pacific Integrated Model) for Environmental Policy**

**Toshihiko Masui**

Social & Environmental Systems Division  
National Institute for Environmental Studies

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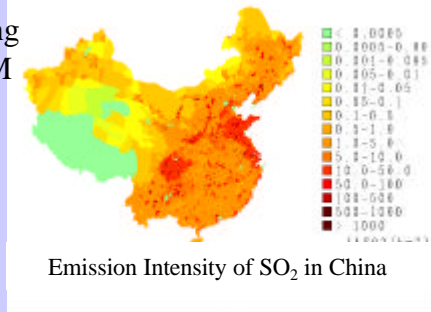
# Contents

- Overview of AIM (Asian-Pacific Integrated Model) activities
- Introduction of AIM/Local
  - Detailed explanation Dr. Yang's presentation
- Results of AIM/Local
  - Application to local area in Japan
- Results of AIM/Material
  - Integration of CO<sub>2</sub> reduction policy and waste treatment policy

# Recent Activities of AIM Team

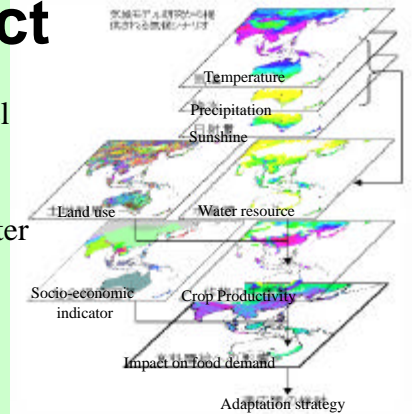
## AIM/Local

Developed for linking CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>2</sub>, SPM reduction program



## AIM/Impact

Detailed process model for climate change impact assessment focused on surface water recycling, crop productivity and vegetation



## AIM/End-use

Country Based Technology Model

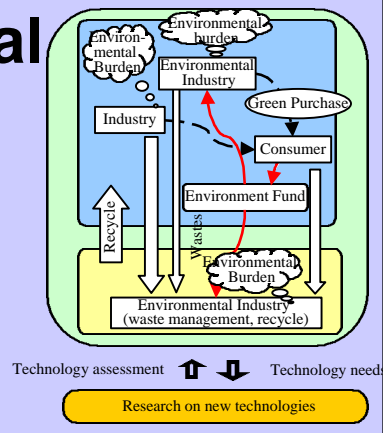
## AIM Family

## AIM/Top-down

World Economic Model

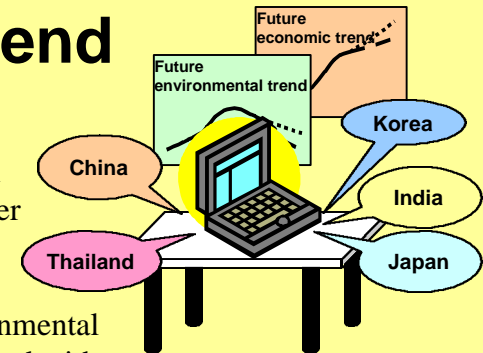
## AIM/Material

One country CGE model with CO<sub>2</sub> and material balance, interface with environmental technology model



## AIM/Trend

Developed as a communication platform in order to construct Asia-pacific regional environmental outlook supported with multi-regional environment-economic CGE model





**AIM Colleagues (at the 6<sup>th</sup> AIM International Workshop, March 2001, NIES)**

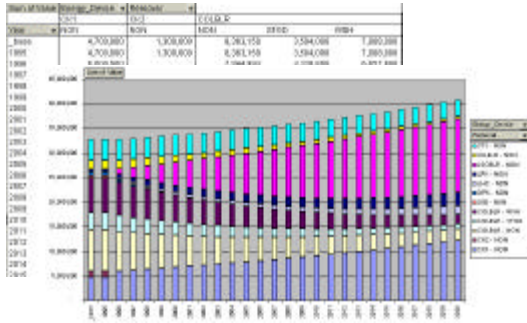
# Background of AIM/Local

- Integration of Climate Policy and Local Environmental Policy
  - Climate Change: global issues rise demand for participation of all members in the world
  - Assess environmental burden in each country
  - Technological innovation will help to reduce both CO<sub>2</sub> and SO<sub>2</sub> emissions
  - International collaboration will benefit for both Japan and developing countries

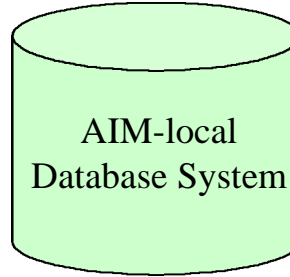


# Overview of AIM/Local

Output

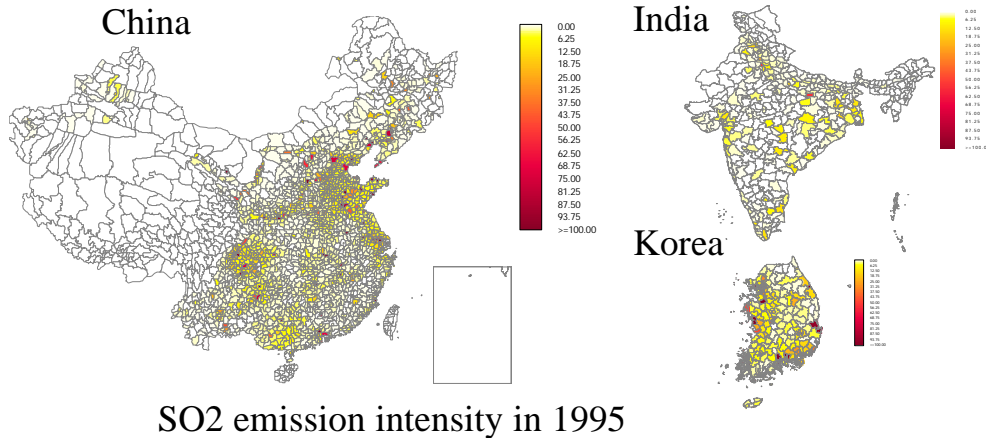


Change of technology share



GIS System

Model:  
 Search technology options  
 -Energy service technology  
 -Pollution removal technology  
 -Cost-benefit



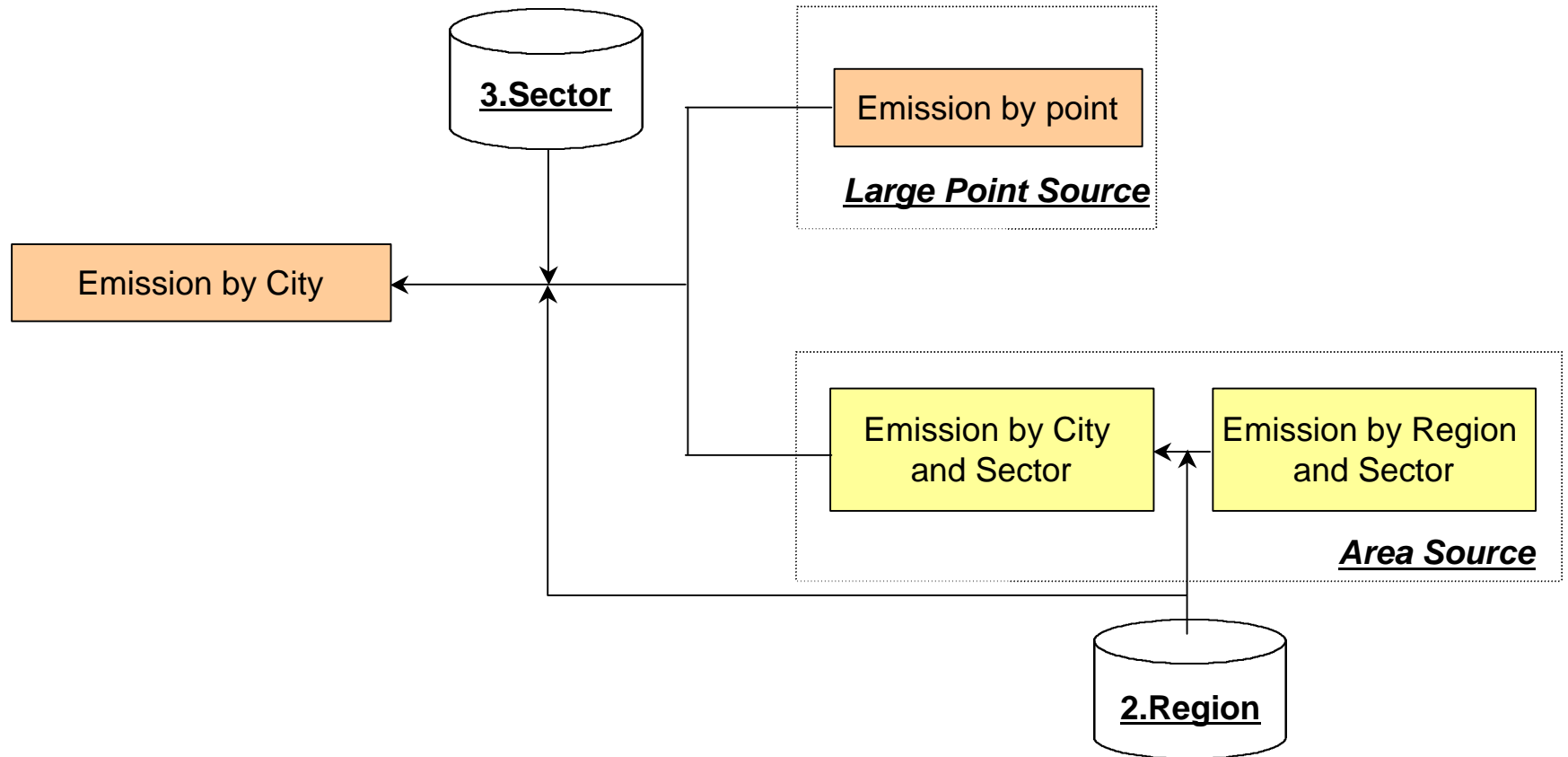
**Database + End-use Model (Local Pollution) + GIS**

# Interface of AIM/Local Database

## AIM-Local 2000 Database System

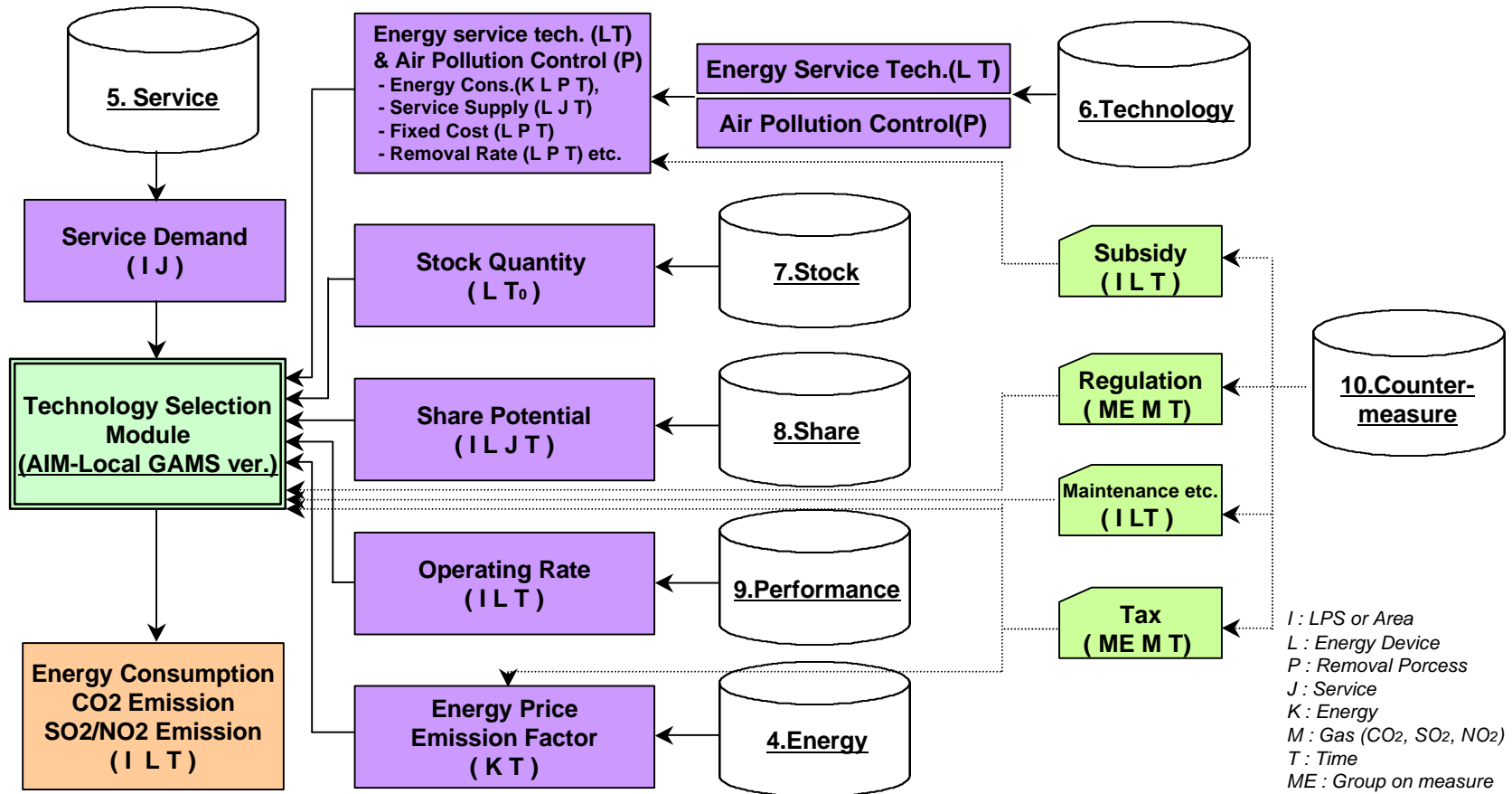
|   |   |  |   |
|---|---|--|---|
| <b>Control parameters</b><br>Parameters used in computation   | <b>Service Database</b><br>Service Classification<br>Service Demand(LPS)<br>Service Demand(Area)  | <b>Stock Database</b><br>Stock (LPS)<br>Stock (Area)   | <b>Countermeasure Database</b><br>Countermeasure Menu at Use Stage<br>Action of Countermeasure<br>Group on measure Classification<br>Group on measure<br>Tax / Regulation<br>Subsidy (Recruited / Operation)<br>Subsidy (Removal Process) |
| <b>Region Database</b><br>Regional Classification 1<br>Regional Classification 2<br>Allocation Index Type<br>Large Point Source | <b>Technology Database</b><br>Energy Device Classification<br>Improvement of Energy Device<br>Removal Process<br>Combination of Removal Process<br>Energy Device -Removal Process | <b>Share Database</b><br>Maximum Share(LPS)<br>Maximum Share(Area)   |   |
| <b>Sector Database</b><br>Sector Classification   |   | <b>Performance Database</b><br>Operating Rate (LPS)  |   |
| <b>Energy Database</b><br>Energy Classification<br>Energy Data by year  |   | <b>Simulation</b><br>Export data to GAMS    Directory: D:\AIM_Local_Test\AIM_Local\data\<br>File: AIM_Local_ex<br>AIM-Local GAMS on GAMSIDE    AIM-Local GAMS on MS-DOS<br>Import data from GAMS    Display Simulation Result    Export result to DB for IDRIS32 |   |

# Large Point Source and Area Source

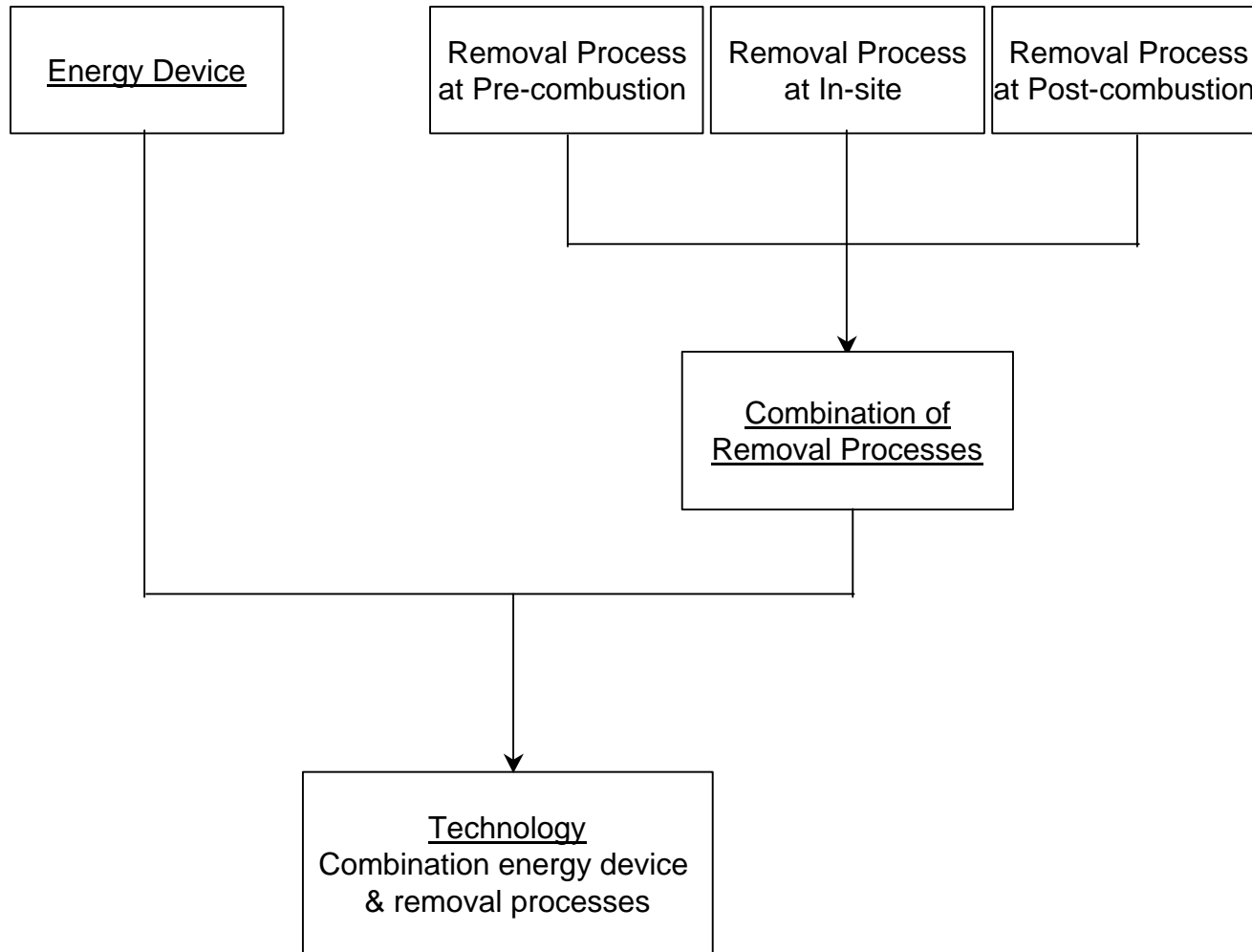




# Structure of AIM-Local Database



# Structure of AIM-Local Database



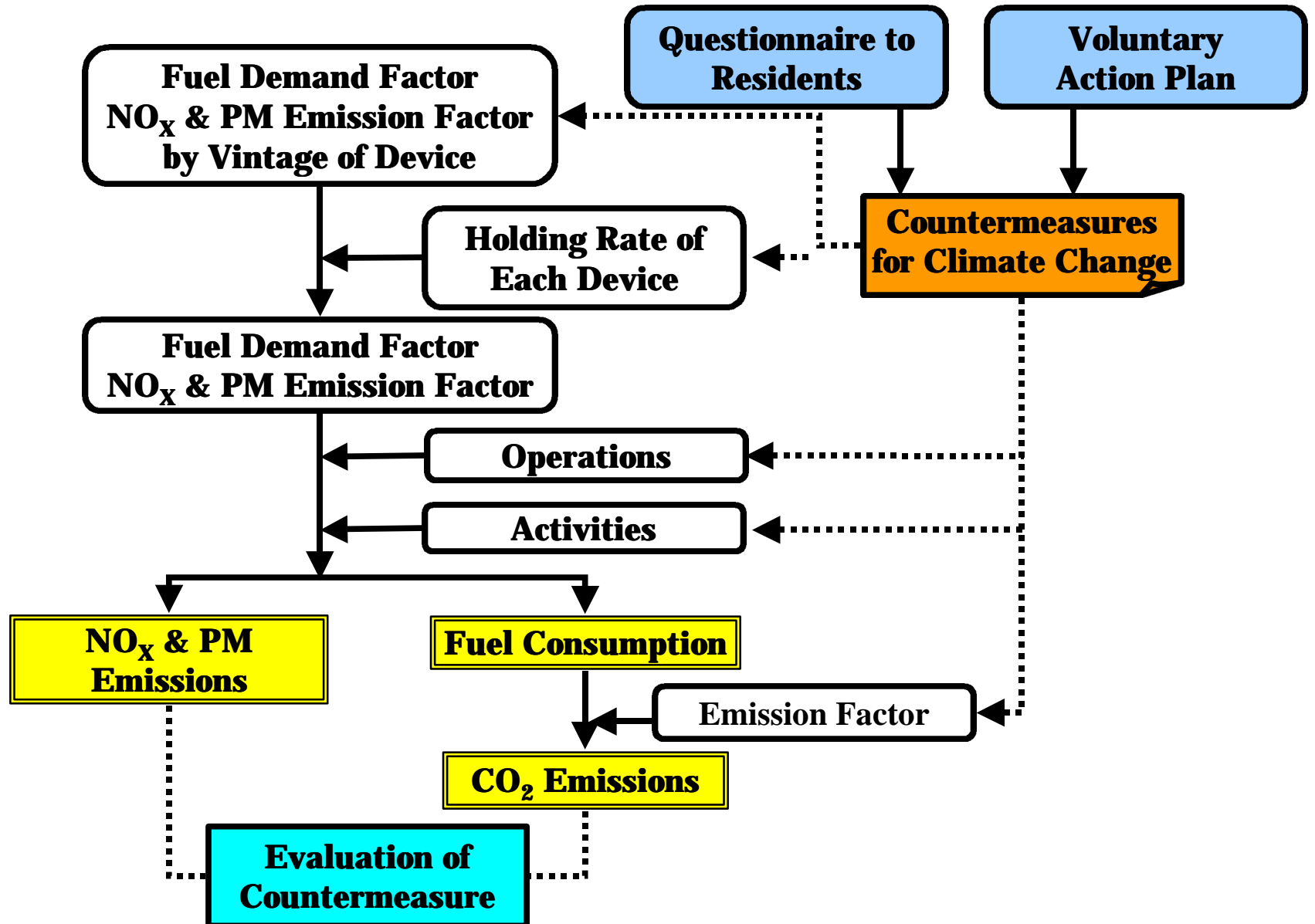
# Application to Japan -Aichi Prefecture

- Background
  - Local governments start countermeasures to climate change.
  - Climate change policy can reduce air pollutants.  
Quantification of ancillary effects improving local air environment by climate change policy can be incentive to promote climate change policies
- Only database and scenarios (not End-use model)
- This model has distributed to local governments in Japan

# Location of Aichi Prefecture



# System of Local Model





# Assumption for estimate

- Aichi prefecture is disaggregated into 103 cities, towns and villages.
- Estimated matters: CO<sub>2</sub>, NO<sub>x</sub>, PM
- Sectors: Industry (28 sectors)  
Transportation (28 technologies)  
Resident (45 technologies)  
Service (23 technologies)
- Base year: 1990 / Target year: 2010
- Scenario: Reference case (no policy)  
Countermeasures case (3 levels)

# Countermeasures Level

- Level 1: achievement by ordinary efforts
  - “usual activities” by questionnaire
  - 40% achievement of voluntary plan target
- Level 2: achievement by active efforts
  - everyone to intend to tackle by questionnaire
  - 70% achievement of voluntary plan target
- Level 3: achievement by maximum efforts
  - 10% more to Level 2
  - 100% achievement of voluntary plan target

questionnaire: October 1999

# Countermeasures to Climate Change

- Industry: Voluntary plan of each sectors
- Transportation/Resident/Service:
  - Introduction of top-runner technology
  - Introduction of energy saving technology
  - sensible attitude

# Examples of energy saving technology

| Sectors | Countermeasure   | Level 1 | Level 2 | Level 3 |
|---------|--|---------|---------|---------|
| Trans.  | Introduction of hybrid-vehicle                               | 10%     | 15%     | 20%     |
|         | Return to small car (gasoline)                               | 10%     | 15%     | 30%     |
|         | Return to small car (diesel)                                 | 10%     | 15%     | 30%     |
|         | Introduction of hybrid public bus                            | 10%     | 15%     | 20%     |
| Resid.  | Liquid crystal display of TV                                 | 30%     | 40%     | 44%     |
|         | Change from incandescent light to fluorescent light          | 30%     | 40%     | 44%     |
|         | Introduction of light with sensor                            | 30%     | 40%     | 44%     |
|         | Introduction of solar heated water                           | 6%      | 16%     | 18%     |
| Serv.   | Introduction of light with sensor                            | 5%      | 15%     | 25%     |
|         | Introduction of Hf-inverter                                  | 12%     | 46%     | 52%     |
|         | Liquid crystal display of PC monitor                         | 5%      | 36%     | 40%     |
|         | Introduction of high brightness guide lamp of emergency exit | 10%     | 20%     | 30%     |

# Examples of sensible attitude

| sectors | countermeasure                               | present share | expected share |         |         |
|---------|--|---------------|----------------|---------|---------|
|         |  |               | Level 1        | Level 2 | Level 3 |
| Trans.  | Stop sudden start of car (10 times/day)      | 37%           | 73%            | 87%     | 96%     |
|         | Drop 10 kg unnecessary baggage               | 27%           | 53%            | 78%     | 86%     |
|         | Stop 5 min. idling/day                       | 33%           | 67%            | 86%     | 94%     |
| Resid.  | 1°C fall of temperature of heat              | 24%           | 48%            | 88%     | 97%     |
|         | Turn off the main power of TV                | 18%           | 35%            | 83%     | 91%     |
|         | Shorten 3 min. of hair drier use             | 15%           | 30%            | 40%     | 50%     |
|         | Turn off heat of toilet seat during midnight | 26%           | 52%            | 78%     | 86%     |
| Servi.  | Revise the temperature of heating            | 42%           | 85%            | 92%     | 100%    |
|         | Revise the temperature of cooling            | 42%           | 84%            | 91%     | 100%    |
|         | Turn off light during lunch break            | 40%           | 80%            | 92%     | 100%    |



# Results of Emissions -CO2

| Sector       | Base Year    | Latest Year  | Target Year  |              |              |              |
|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
|              |              |              | Ref.         | CM-1         | CM-2         | CM-3         |
| Ind.         | 36603        | 41309        | 41144        | 35745        | 34630        | 33515        |
|              |              | 13%          | 12%          | -2%          | -5%          | -8%          |
| Trans.       | 7444         | 8489         | 10680        | 8934         | 8490         | 8081         |
|              |              | 14%          | 43%          | 20%          | 14%          | 9%           |
| Resid.       | 8130         | 9354         | 11181        | 8638         | 7661         | 7436         |
|              |              | 15%          | 38%          | 6%           | -6%          | -9%          |
| Service      | 6009         | 6829         | 7620         | 5613         | 5124         | 4844         |
|              |              | 14%          | 27%          | -7%          | -15%         | -19%         |
| <b>Total</b> | <b>58187</b> | <b>65980</b> | <b>70625</b> | <b>58930</b> | <b>55905</b> | <b>53875</b> |
|              |              | 13%          | 21%          | 1%           | -4%          | -7%          |

Unit:KtCO2

# Results of Emissions -NOx

| Sector       | Base Year    | Latest Year        | Target Year          |                      |                      |                      |
|--------------|--------------|--------------------|----------------------|----------------------|----------------------|----------------------|
|              |              |                    | Ref.                 | CM-1                 | CM-2                 | CM-3                 |
| Ind.         | 44214        | 43847<br>-1%       | 43770<br>-1%         | 41700<br>-6%         | 40380<br>-9%         | 39060<br>-12%        |
| Trans.       | 40677        | 43616<br>7%        | 27458<br>-32%        | 25969<br>-36%        | 25444<br>-37%        | 24991<br>-39%        |
| Resid.       | 3827         | 3898<br>2%         | 4636<br>21%          | 3821<br>0%           | 3337<br>-13%         | 3238<br>-15%         |
| Service      | 2817         | 2796<br>-1%        | 3176<br>13%          | 2516<br>-11%         | 2352<br>-17%         | 2241<br>-20%         |
| <b>Total</b> | <b>91534</b> | <b>94157</b><br>3% | <b>79039</b><br>-14% | <b>74006</b><br>-19% | <b>71513</b><br>-22% | <b>69531</b><br>-24% |

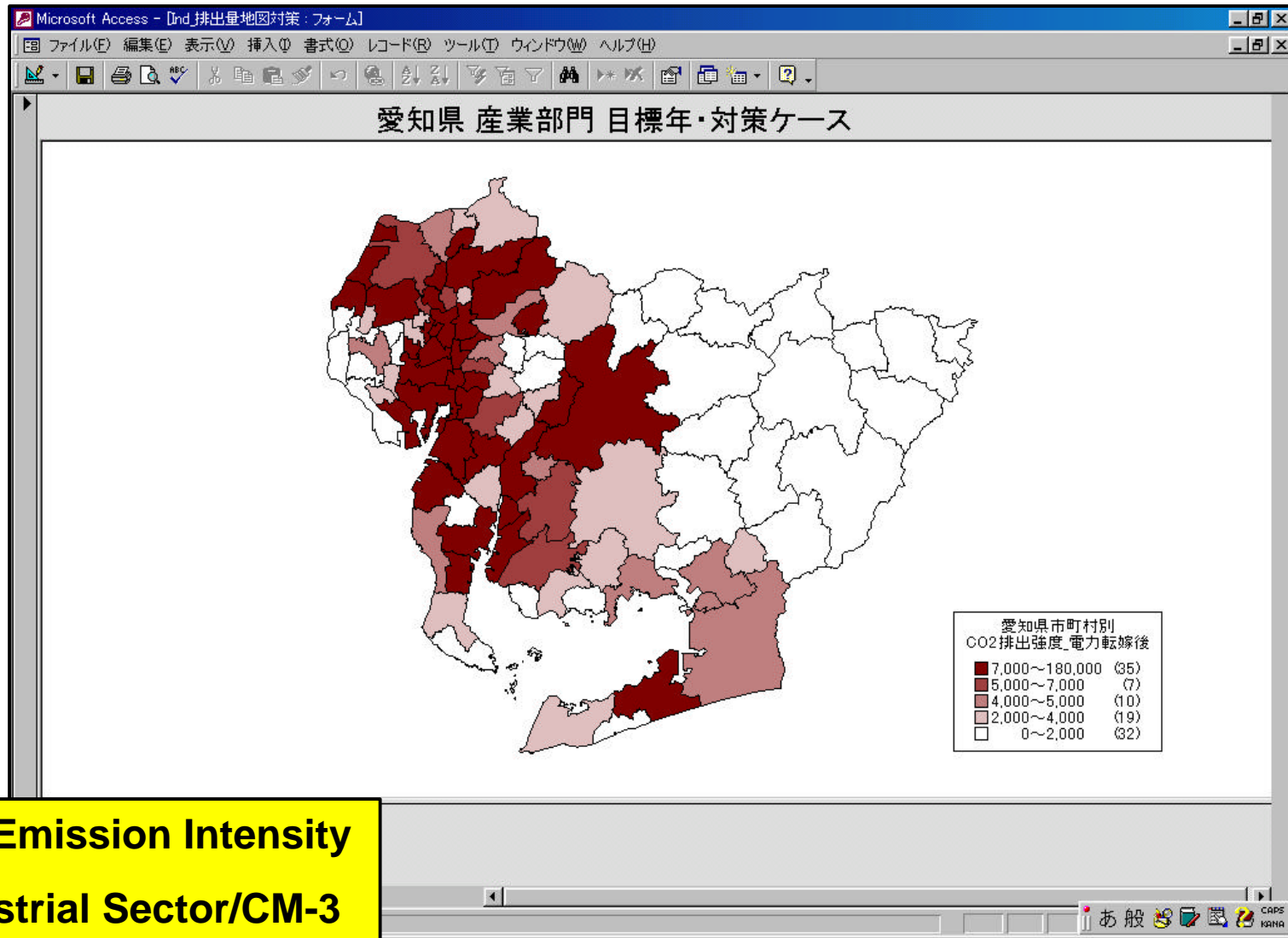
Unit:ton

# Results of Emissions -PM

| Sector  | Base Year | Latest Year | Target Year |       |       |       |
|---------|-----------|-------------|-------------|-------|-------|-------|
|         |           |             | Ref.        | CM-1  | CM-2  | CM-3  |
| Ind.    | 7470      | 6671        | 6720        | 6592  | 6380  | 6168  |
|         |           | -11%        | -10%        | -12%  | -15%  | -17%  |
| Trans.  | 3612      | 3738        | 1230        | 1188  | 1175  | 1163  |
|         |           | 3%          | -66%        | -67%  | -67%  | -68%  |
| Resid.  | 220       | 289         | 364         | 250   | 224   | 218   |
|         |           | 32%         | 66%         | 14%   | 2%    | -1%   |
| Service | 473       | 571         | 648         | 499   | 463   | 438   |
|         |           | 21%         | 37%         | 6%    | -2%   | -8%   |
| Total   | 11775     | 65980       | 70625       | 58930 | 55905 | 53875 |
|         |           | -4%         | -24%        | -28%  | -30%  | -32%  |

Unit:ton

# Results of Emissions -GIS



# AIM/Material

- Background

Both CO<sub>2</sub> reduction and solid waste management are significant environmental problems in Japan.

Industrial waste (in 1996)

generation: 405 mi. ton    reuse: 150 mi. ton  
residual landfill year: 3.1 years

Municipal waste (in 1996)

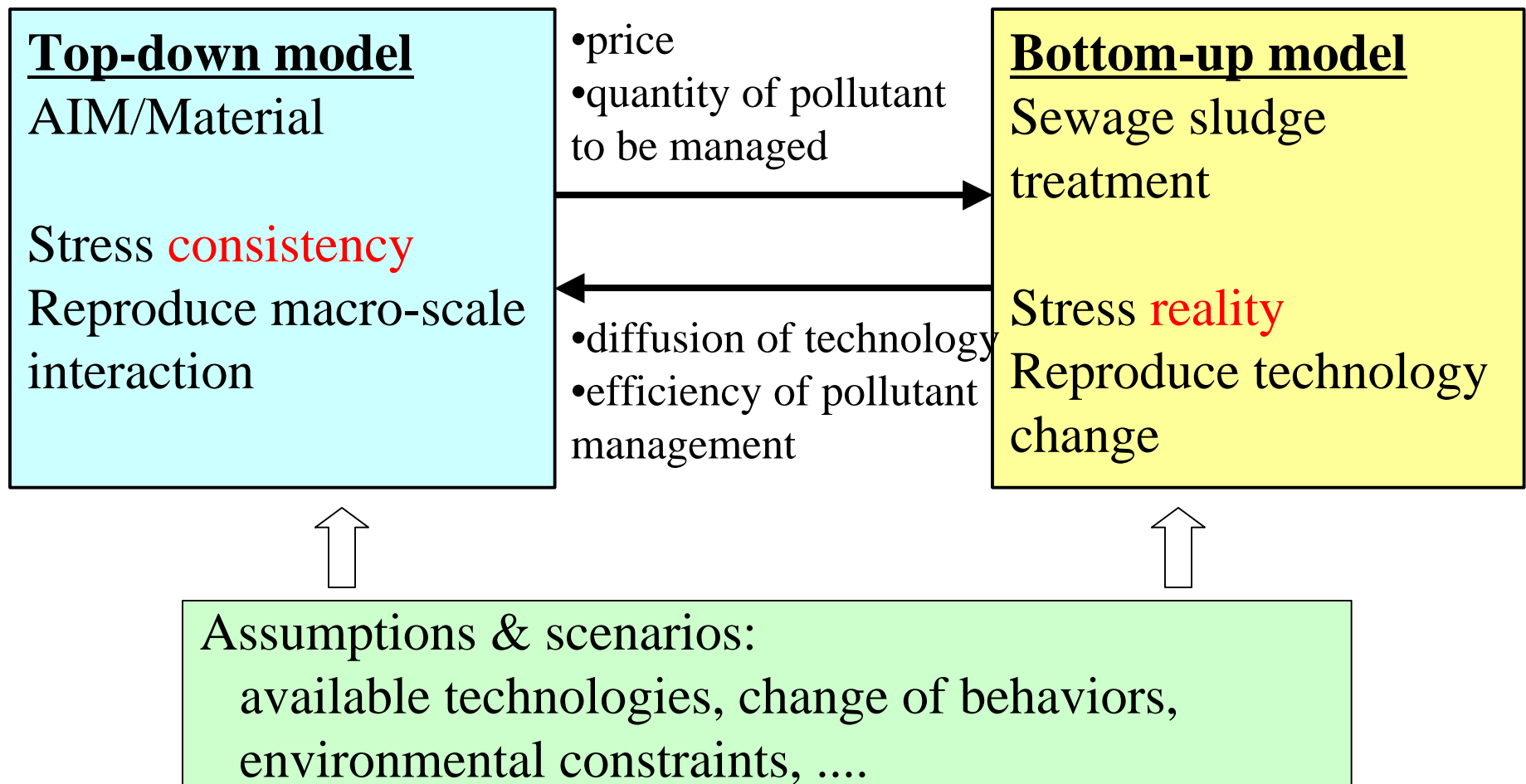
generation: 51.2 mi. ton    reuse: 5.5 mi. ton  
residual landfill year: 8.8 years



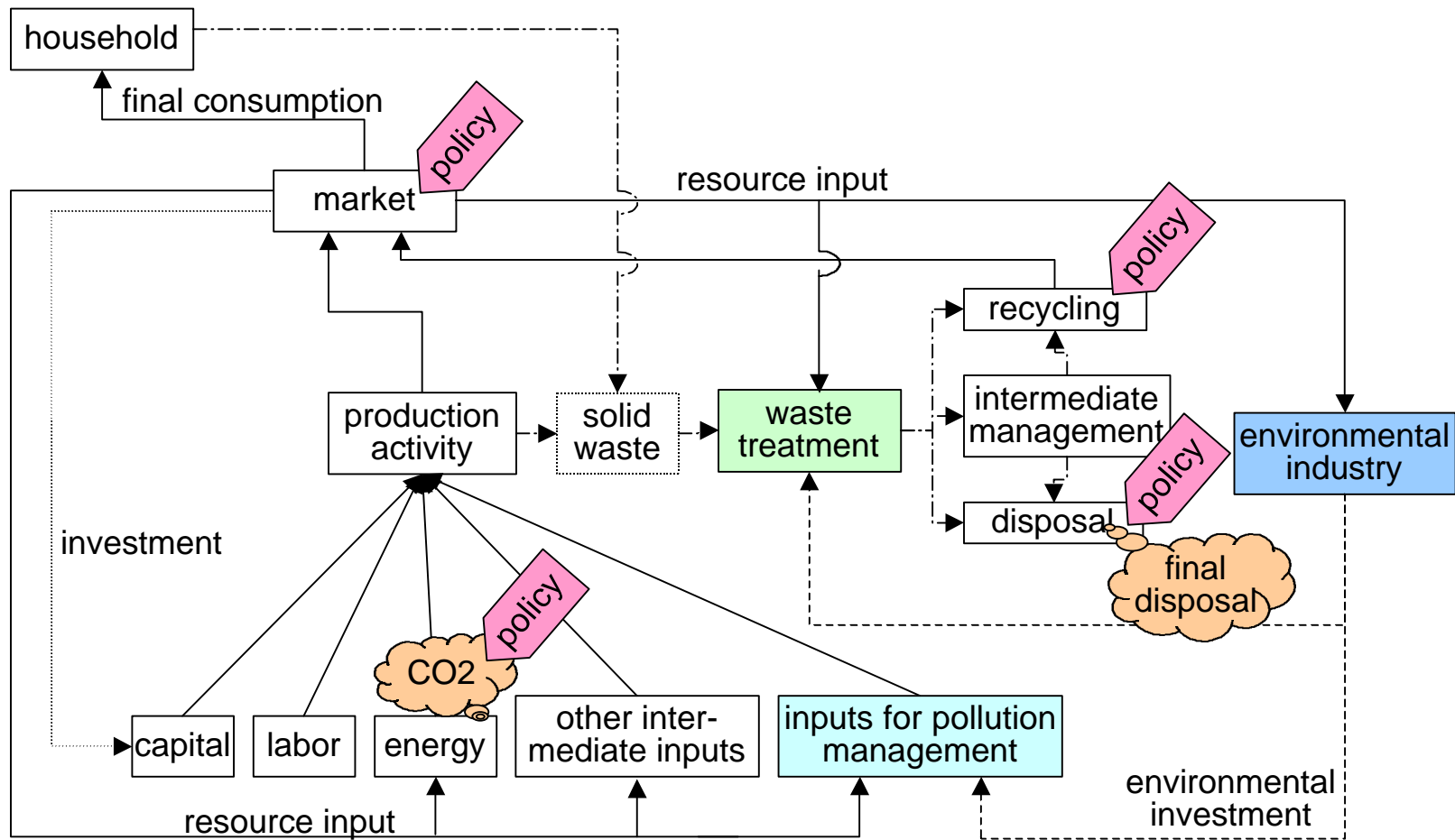
# Overview of AIM/Material

- Computable General Equilibrium Model
- Recursive Dynamics (1995-2010; time step –1year)
- Internalized Pollutant Generation and Treatment
  - Pollutant is regarded as “**bads**”
- Recyclable solid wastes
- Consistent material balance – 0 or infinite elasticity of substitution
- Environmental Constraints:
  - CO<sub>2</sub> Emissions –Kyoto Target (6% reduction from 1990 to 2010)
  - Final Disposal of Solid Wastes –Government target (50% reduction from 1996 to 2010)
- 33 Sectors, 31 Commodities, and 18 Solid Wastes
- Connection with bottom-up model
  - min. Cost s.t. quantity of pollutant to be treated.

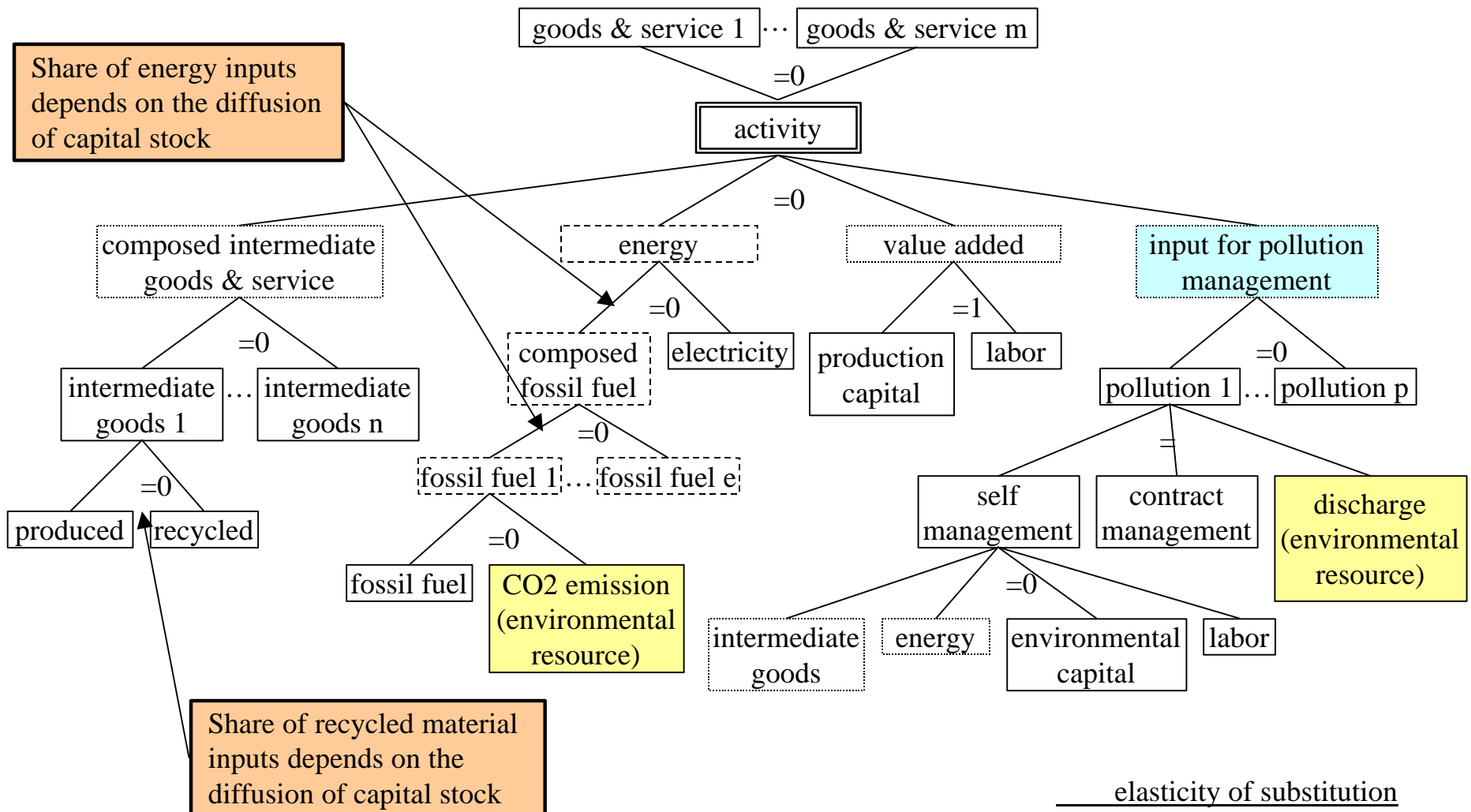
# AIM/Material & bottom-up model



# Overview of AIM/Material



# Production Structure of AIM/Material



# Economic Sectors & Commodities in AIM/Material

| ID  | contents   | ID    | contents  |
|-----|--|-------|---|
| AGR | agriculture, forestry and fisheries                                  | WTR   | collection, purification and distribution of water      |
| MIN | mining   | SAL   | wholesale and retail trade                              |
| FOD | manufacture of food  | FIN   | finance and insurance                                   |
| TEX | manufacture of textile mill products                                 | EST   | real estate   |
| PLP | manufacture of lumber, wood products, pulp, paper and paper products | TRS   | transportation and communications                       |
|     |  | SRV   | services  |
| CHM | manufacture of chemical and allied products                          | GOV   | government service                                      |
| NMM | manufacture of ceramic, stone, and clay products                     | NPS   | non-profit institution services                         |
|     |  | EMC   | manufacture of equipment for environmental preservation |
| BMT | manufacture of iron, steel, non-ferrous metals and products          | SEW   | sewage service  |
| FMT | manufacture of fabricated metal products                             | MWM   | municipal waste treatment service                       |
| MCH | manufacture of general machinery                                     | IWM   | industrial waste treatment service                      |
| ELM | manufacture of electrical machinery, equipment and supplies          | COL   | coal mining and manufacture of coal products            |
|     |  | OIL   | crude oil production and manufacture of petroleum       |
| TRE | manufacture of transportation equipment                              | GAS   | natural gas production and manufacture of gas           |
| PRI | manufacture of precision instruments and machinery                   | THE*  | thermal power generation                                |
|     |  | HYD*  | hydro power generation                                  |
| OTH | miscellaneous manufacturing industries                               | NUC*  | nuclear power generation                                |
| CNS | construction   | ELE** | electricity   |

\*: only sector, and \*\*: only commodity.

# Treated Solid Wastes in AIM/Material

| ID    | Contents                          |
|-------|-----------------------------------|
| ASH   | ash                               |
| SLD   | sludge                            |
| WOL   | slush, waste oil                  |
| WAC   | waste acid                        |
| WAL   | waste alkali                      |
| WPL * | waste plastics                    |
| WPP * | waste paper                       |
| WWD * | waste wood                        |
| WTX * | waste fiber and textile           |
| WAP * | animal and plants wastes          |
| WRB * | waste rubber                      |
| SCM * | metal trash, scrap metal          |
| WGC * | waste glass                       |
| SLG   | slag                              |
| WCT   | construction and demolition waste |
| DST   | dust, soot                        |
| EXC   | animal excrement                  |
| CRC   | animal carcass                    |

\*: category of municipal waste.

# Simulation Results 1

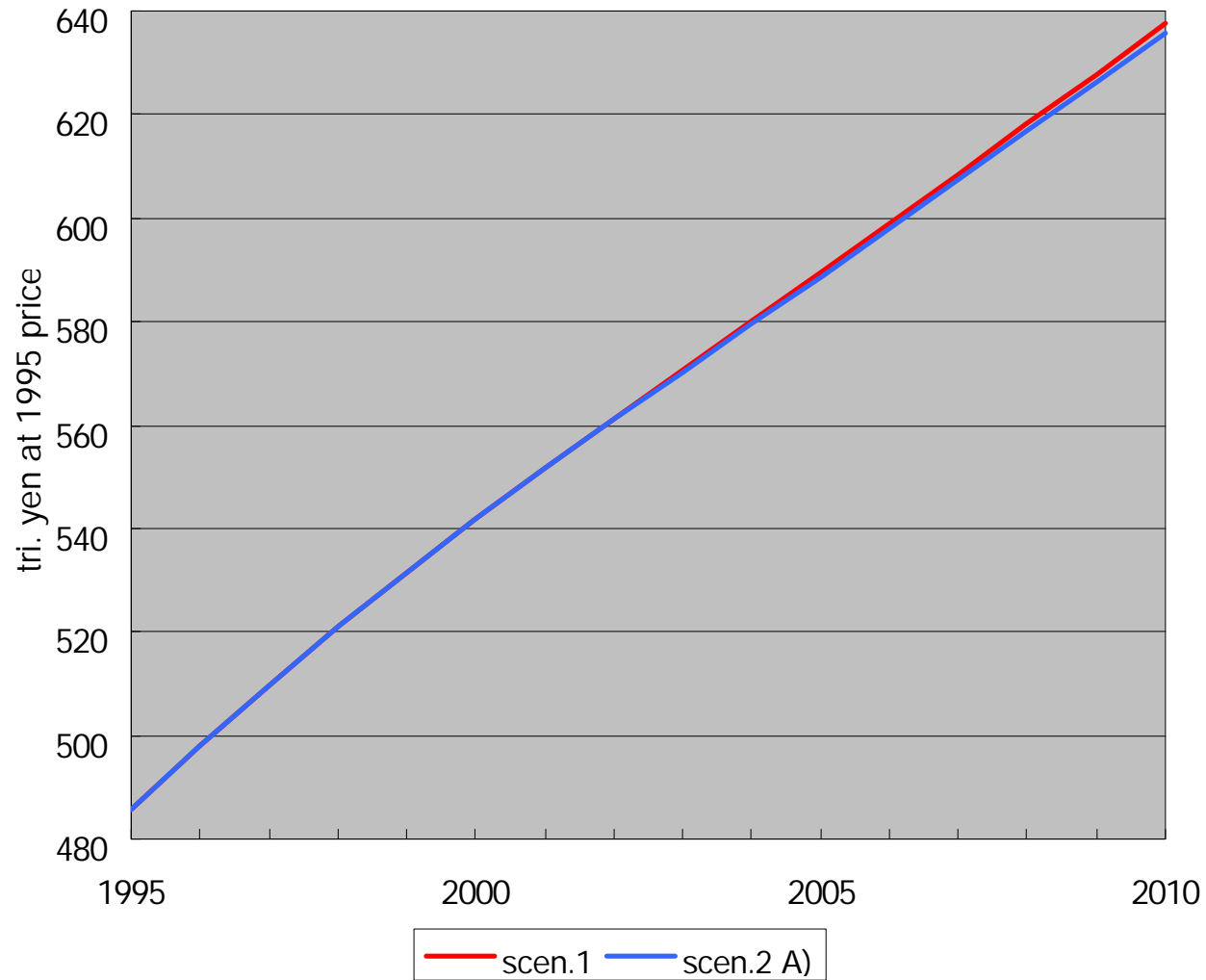
## -Scenarios-

1. Reference case
  - Including solid waste reduction based on the voluntary action plans
2. Environmental Constraints Case
  - A) Same technology as the reference case
  - B) Promotion of demand of recycled material in production sectors
  - C) Enhancement of demand of low emissions vehicle
  - D) B)+C)

1995-2000: parameters on efficiency improvement are defined based on the recent trend such as solid waste disposal.

# Simulation Results 2

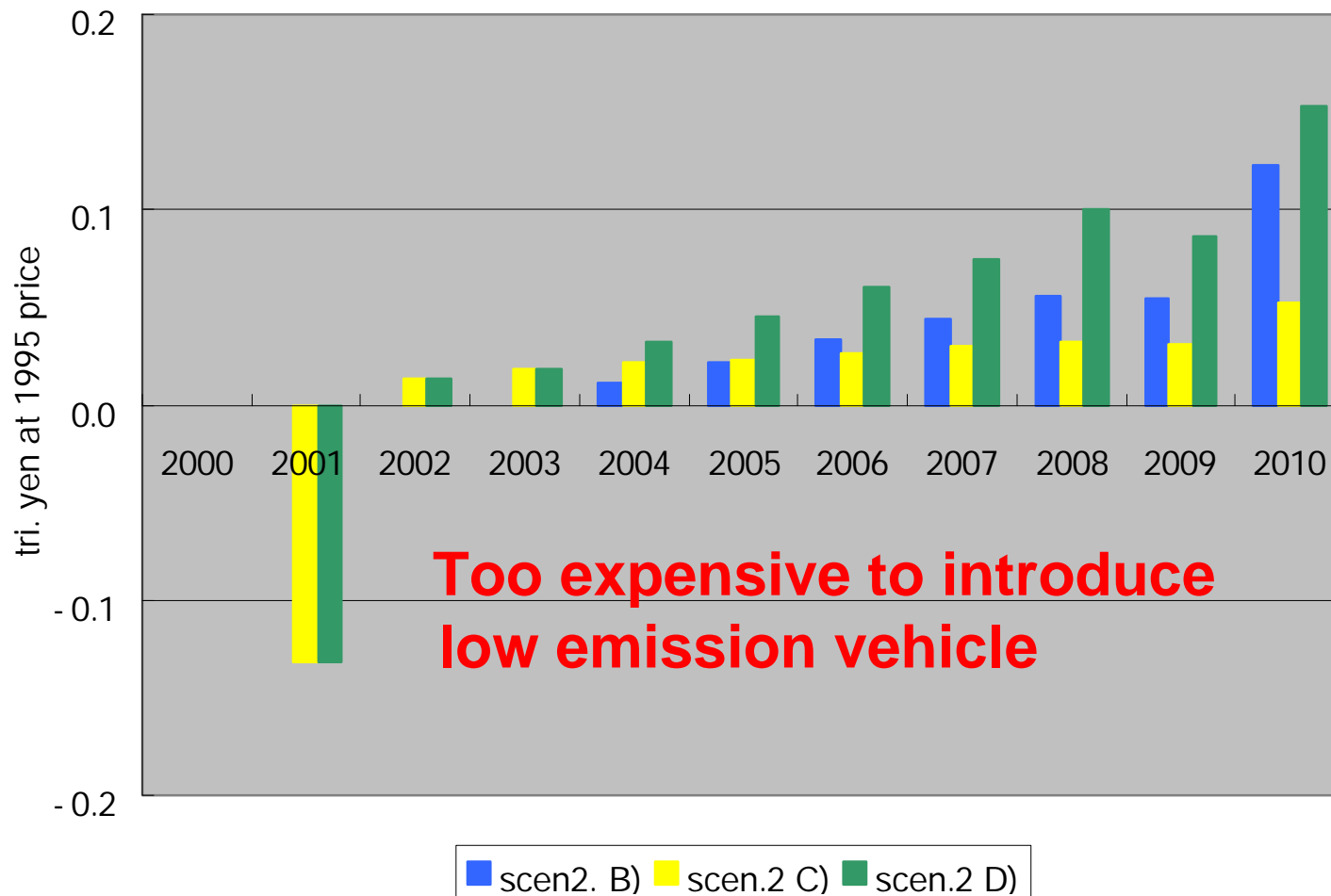
## -GDP-





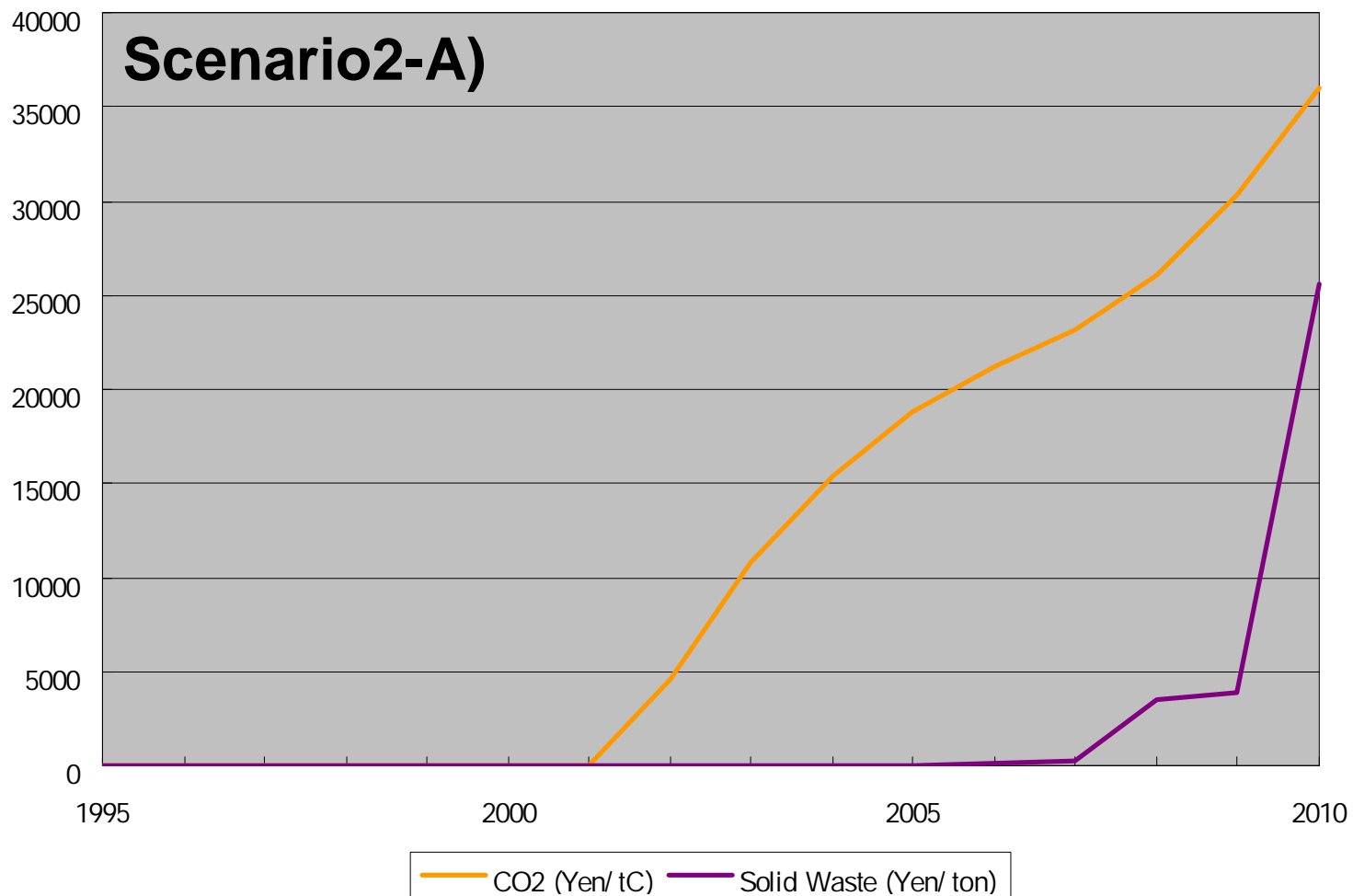
# Simulation Results 3

## -GDP Recovery by policy-



# Simulation Results 4

## -Marginal cost of environment-



# Simulation Results 5

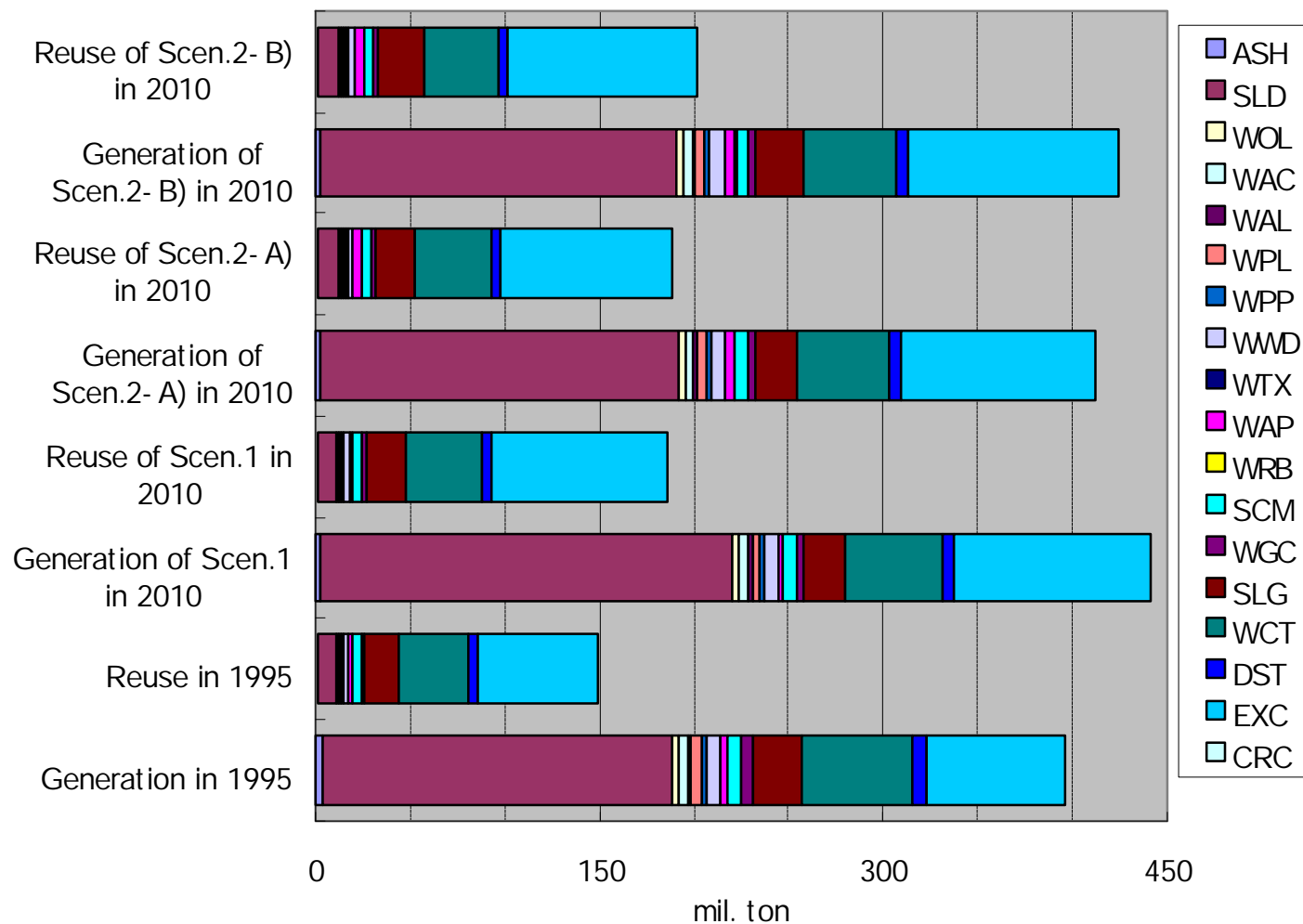
## -Change of environmental marginal cost-

| Scenario                | Scen.2-A) | Scen.2-B) | Scen.2-C)             | Scen.2-D) |
|-------------------------|-----------|-----------|-----------------------|-----------|
|                         |           | Recycling | Low emissions vehicle | B)+C)     |
| CO2<br>-yen/tC          | 36,000    | 34,500    | 29,300                | 27,700    |
| Solid waste<br>-yen/ton | 25,500    | 9,600     | 25,300                | 8,500     |

Year: 2010

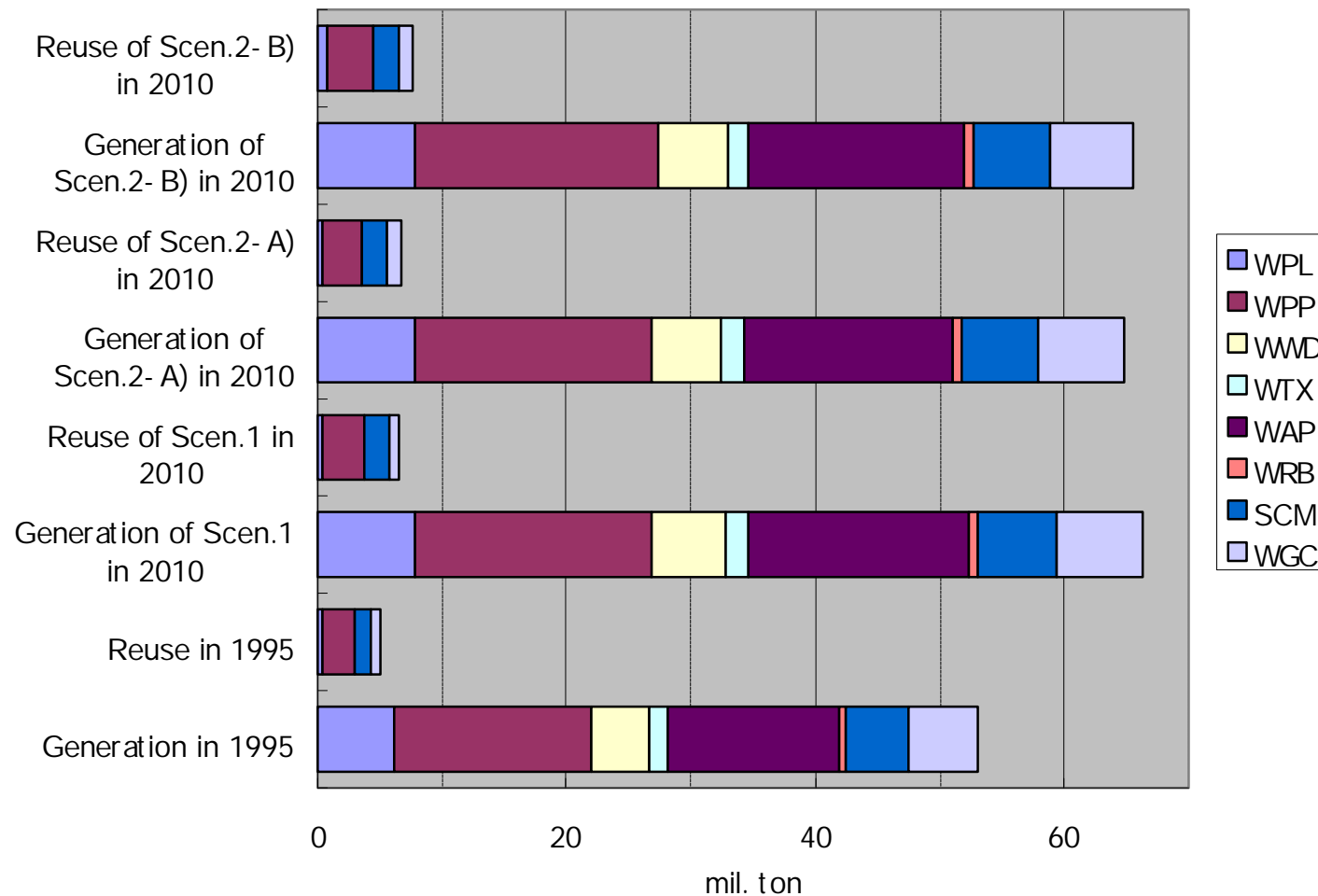
# Simulation Results 6

## -Industrial waste generation and recycle-



# Simulation Results 7

## -Municipal waste generation and recycle-



# Future Directions of AIM Activity

- Integrated Assessment for Comprehensive Environmental Policy
  - AIM/End-use, AIM/Local, AIM/Material
    - Climate change + Local air pollutant + Solid waste management + ...
- Support Environmental Policy in Asian-Pacific Countries
  - AIM/Trend
- Integration of AIM and GCM
  - AIM/Top-down, AIM/Impact