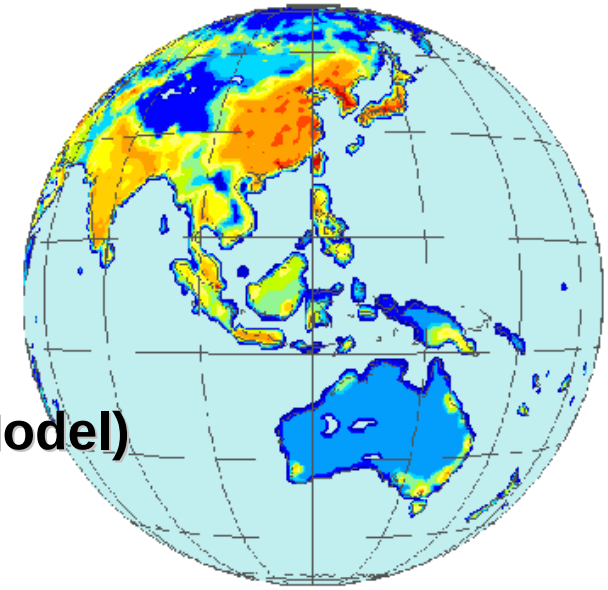
Carbon Tax, Carbon Reduction Potential, and Economic Impact in Japan

-Application of AIM (Asia-Pacific Integrated Model)



Contents:

- What's AIM?
- CO2 reduction in Japan
- Model analysis
- AIM/Enduse
- AIM/Top-down
- AIM/Material
- Conclusion

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6th Sino-U.S.-Korea Economic and Environmental Modeling Workshop

Beijing, China, 20-21 May, 2004

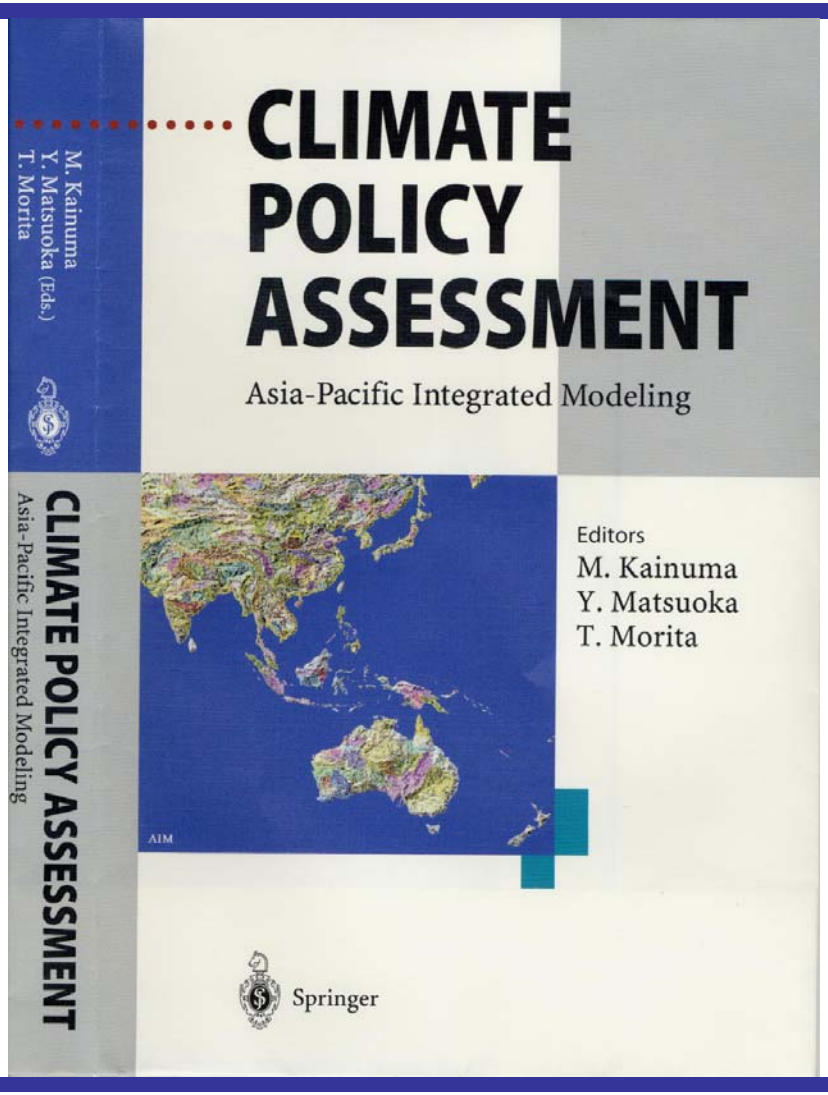
What's AIM (Asia-Pacific Integrated Model)?

AIM is one of integrated assessment models to assess policy options in Asia-Pacific region for reducing GHG emissions & avoiding climate change impacts

Published in 2002 ⇒

- **findings of research**
- **code & data of technology model**

http://www-iam.nies.go.jp/aim/datalibrary.htm



Members of AIM team

What's AIM?

CO2 reduction in Japan

Model analysis

AIM/Enduse

AIM/Top-down

AIM/Material

Conclusion

9th AIM International Workshop, NIES, March 2004

Outline of AIM

What's AIM?

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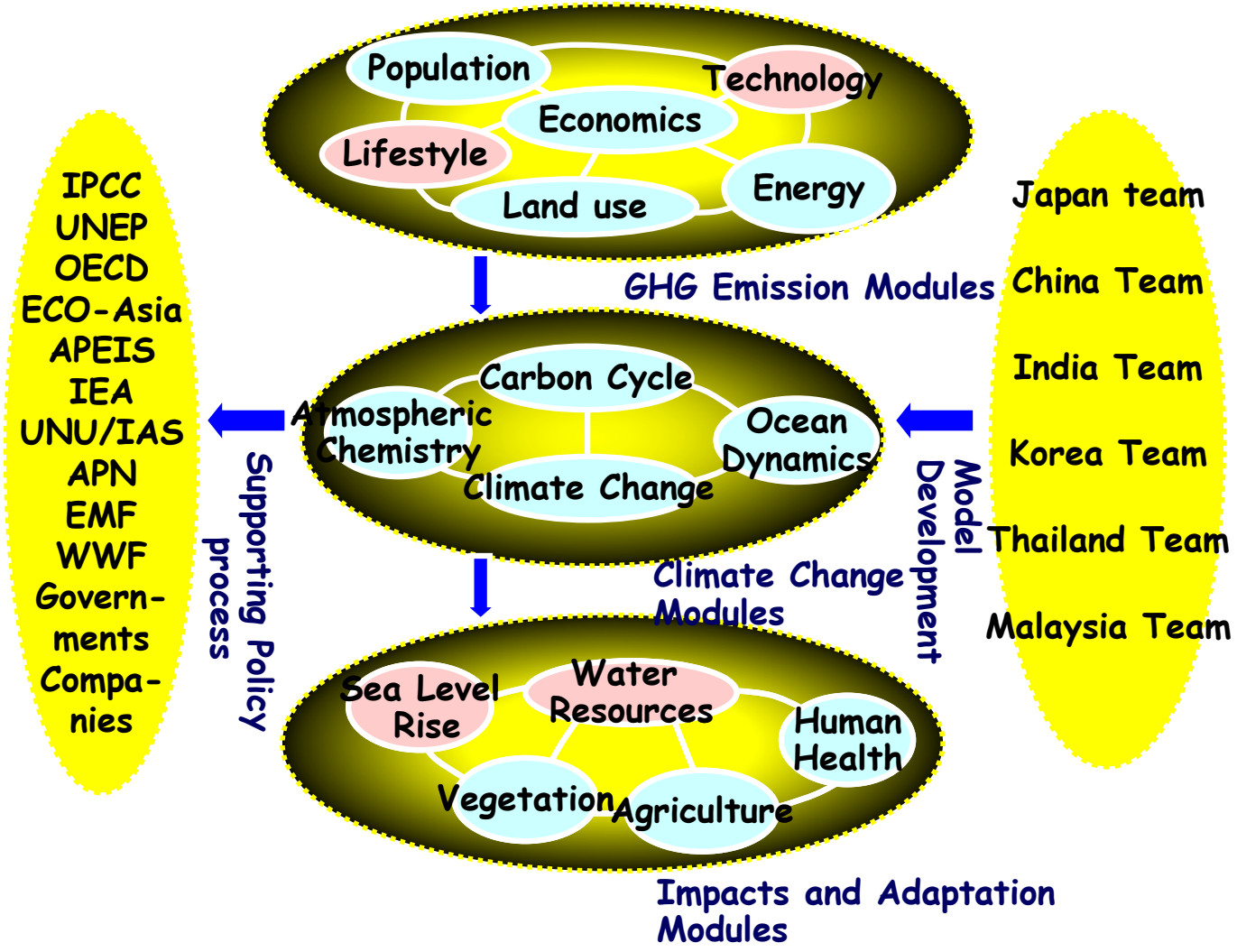


Outline of this presentation

- **CO2 reduction policy in Japan**
  - **Target of CO2 reduction**
  - **Model analysis on CO2 reduction policy**

    Reproducing both reality and consistency
    - **Potential reduction of CO2 emissions**
    - **CO2 reduction cost (carbon tax rate)**
    - **International competitiveness**
    - **Economic impact on whole country and specific sectors**

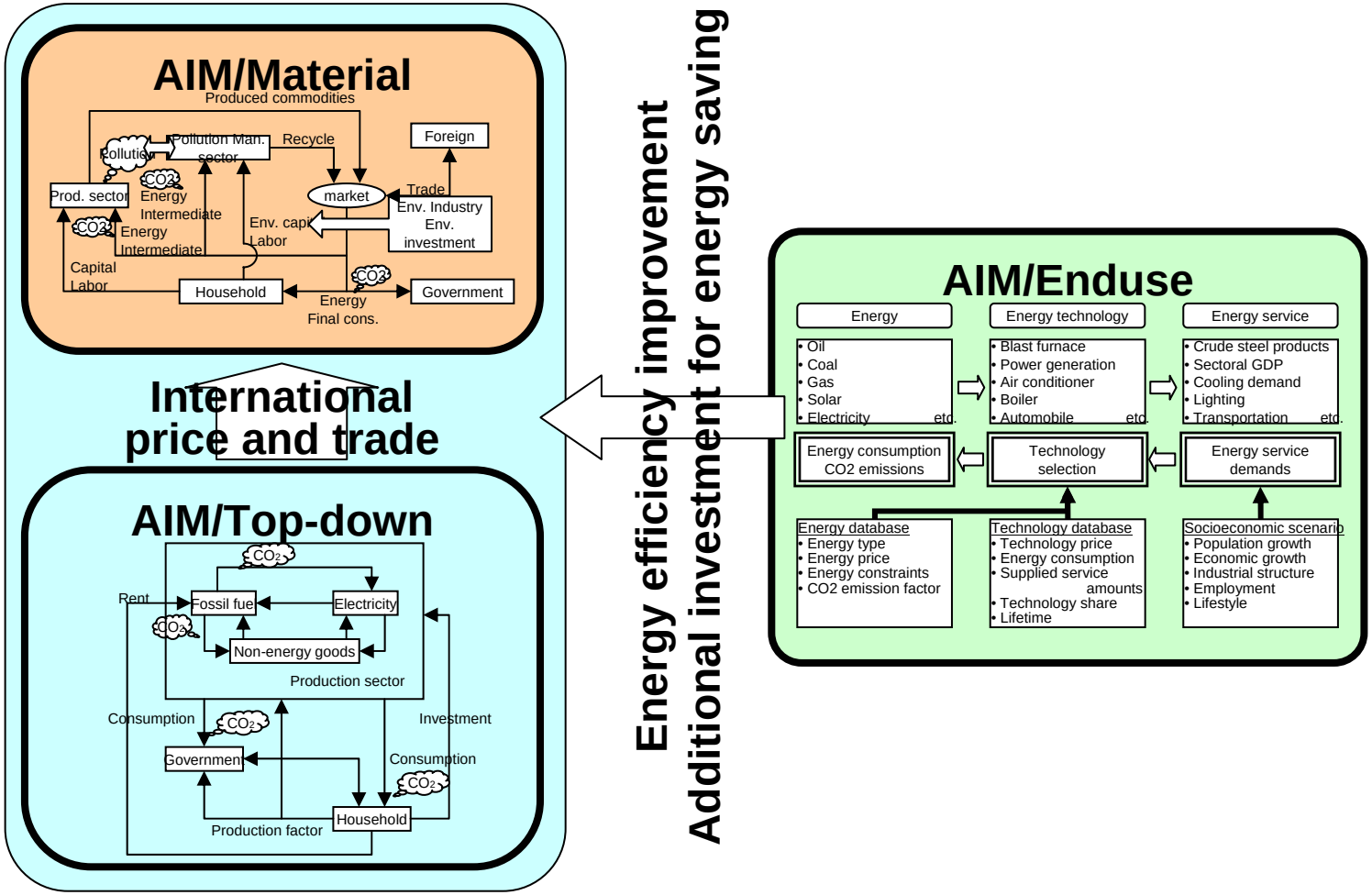
CO2 reduction policy in Japan

- **Carbon reduction target**
  - **Kyoto Protocol**
    - **In Japan, GHG emissions in the 1st commitment period (2008-2012) should be reduced by 6% of those in 1990.**
  - **New Climate Change Policy Programme (2002, Gov. of Japan)**
    - **CO2 emissions from energy use: ±0%**
    - **Reduction by innovative technologies and change of lifestyle: -2%**

Model analysis on CO2 reduction policy

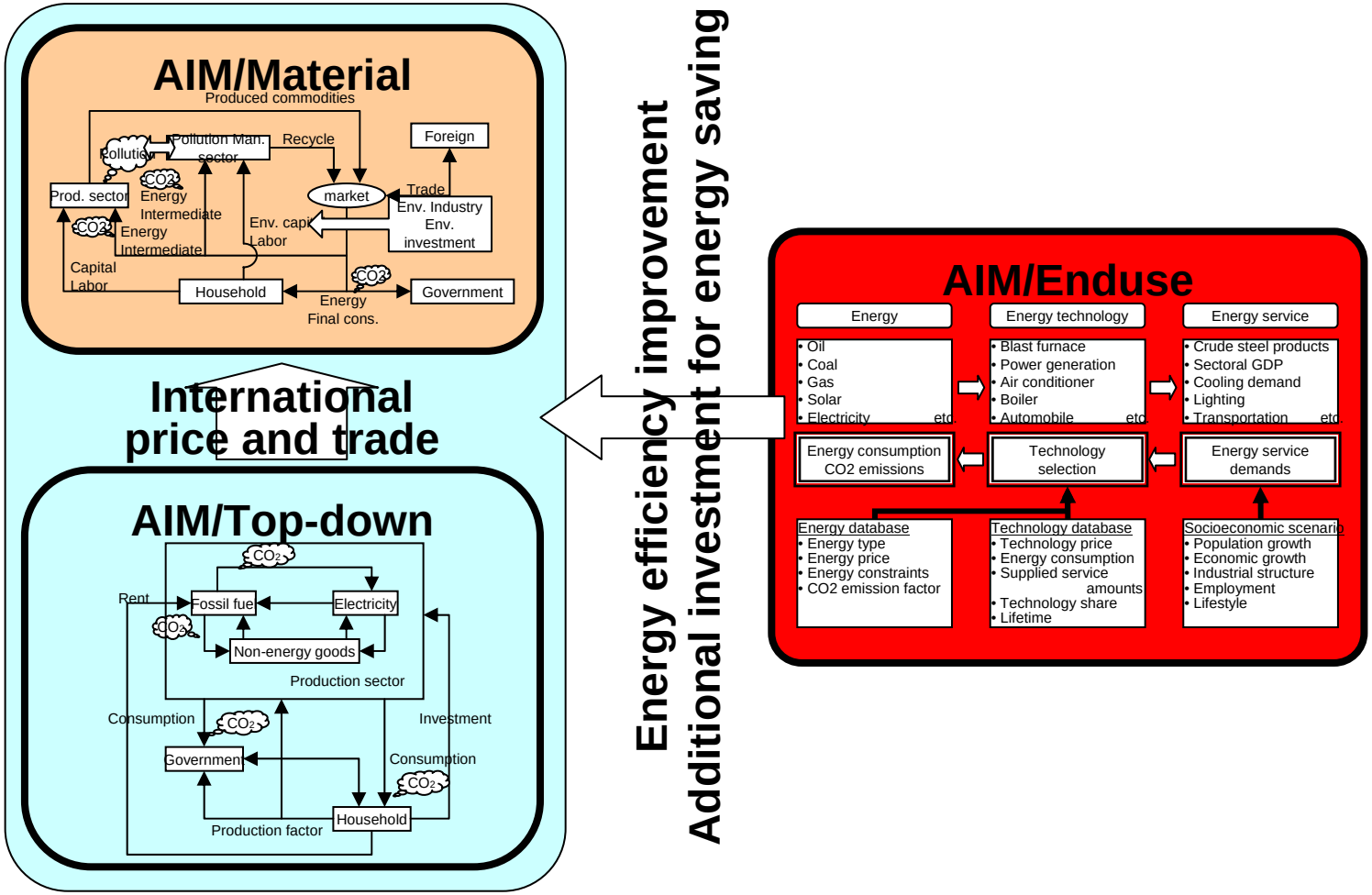
- **Model approaches**
  - **Bottom-up approach: represent reality**
  - **Top-down approach: represent consistency**
- **Mixture of these 2 approaches;**
  - **Bottom-up (technology)**
    - **AIM/Enduse model: Potential CO2 reduction and carbon tax & subsidy to technologies**
  - **Top-down (economic theory)**
    - **AIM/Top-down model: International competitiveness of energy intensive industries**
    - **AIM/Material model: Detailed economic impact in Japan**

Model analysis on CO2 reduction policy



Model analysis on CO2 reduction policy

-Bottom-up model approach-



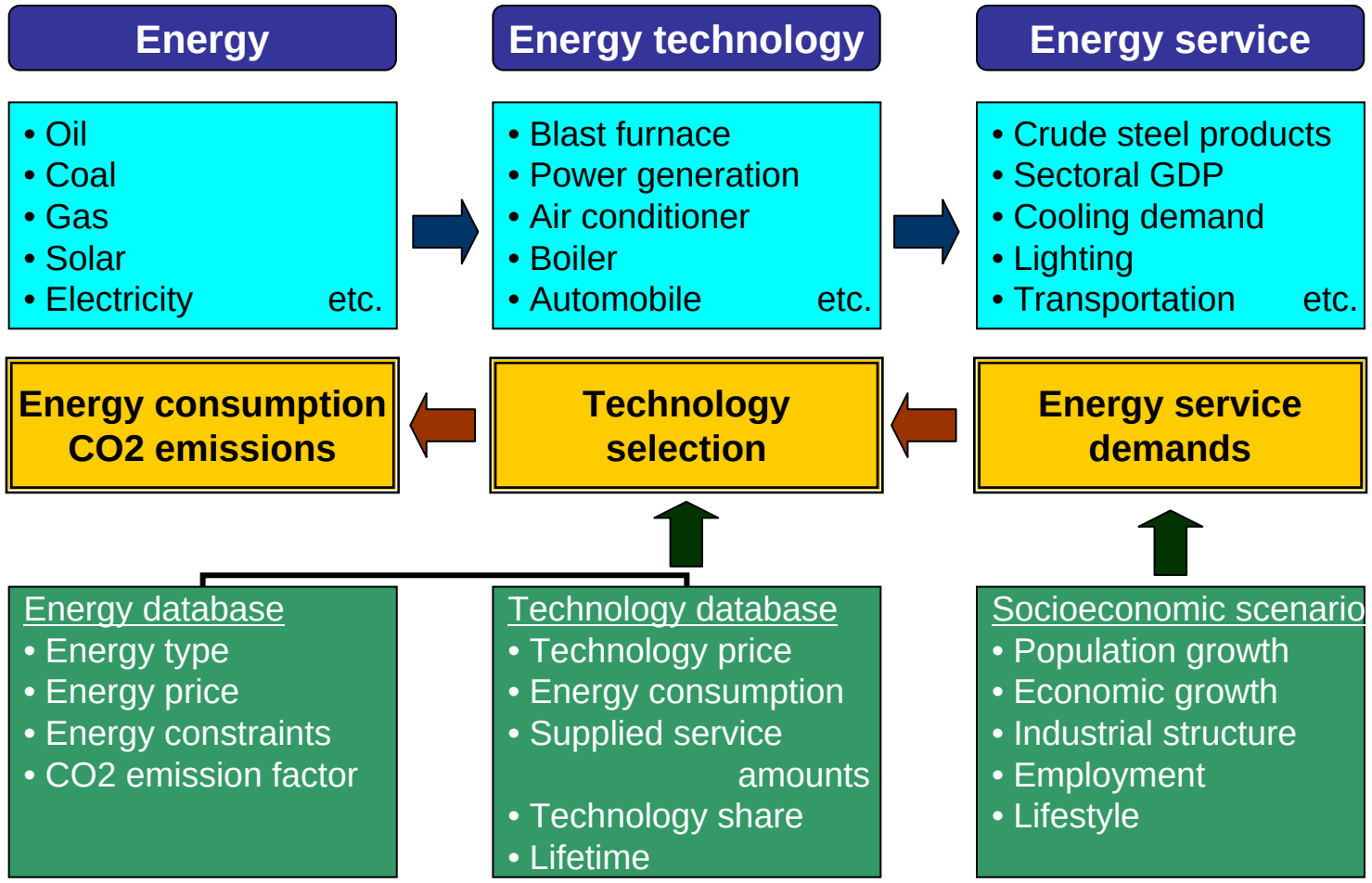
Model analysis on CO2 reduction policy

-Bottom-up model approach-

- **AIM/Enduse model**
  - Based on socioeconomic scenario, energy devices and energy types are selected to minimize total cost.
- **Messages from AIM/Enduse model**
  - CO2 reduction potential
  - Necessary carbon tax rate to achieve Kyoto Protocol
  - Effective policy mix to lower carbon tax rate

Model analysis on CO2 reduction policy

-Bottom-up model approach-



Structure of AIM/Enduse model

Model analysis on CO2 reduction policy

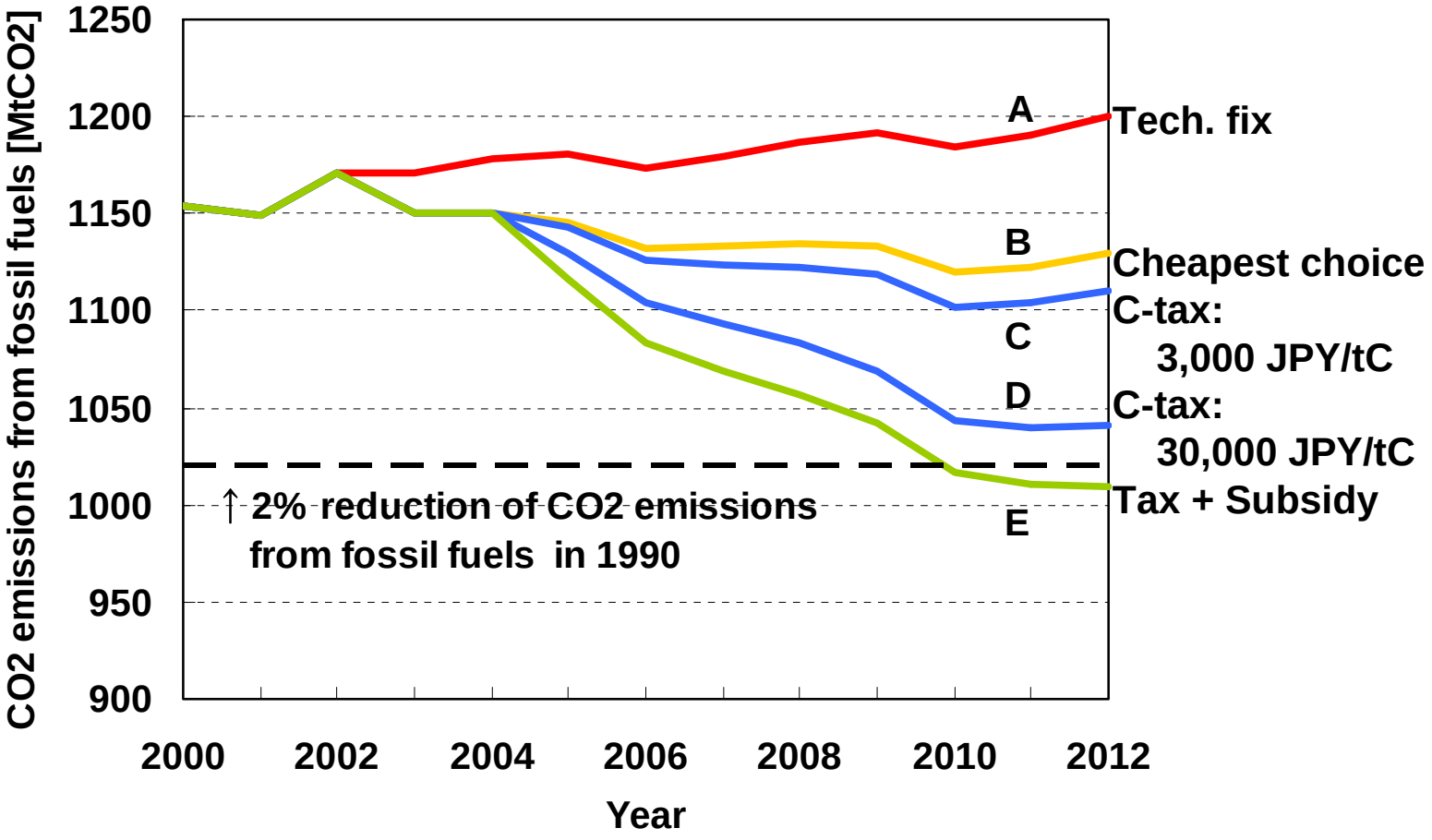
-Bottom-up model approach-

Examples of socioeconomic scenarios

			2000	2010	2012
Real GDP growth rate		%/year	0.9	1.9	1.9
Raw material production	Crude steel	mil. ton	106.9	95.9	94.8
	Cement	mil. ton	79.3	70.3	69.8
	Ethylene	mil. ton	7.6	6.7	6.7
	Paper & board	mil. ton	31.8	36.0	36.7
Number of households		mil.	46.8	49.1	49.2
Floor space in com. sector		mil. m^2	1,655	1,793	1,844
Passenger transportation		tri.*person*km	1.42	1.51	1.53
Freight transportation		tri.*ton*km	0.56	0.57	0.57
Nuclear power generation (new construction after 2002)		Plants	—	8	8

Model analysis on CO2 reduction policy

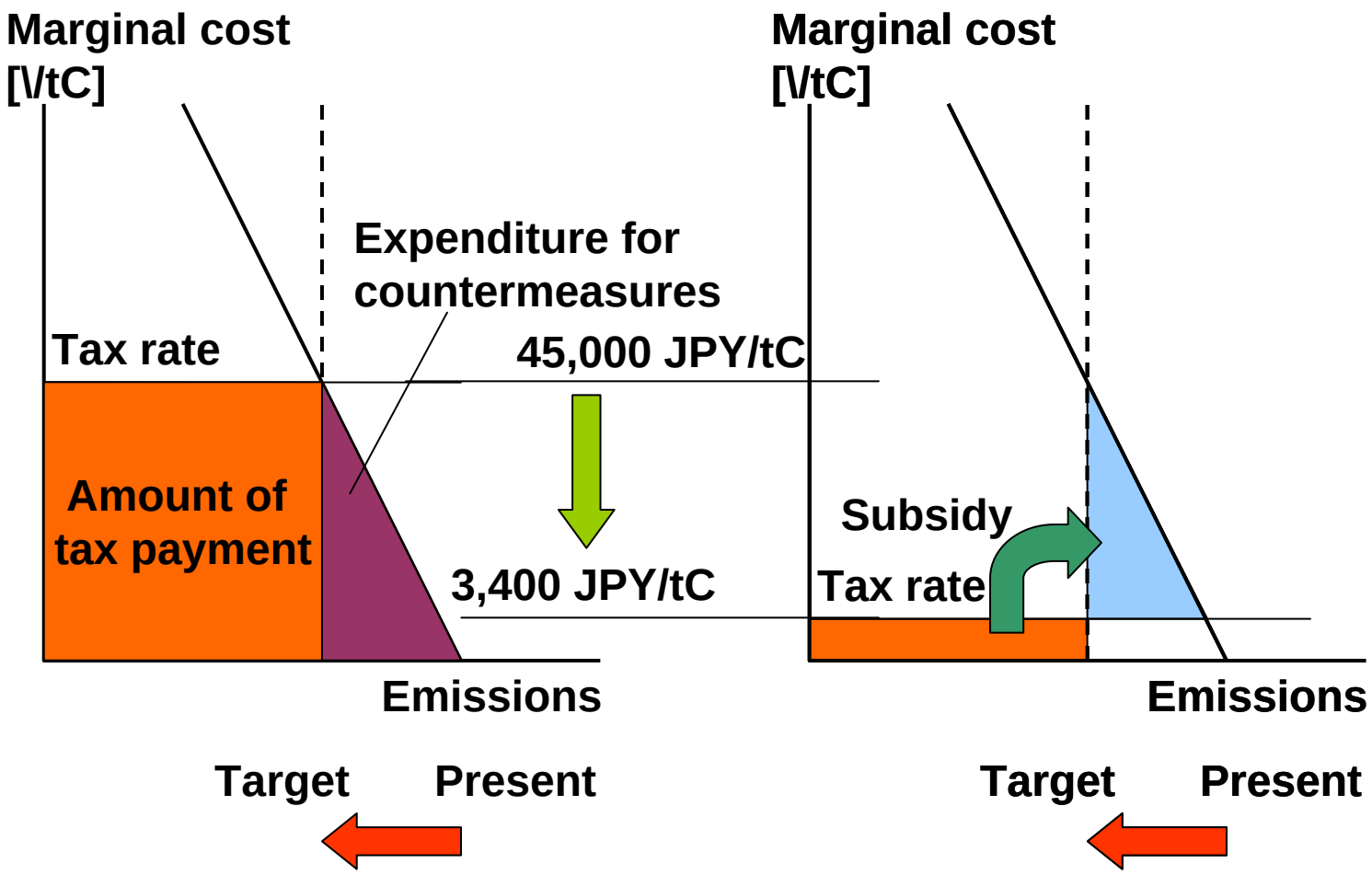
-Bottom-up model approach-



CO2 emissions trajectories by scenarios

Model analysis on CO2 reduction policy

-Bottom-up model approach-



Model analysis on CO2 reduction policy

-Bottom-up model approach-

Carbon tax rate and required additional investments for reducing CO2 emissions in Japan

sector	Subsidized measures and devices	Add. investment
Industrial sector	Boiler conversion control, High performance motor, High performance industrial furnace, Waste plastic injection blast furnace, LDF with closed LDG recovery, High efficiency continuous annealing, Diffuser bleaching device, High efficiency clinker cooler, Biomass power generation	101.3
Residential sector	High efficiency air conditioner, High efficiency gas stove, Solar water heater, High efficiency gas cooking device, High efficiency television, High efficiency VTR, Latent heat recovery type water heater, High efficiency illuminator, High efficiency refrigerator, Standby electricity saving, Insulation	353.9
Commercial sector	High efficiency electric refrigerator, High efficiency air conditioner, High efficiency gas absorption heat pump, High efficiency gas boiler, Latent heat recovery type boiler, Solar water heater, High efficiency gas cooking device, High frequency inverter lighting with timer, High efficiency vending machine, Amorphous transformer, Standby electricity saving, Heat pump, Insulation	194.5

bil. JPY / year

Model analysis on CO2 reduction policy

-Bottom-up model approach-

Carbon tax rate and required additional investments for reducing CO2 emissions in Japan (continued)

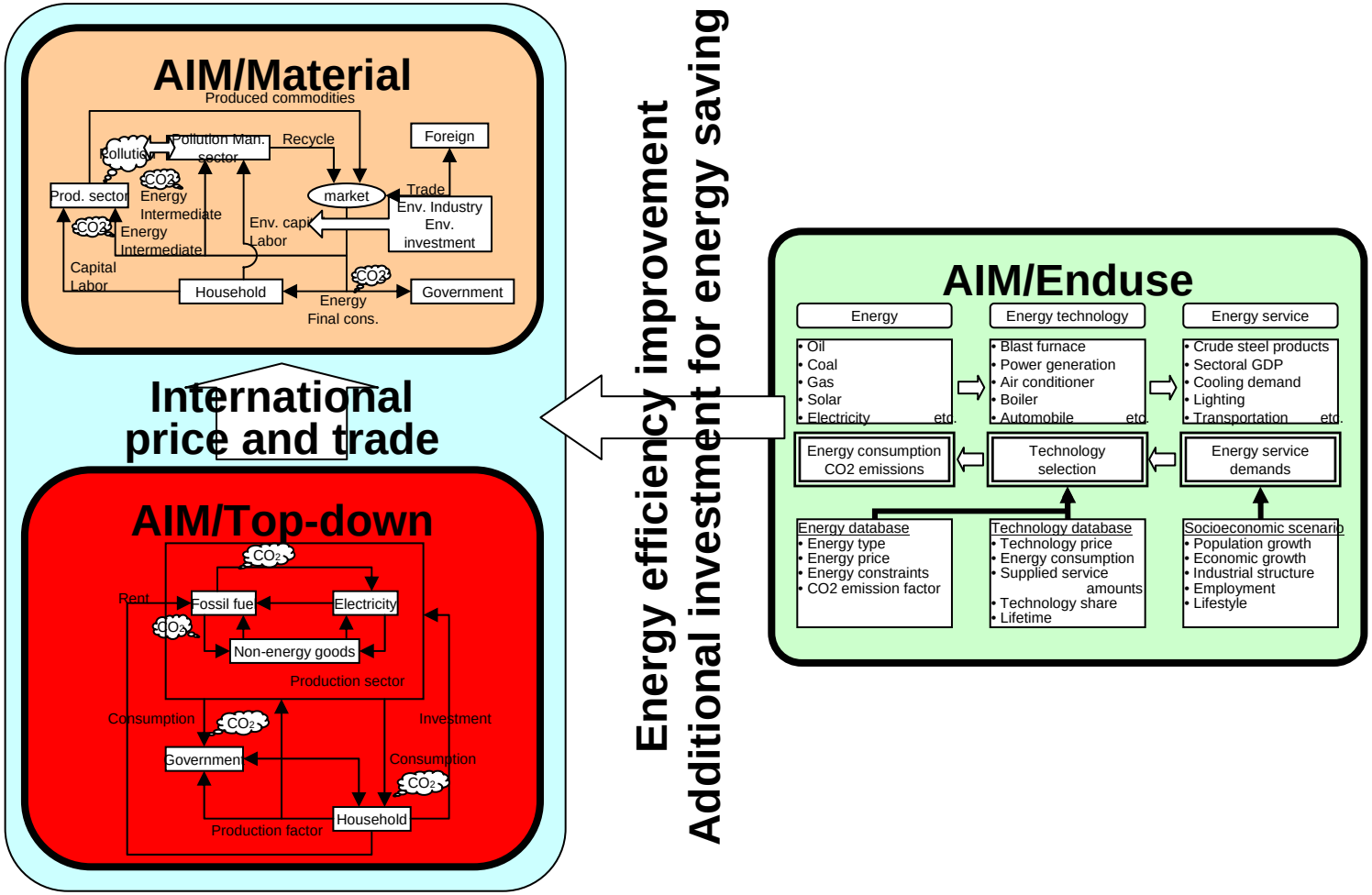
sector	Subsidized measures and devices	Add. investment
Transportation sector	High efficiency gasoline private car, High efficiency diesel car, Hybrid commercial car, High efficiency diesel bus, High efficiency small-sized truck, High efficiency standard-sized track	106.6
Forest management	Plantation, Weeding, Tree thinning, Multilayered thinning, Improvement of natural forest	195.7
Total		952.0

bil. JPY / year

Tax rate to appropriate required subsidiary payments (JPY/tC)	3,433

Model analysis on CO2 reduction policy

-Global top-down model approach-



Model analysis on CO2 reduction policy
-Global top-down model approach-

- **AIM/Top-down model**

  Global general equilibrium model with multi regions and multi sectors

- **Messages from AIM/Top-down model**
  - **International competitiveness**
  - **Effectiveness of emission trading**
  - **Impact of US climate policy**

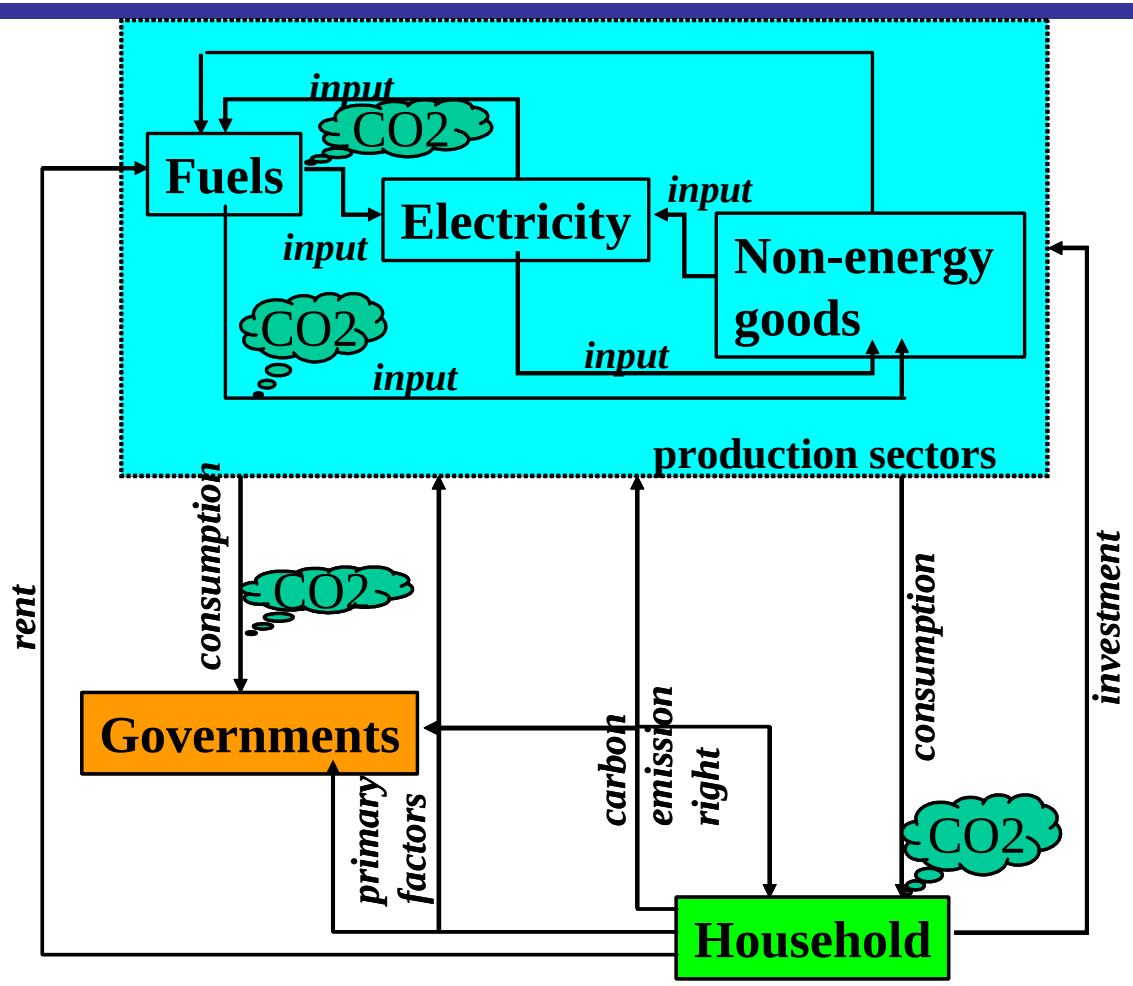
    keep original policy or ratify Kyoto Protocol

Model analysis on CO2 reduction policy
-Global top-down model approach-

- **Overview of AIM/Top-down model**
  - Data from GTAP (ver.3) and energy balance table (IEA)
  - Computable general equilibrium model with recursive dynamics
  - CO2 emissions from fossil fuels
  - Time period: 1992-2010
  - Region: 21
  - Sector: 8

Model analysis on CO2 reduction policy

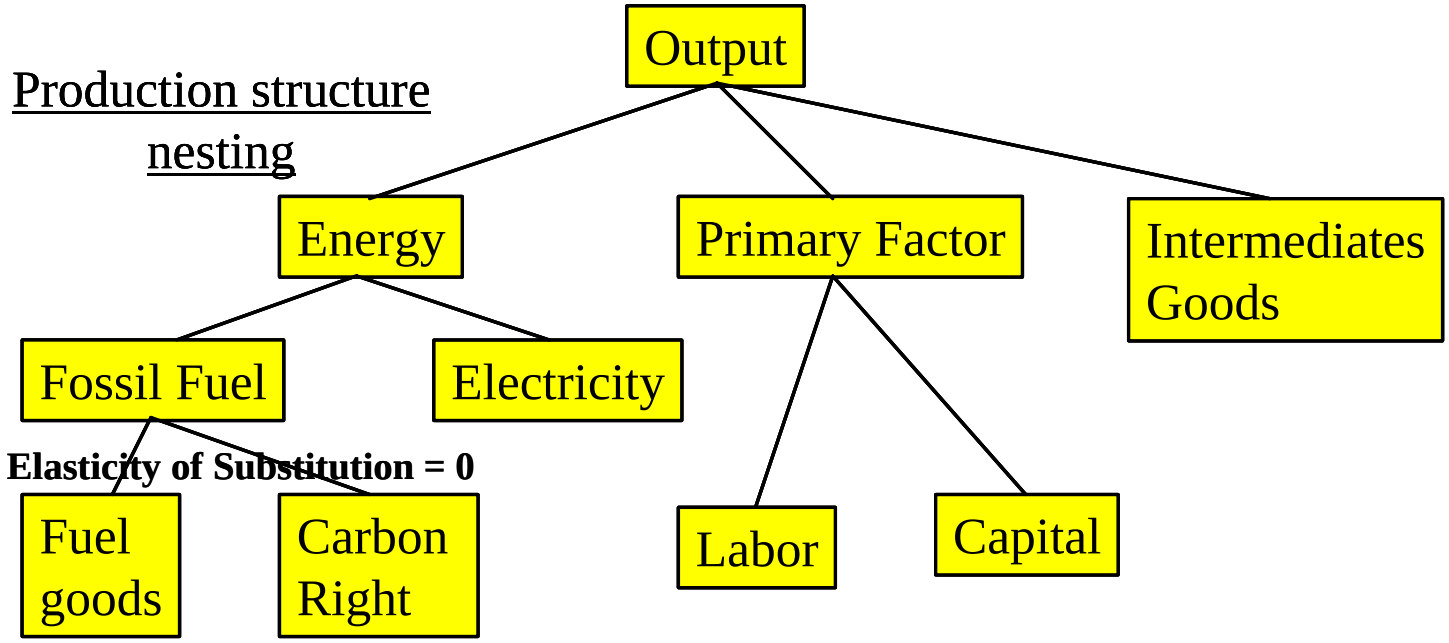
-Global top-down model approach-



Model structure

Model analysis on CO2 reduction policy

-Global top-down model approach-



Production structure

Model analysis on CO2 reduction policy

-Global top-down model approach-

Classification of sector

Y	Agricultures, other manufactures and services
COL	Coal
CRU	Crude CRU
GAS	Natural gas
EGW	Electricity
OIL	Petroleum and coal products (refined)
EIS	Energy intensive products
TRN	Transport industries
CGD	Savings good

Model analysis on CO2 reduction policy

-Global top-down model approach-

Definition of region

JPN	Japan	CHN	China
AUS	Australia	IDI	India
NZL	New Zealand	IDN	Indonesia
USA	United States of America	MYS	Malaysia
CAN	Canada	PHL	Philippines
EUR	Western Europe	THA	Thailand
TWN	Taiwan	LAM	Latin America
KOR	Republic of Korea	MEA	Middle East and North Africa
HKG	Hong Kong	SSA	Sub Saharan Africa
SGP	Singapore	ROW	Rest of World
EEU+ CIS	Eastern Europe + Commonwealth of Independent States		

Model analysis on CO2 reduction policy

-Global top-down model approach-

Scenarios for analysis

	Climate policy in US and Australia	Emission trade	
		Japan	Others
BaU	No CO2 reduction		
Scenarios reducing CO2 emissions			
Scenario 1	Keep original policy	No trade	
Scenario 2	Keep original policy	1.6% of emissions in 1990	Half of reduction
Scenario 3	Ratify Kyoto in 2008	1.6% of emissions in 1990	Half of reduction
Scenario 4	Keep original policy	Half of reduction	

Model analysis on CO2 reduction policy

-Global top-down model approach-

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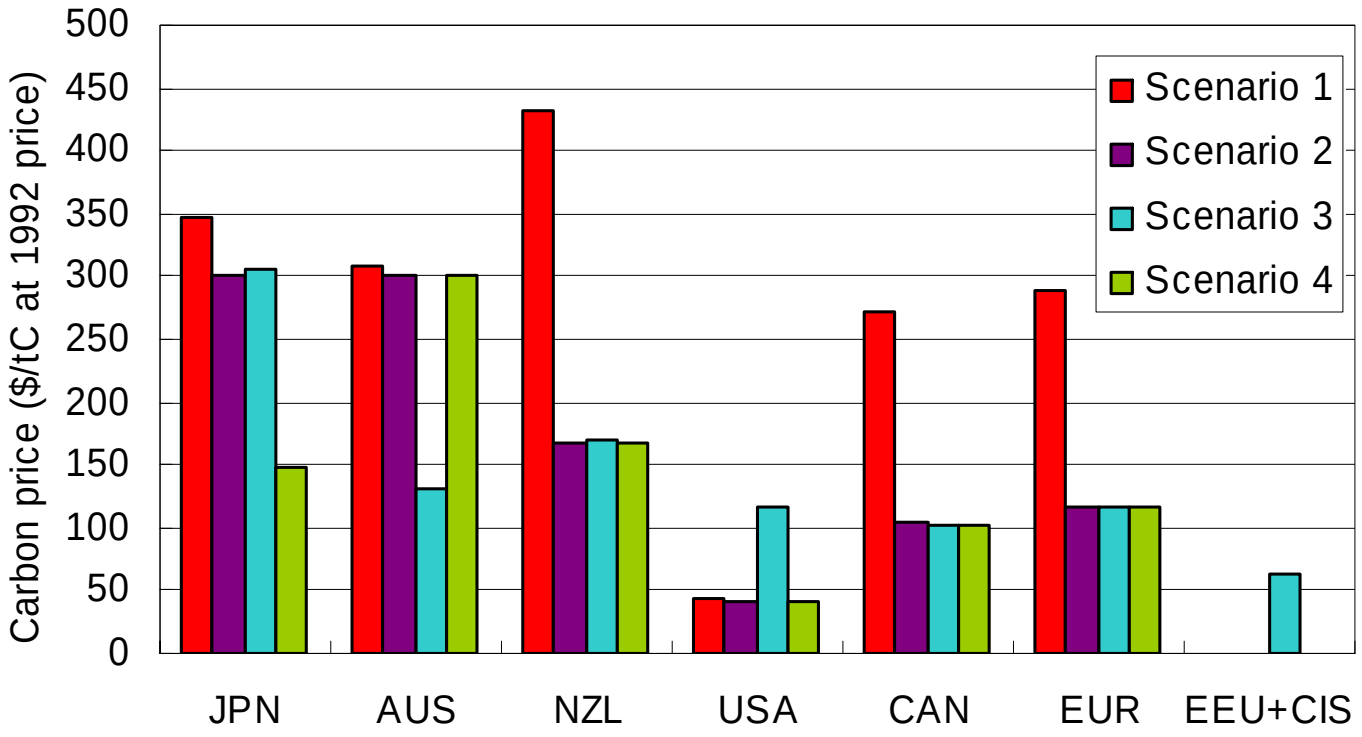
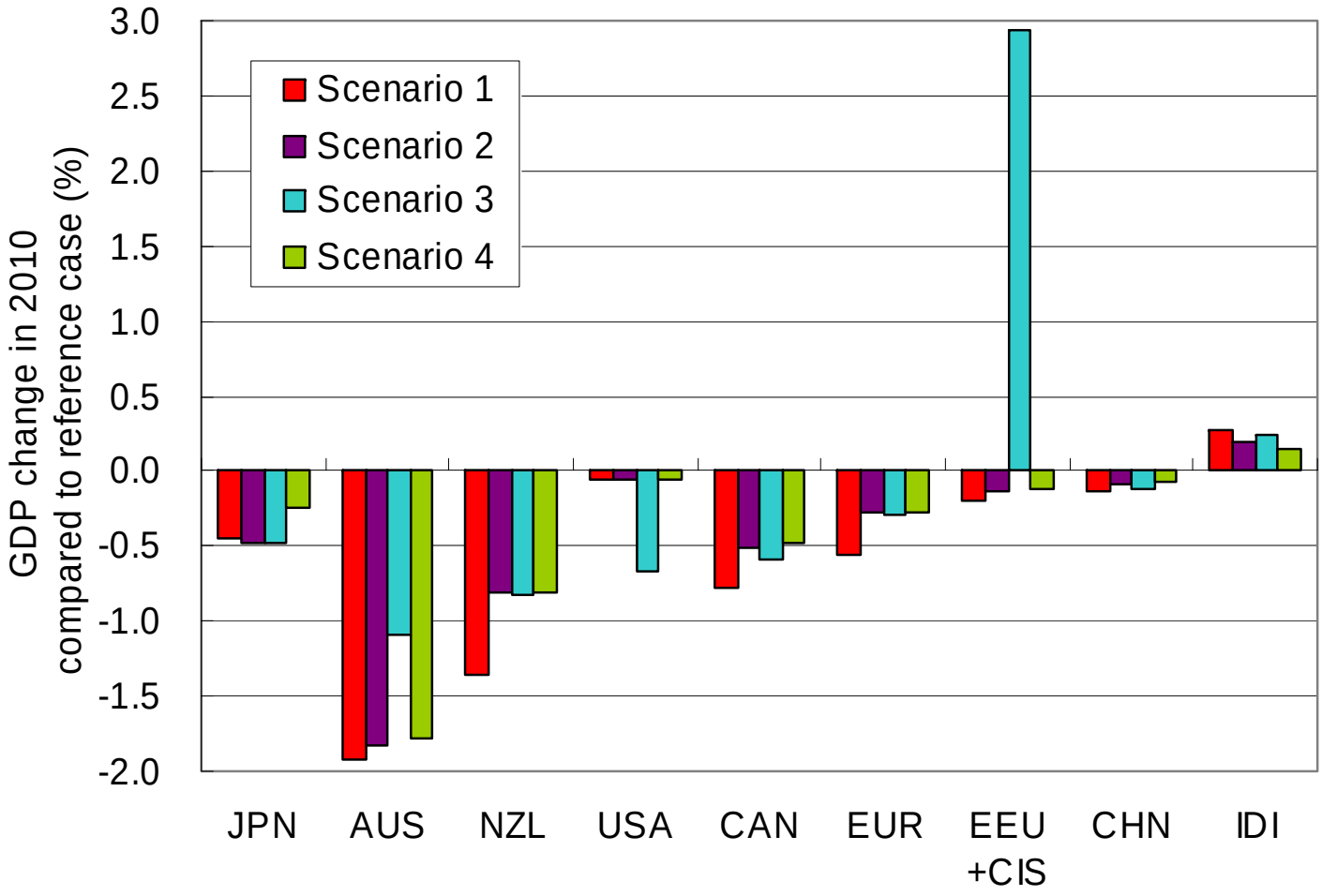


Price of carbon tax in 2010

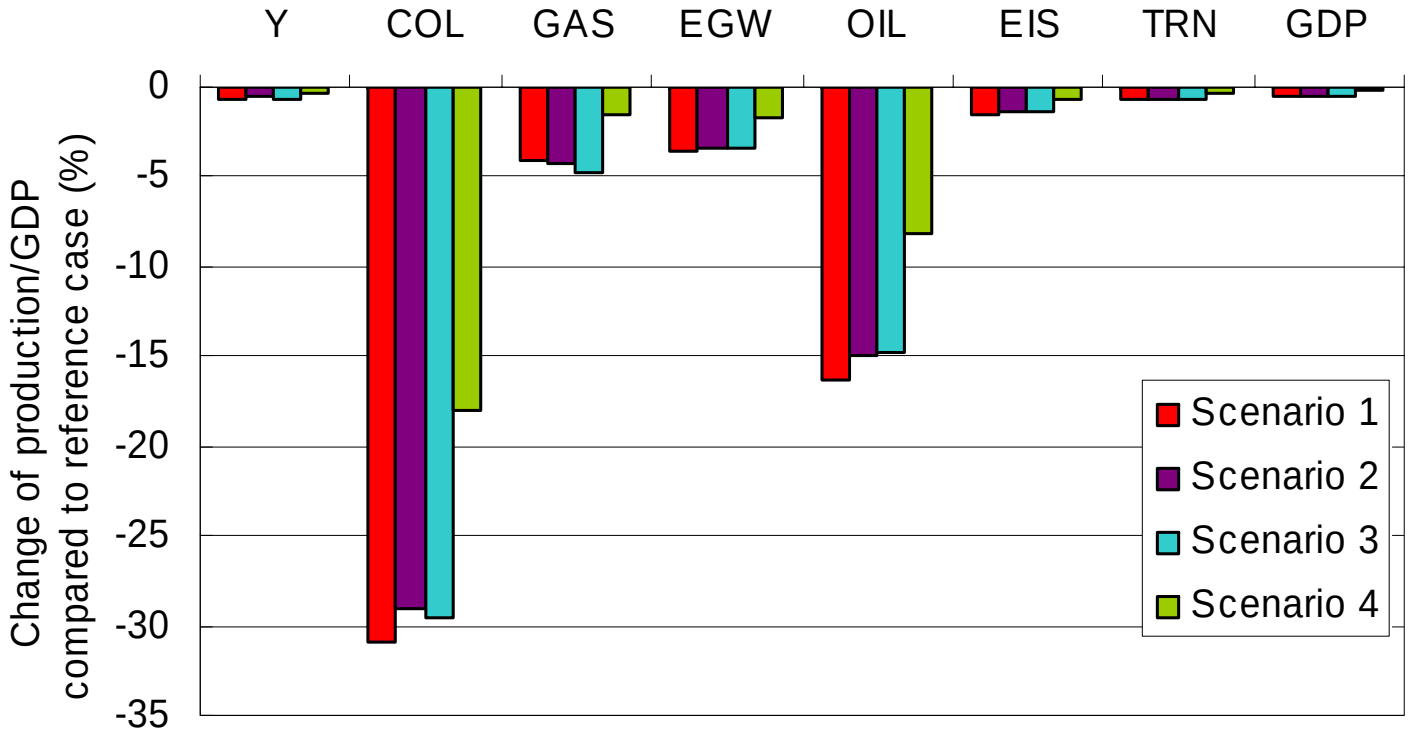
Model analysis on CO2 reduction policy

-Global top-down model approach-



GDP change in 2010 compared to BaU

Model analysis on CO2 reduction policy
-Global top-down model approach-



Change of production in each sector and GDP in Japan (2010)

Model analysis on CO2 reduction policy

-Global top-down model approach-

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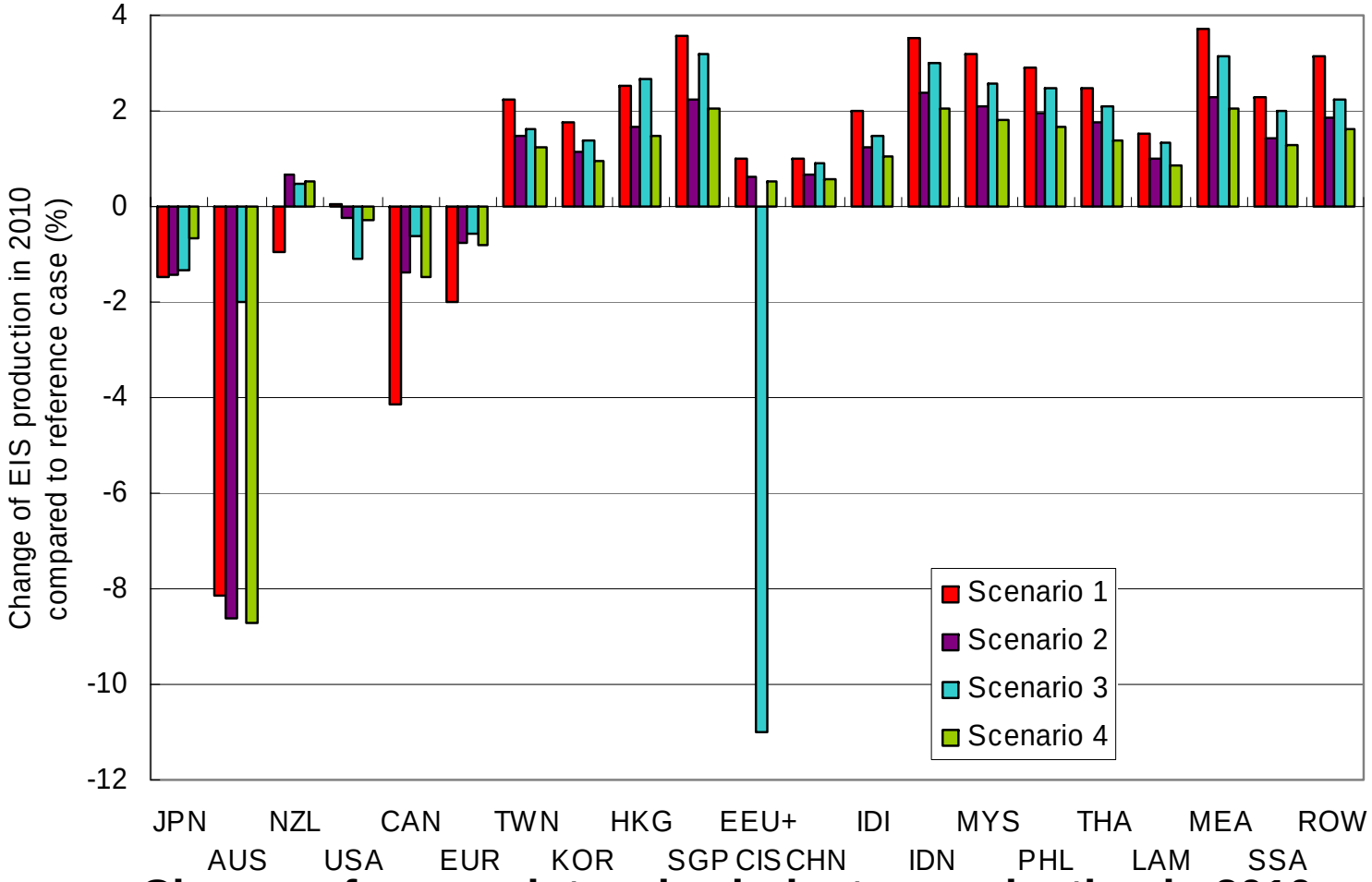
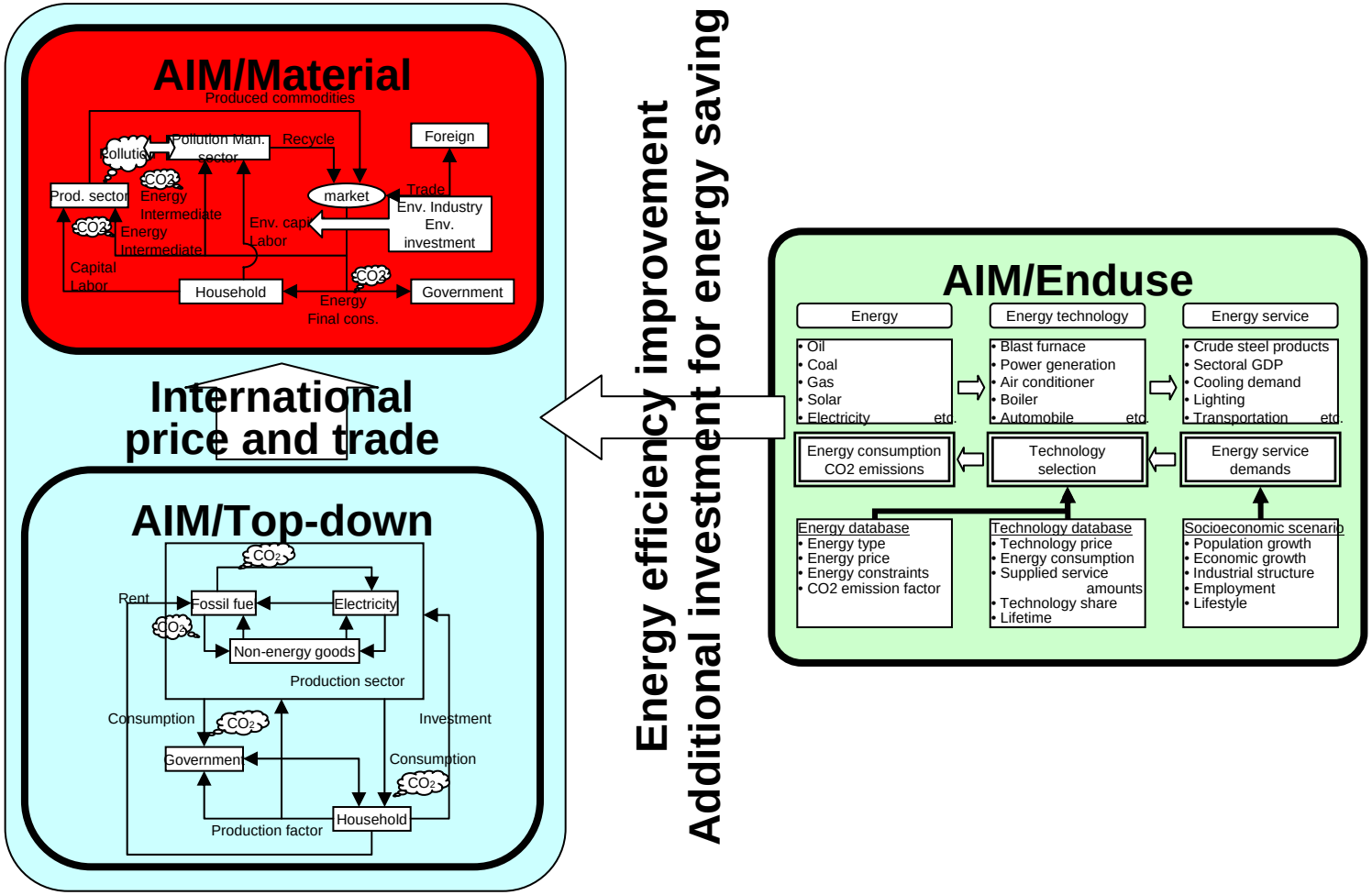


Change of energy intensive industry production in 2010 compared to BaU

Model analysis on CO2 reduction policy

-Country top-down model approach-



Model analysis on CO2 reduction policy

-Country top-down model approach-

- **AIM/Material model**
  - **Based on technology and international trade assumption, economic impacts by carbon reduction in Japan can be simulated.**

- **Messages from AIM/Material model**
  - **Impact on economy in Japan**
    - **Production, employment, ...**
  - **Economic impact on specific sectors**

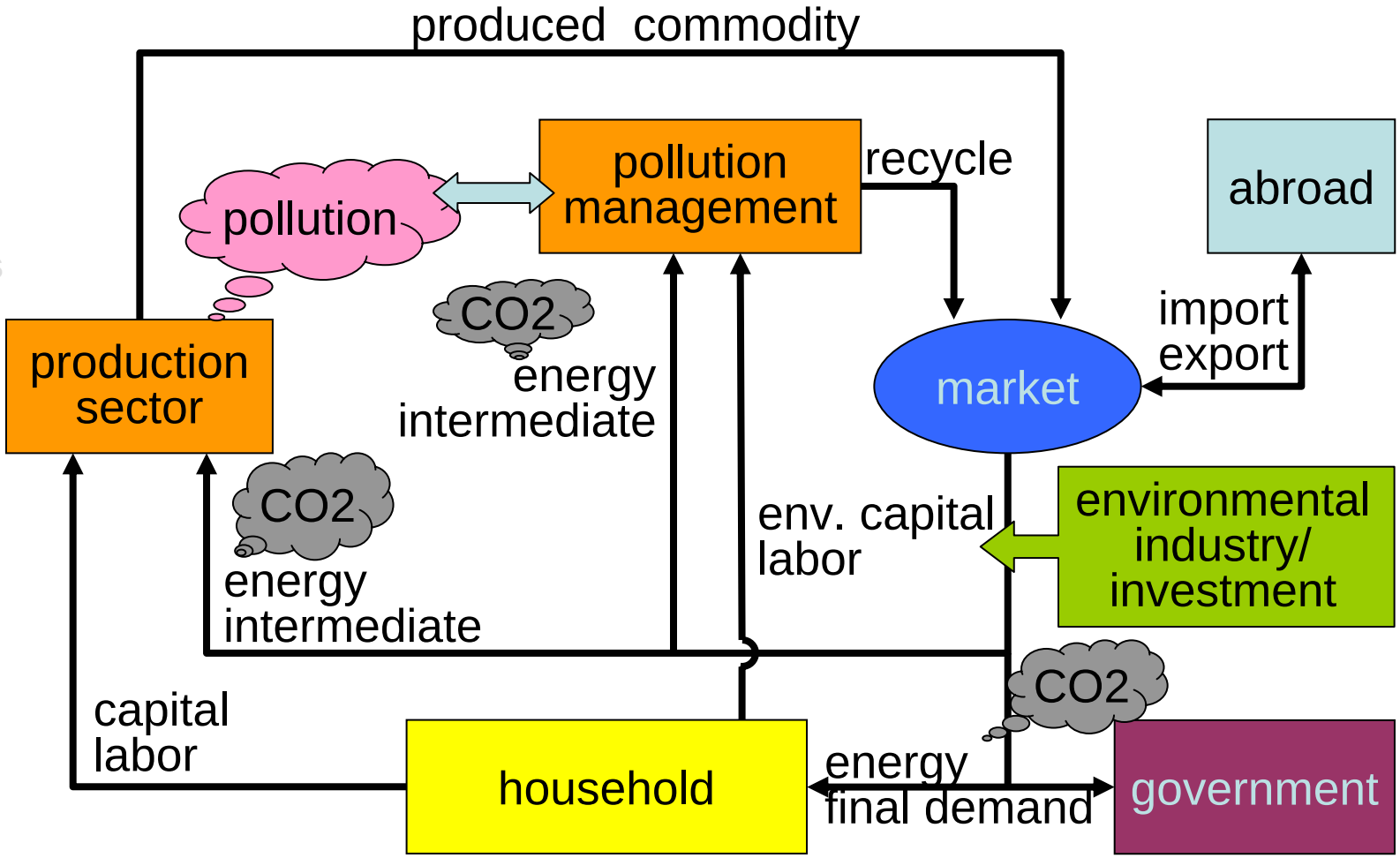
Model analysis on CO2 reduction policy

-Country top-down model approach-

- **Features of AIM/Material model**
  - **Model: Computable general equilibrium model**
  - **Country: Japan**
  - **Time period: 1995 to 2012 (recursive dynamic)**
  - **Activity: 41 sectors and 49 commodities**
  - **Solid waste: 18 waste types of industrial waste and 8 types of municipal waste.**
    - **In this analysis, the constraint on solid waste is not taken into account.**
  - **Other features**
    - **Both economic balance and material balance are kept.**
    - **Energy efficiency improvement is given from solution of AIM/End-use model**
  - **Scenarios:**
    - **Reference Case: Without CO2 constraints.**
    - **Tax case: CO2 reduction by only introducing carbon tax.**
    - **Tax + subsidy case: CO2 reduction by introducing carbon tax with subsidy for energy saving equipment.**

Model analysis on CO2 reduction policy

-Country top-down model approach-



Structure of AIM/Material

Model analysis on CO2 reduction policy

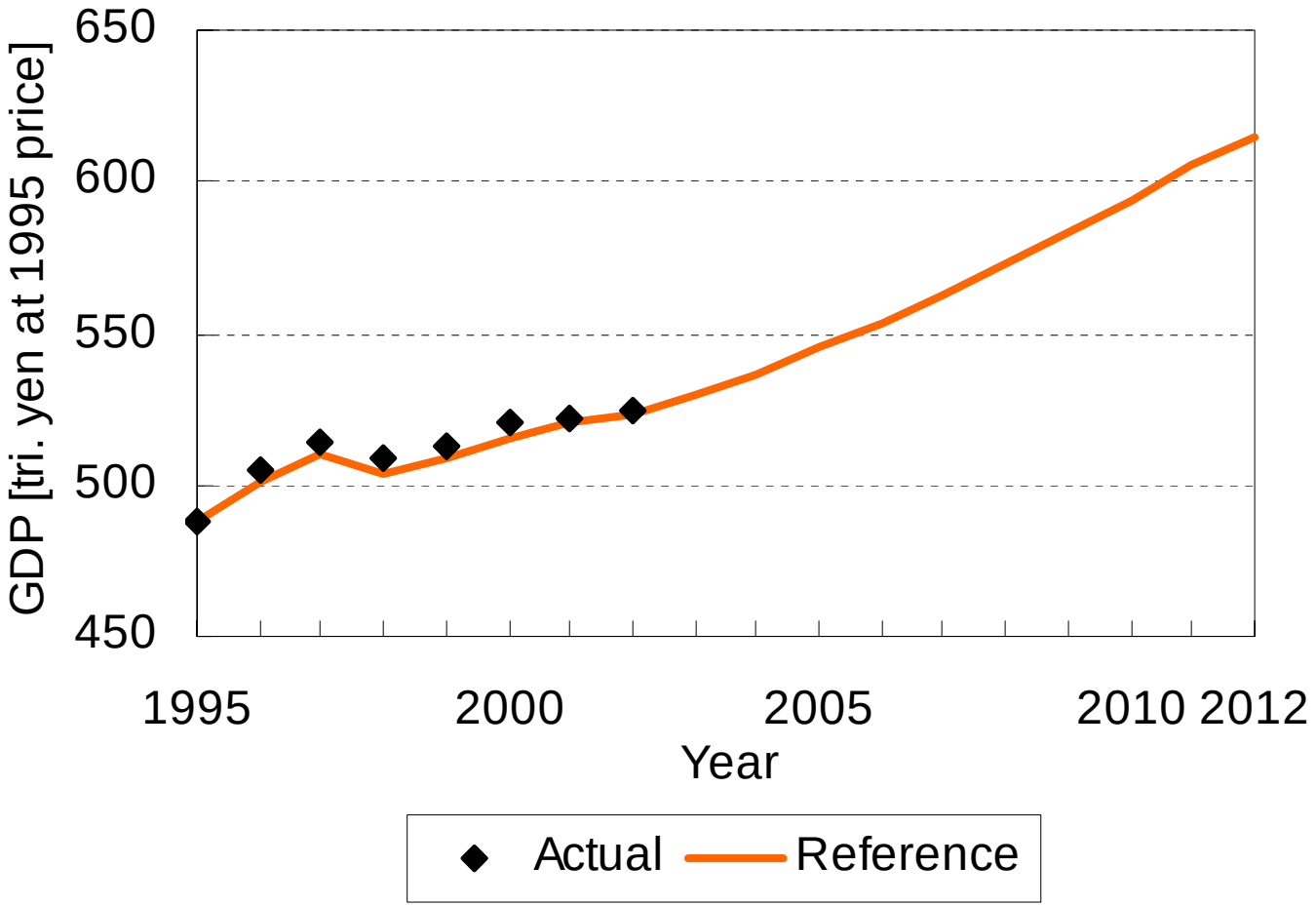
-Country top-down model approach-

Sectors and commodities

sector	commodity	sector	commodity
Agriculture, forestry & fisheries		Education, research, medical service, health & hygiene, & social welfare	
Mining except energy			
Coal mining	Coking coal	Goods renting & leasing	
	Coal for general use, lignite, anthracite	Car & machine repairing	
Crude oil mining		Other service	
Natural gas mining		Government service	
Food		Pollution management devices	
Textile mill products		Sewage service	
Lumber, wood products, pulp, paper & paper products		Municipal solid waste treatment service	
Chemical & allied products		Industrial solid waste treatment service	
Plastic		Manufacture of coal products	Coke
Ceramic, stone, & clay products			Other coal products
Iron, steel, non-ferrous metals & products			Paving materials
Non-ferrous metals & products		Manufacture of petroleum	Gasoline
Fabricated metal products			Jet fuel oil
General machinery			Kerosene
Electrical machinery, equipment & supplies			Light oil
Transportation equipment			Heavy oil
Precision instruments & machinery			Naphtha
Miscellaneous manufacturing industries			LPG
Construction			Other petroleum products
Steam & hot water supply		Manufacture of gas	Town gas
Water supply		Coal power generation	Electricity
Wholesale & retail trade		Oil power generation	
Finance & insurance		Gas power generation	
Real estate		Hydro power generation	
Transportation & communications		Nuclear power generation	

Model analysis on CO2 reduction policy

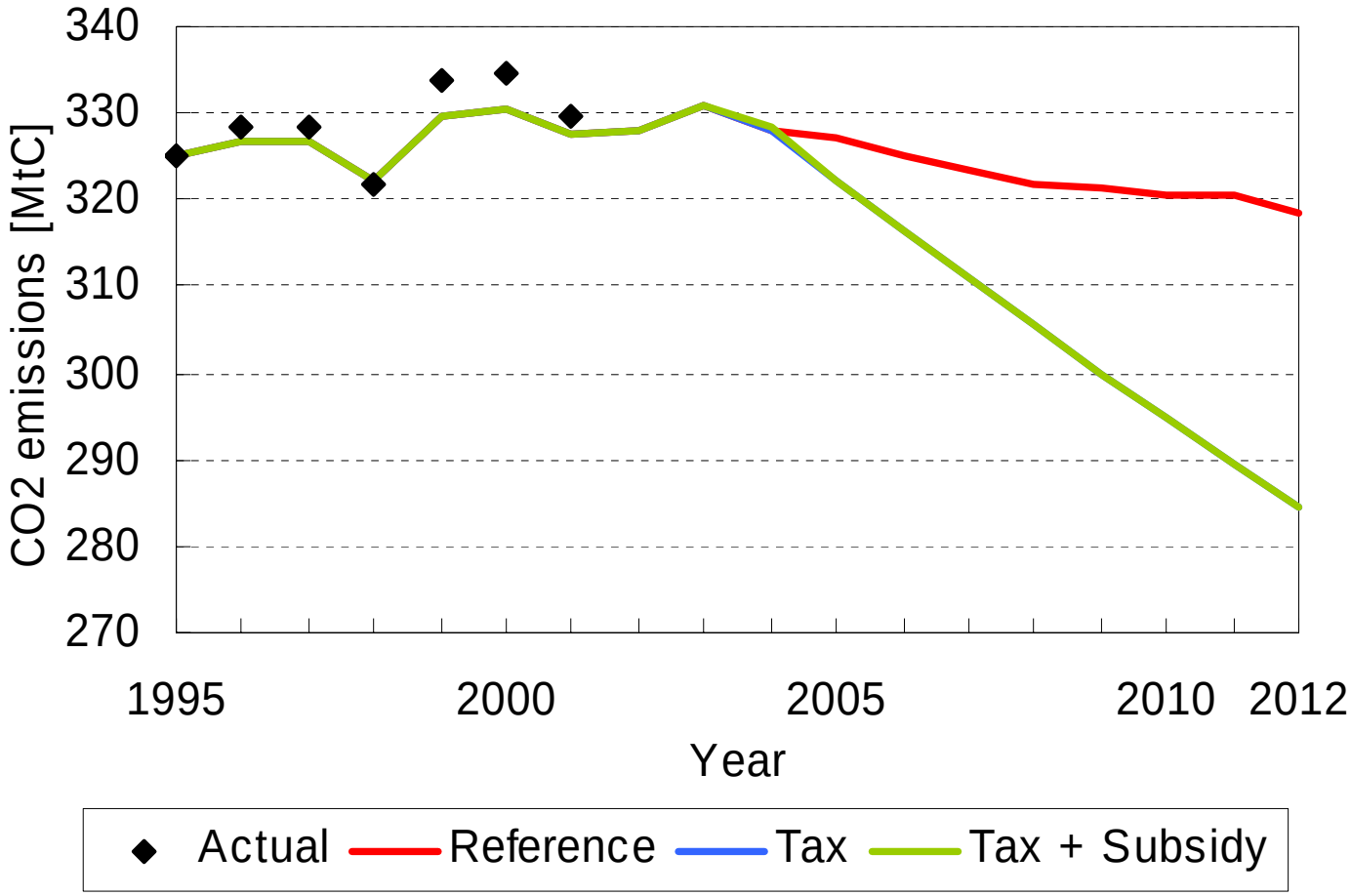
-Country top-down model approach-



Future GDP estimated from AIM/Material model

Model analysis on CO2 reduction policy

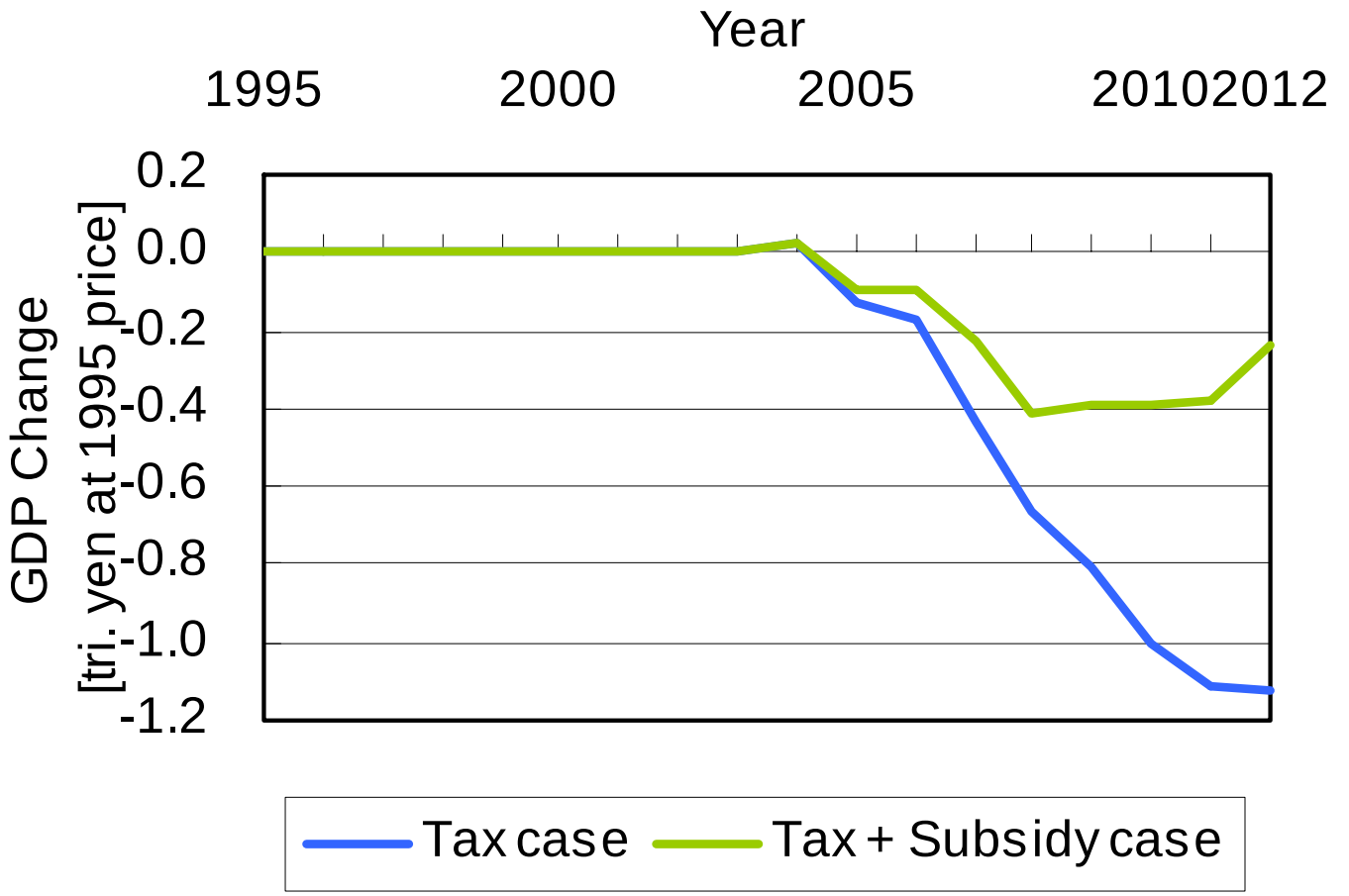
-Country top-down model approach-



Carbon emissions in Japan

Model analysis on CO2 reduction policy

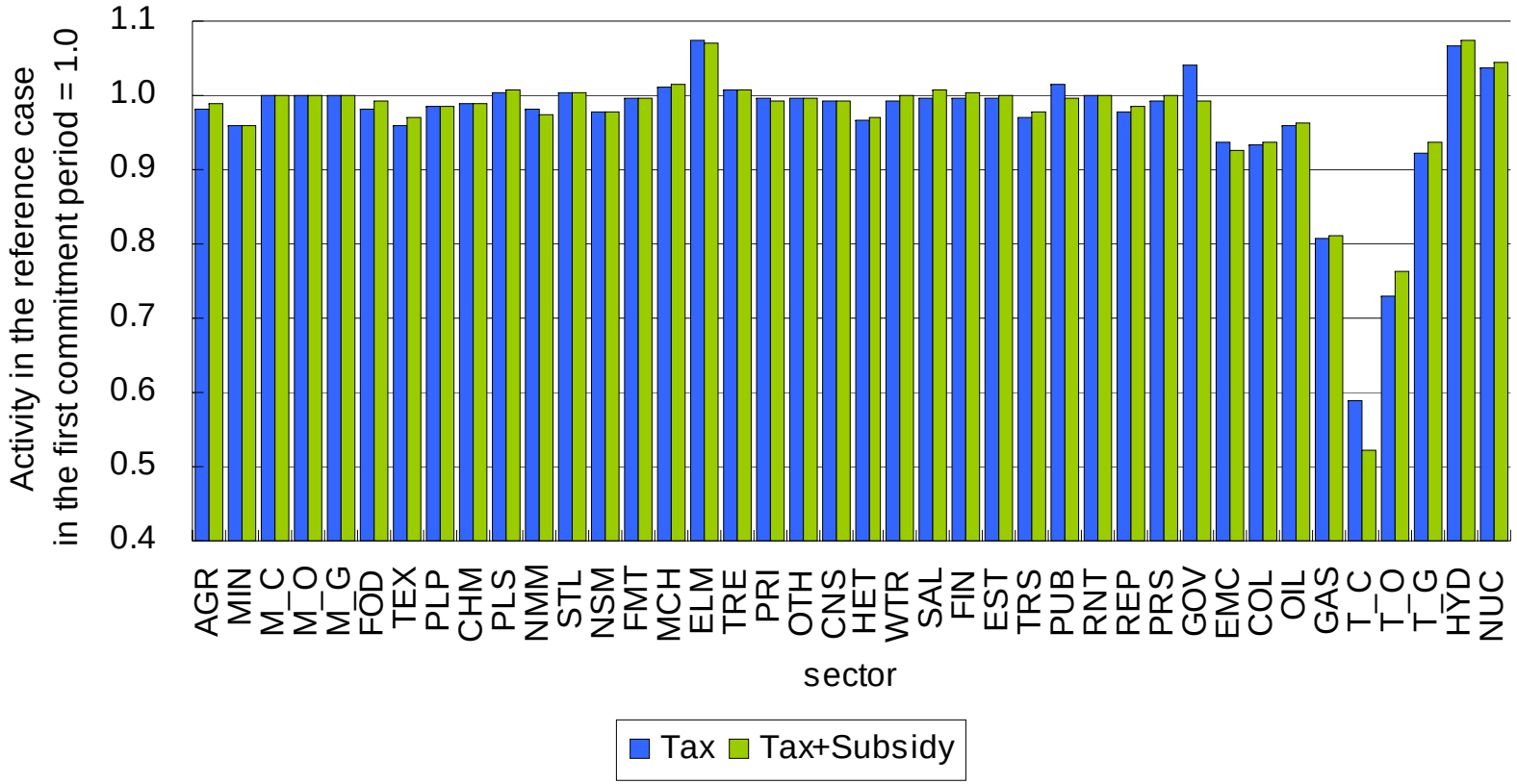
-Country top-down model approach-



GDP change compared to the reference case

Model analysis on CO2 reduction policy

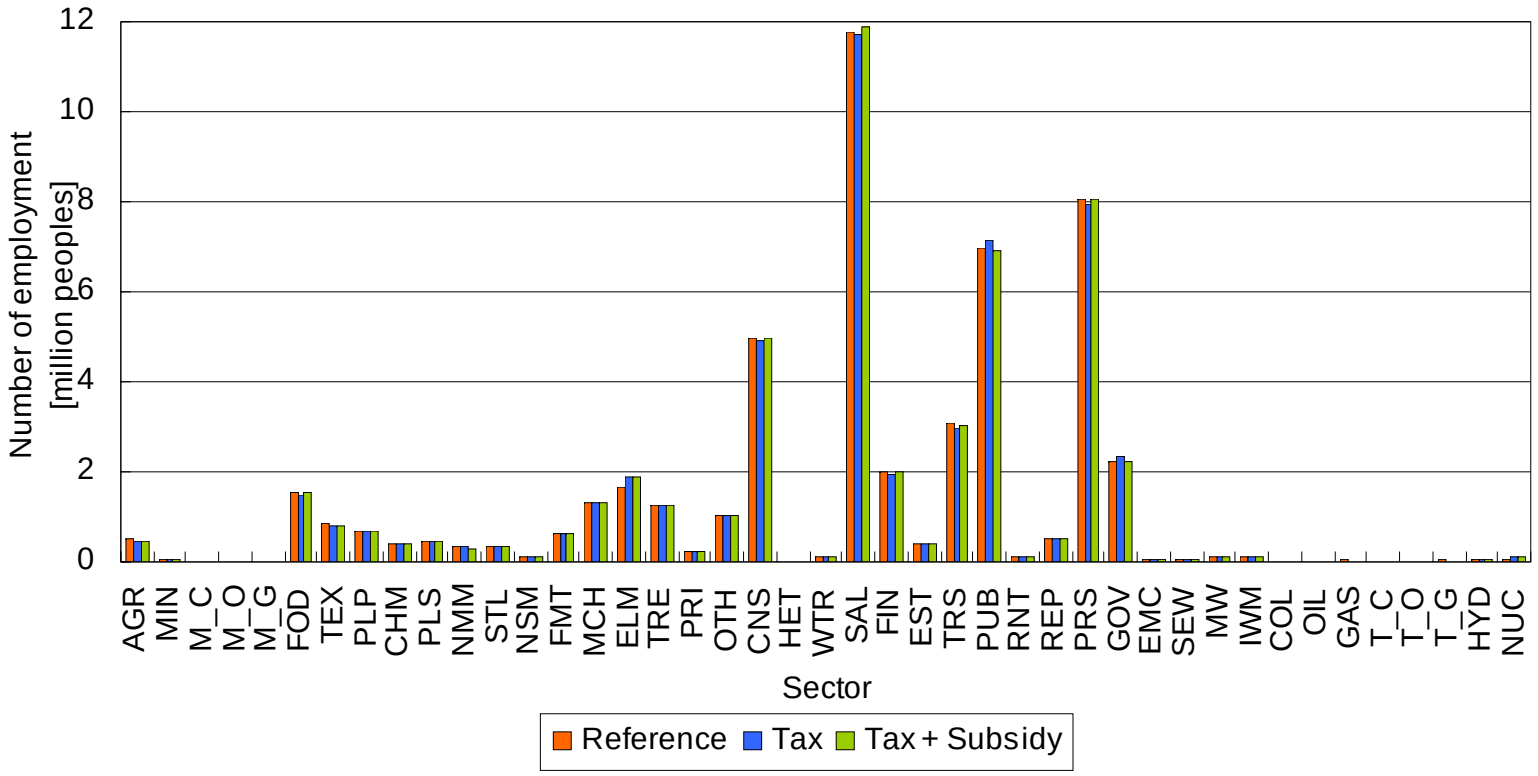
-Country top-down model approach-



Activity Change of each sector in the first commitment period (compared to reference case)

Model analysis on CO2 reduction policy

-Country top-down model approach-



Number of employment in the first commitment period

Conclusion

- **In Japan, even existing or practical technologies can reduce the CO2 emissions to the Kyoto Target. The necessary carbon tax rate will be 45,000 yen/tC.**
- **When the tax revenue is utilized for subsidy, the carbon tax rate will be 3,400 yen/tC. In this case, the GDP loss will be 0.061% comparing to reference case.**
- **Although activities of thermal power generation and fossil fuel production sectors will decrease severely by introducing carbon tax, energy intensive industries such as steel, paper etc. will not be damaged so much.**
- **Because of the subsidy for energy saving devices, production and employment in the manufacture of the energy saving devices will increase.**