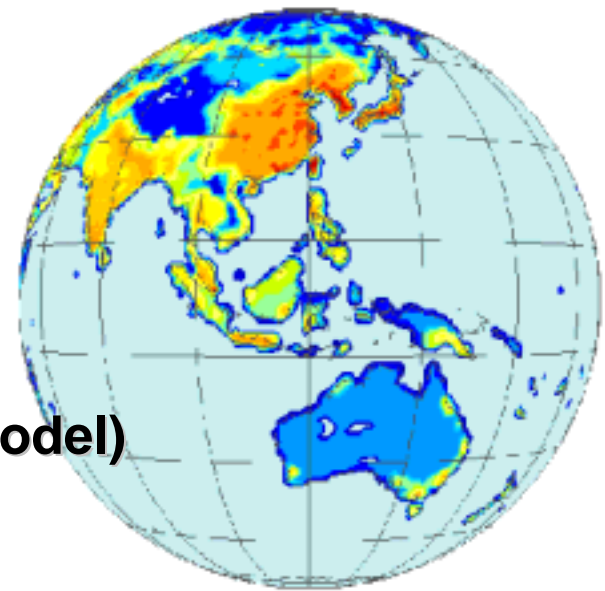


Carbon Tax, Carbon Reduction Potential, and Economic Impact in Japan

-Application of AIM (Asia-Pacific Integrated Model)



Contents:
**CO2 reduction
in Japan**
Model analysis
AIM/Enduse
AIM/Top-down
AIM/Material
Conclusion

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NIES, Tsukuba Japan
12-14 March, 2004

Outline of this presentation

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- **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

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➤ 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: $\pm 0\%$
- Reduction by innovative technologies and change of lifestyle: -2%



Model analysis on CO2 reduction policy

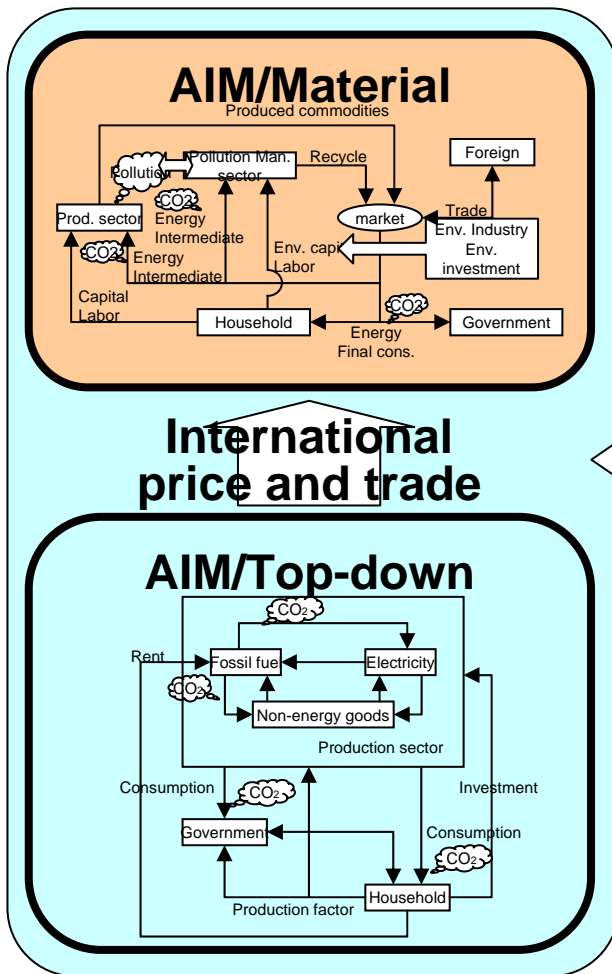
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- **Model approaches**
 - **Bottom-up approach: represent reality**
 - **Top-down approach: represent consistency**
- **Mixture of these 2 approaches;**
 - **Bottom-up (technology)**
 - **AIM/Enduse model: Potential CO2 reduction and carbon tax & subsidy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



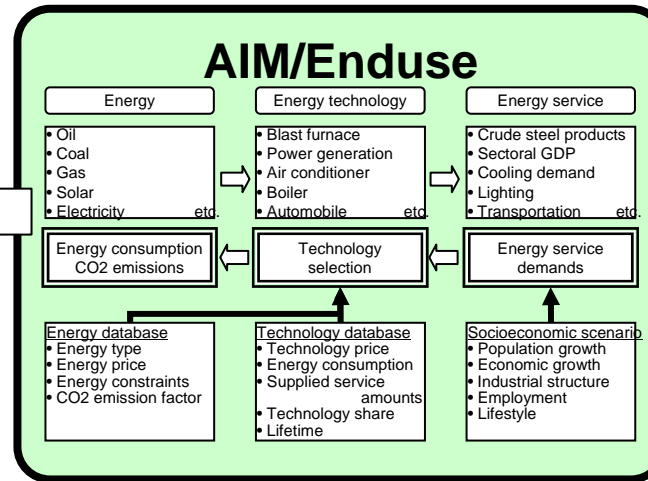
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International price and trade

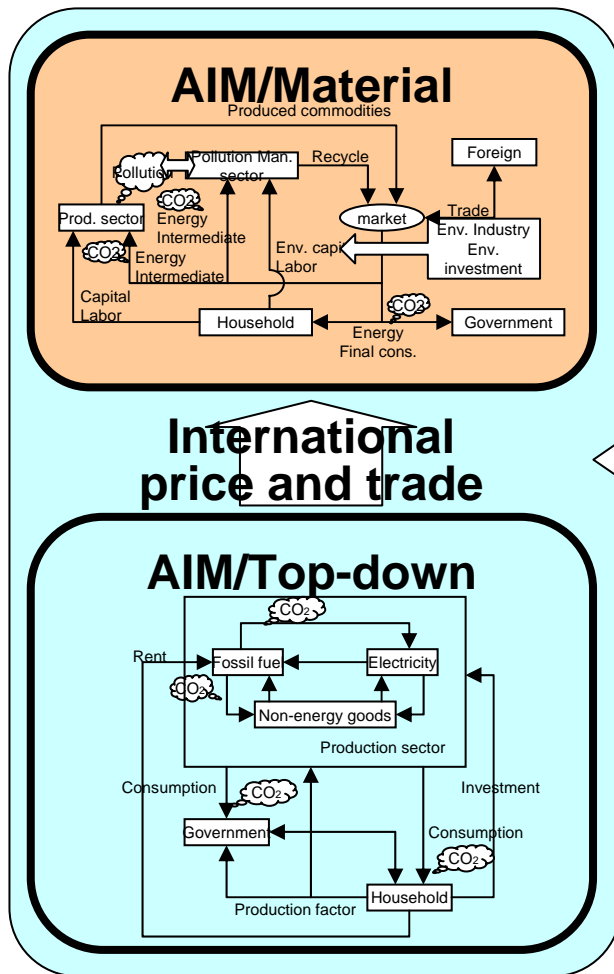
Energy efficiency improvement



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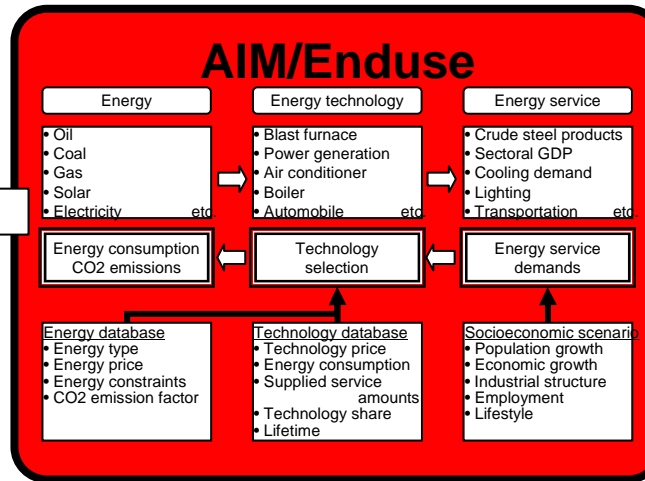
-Bottom-up model approach-

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Energy efficiency improvement



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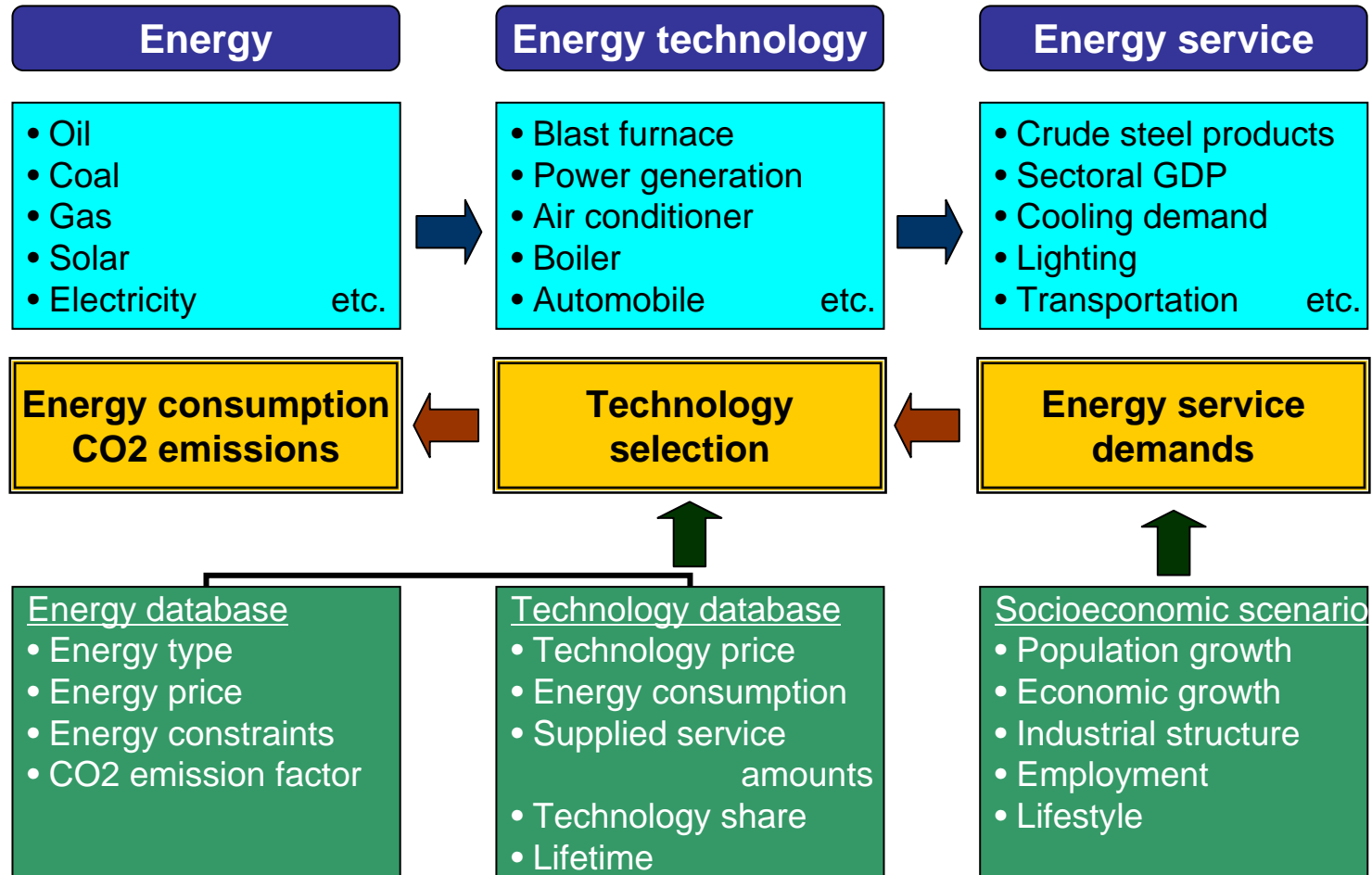
- **AIM/Enduse model**
 - Based on socioeconomic scenario, energy devices and energy types are selected to minimize total cost.

- **Messages from AIM/Enduse model**
 - CO2 reduction potential
 - Necessary carbon tax rate to achieve Kyoto Protocol
 - Effective policy mix to lower carbon tax rate



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Structure of AIM/Enduse model

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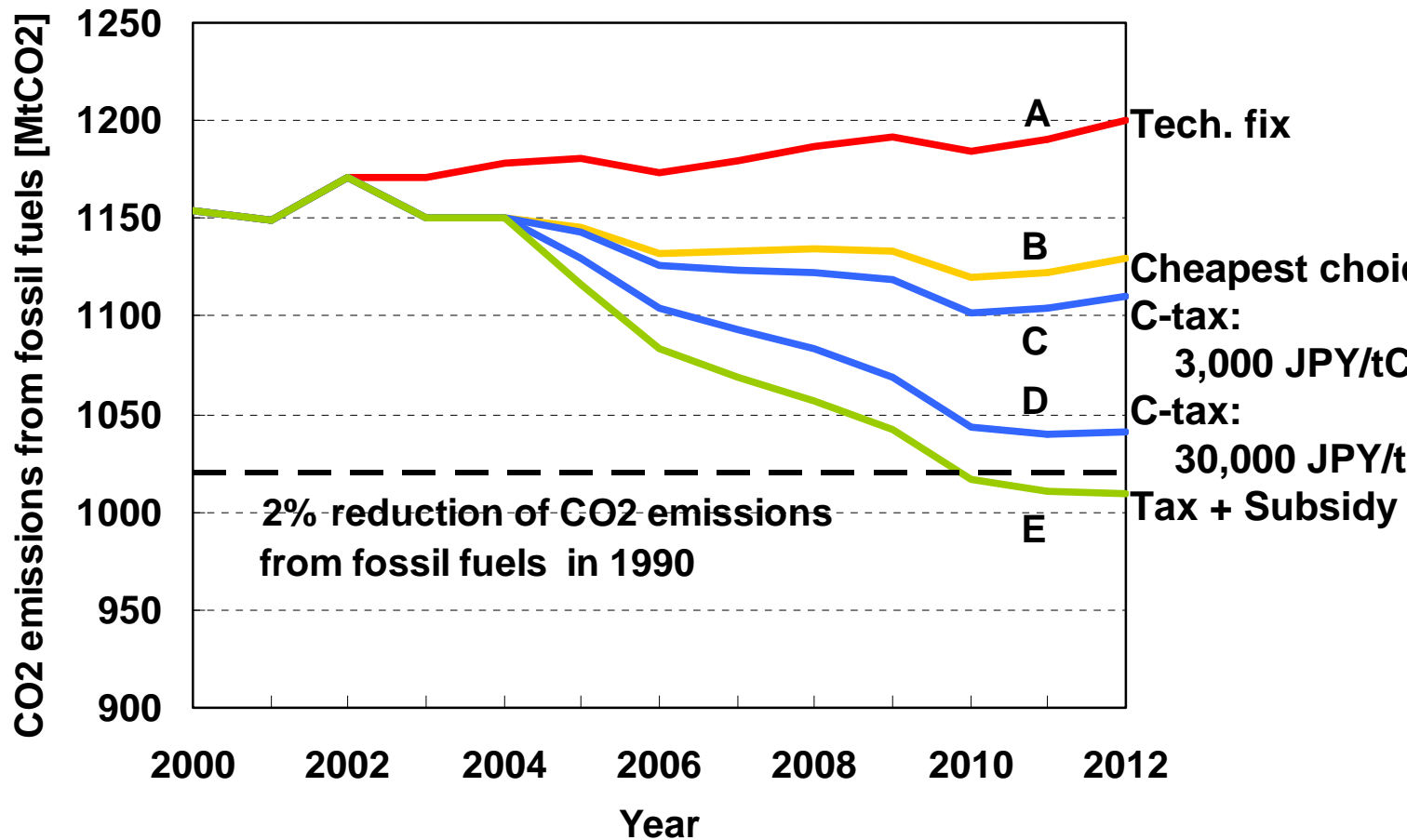
Examples of socioeconomic scenarios

		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

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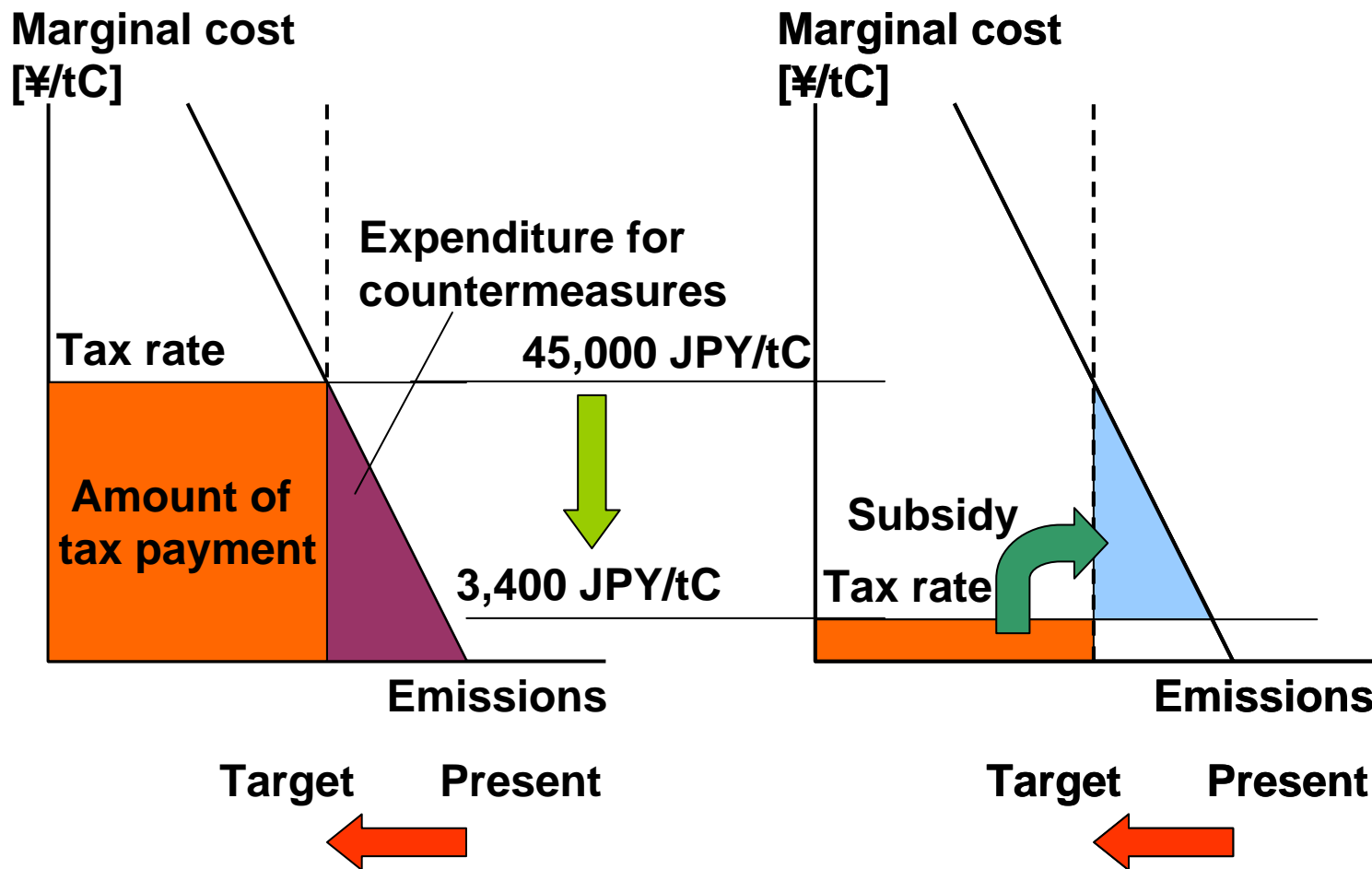
CO2 emissions trajectories by scenarios

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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

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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 truck	106.6
Forest management	Plantation, Weeding, Tree thinning, Multilayered thinning, Improvement of natural forest	195.7
Total		952.0

bil. JPY / year

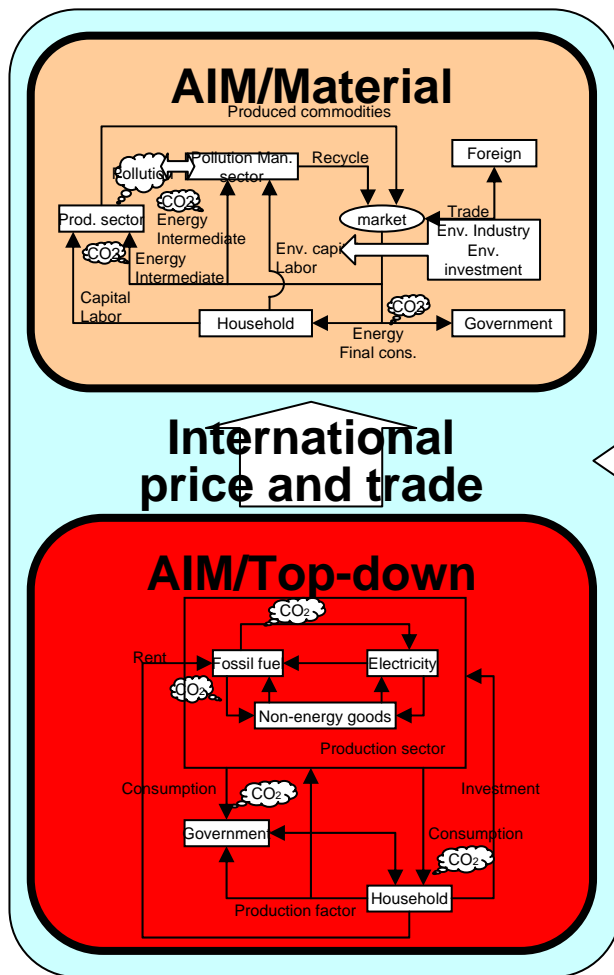
Tax rate to appropriate required subsidiary payments (JPY/tC)	3,433
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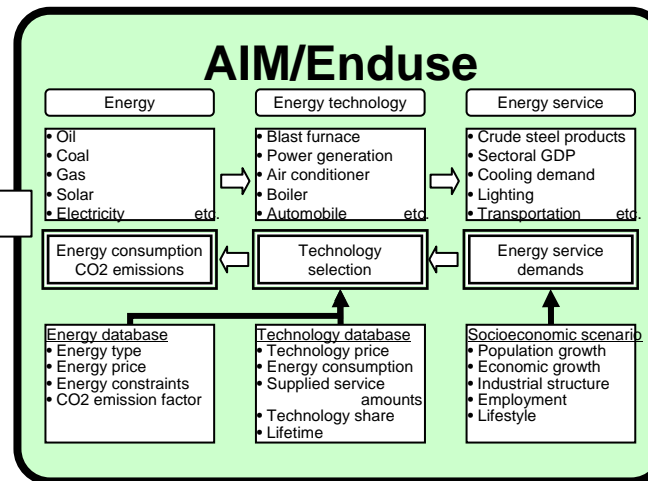
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➤ **AIM/Top-down model**

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



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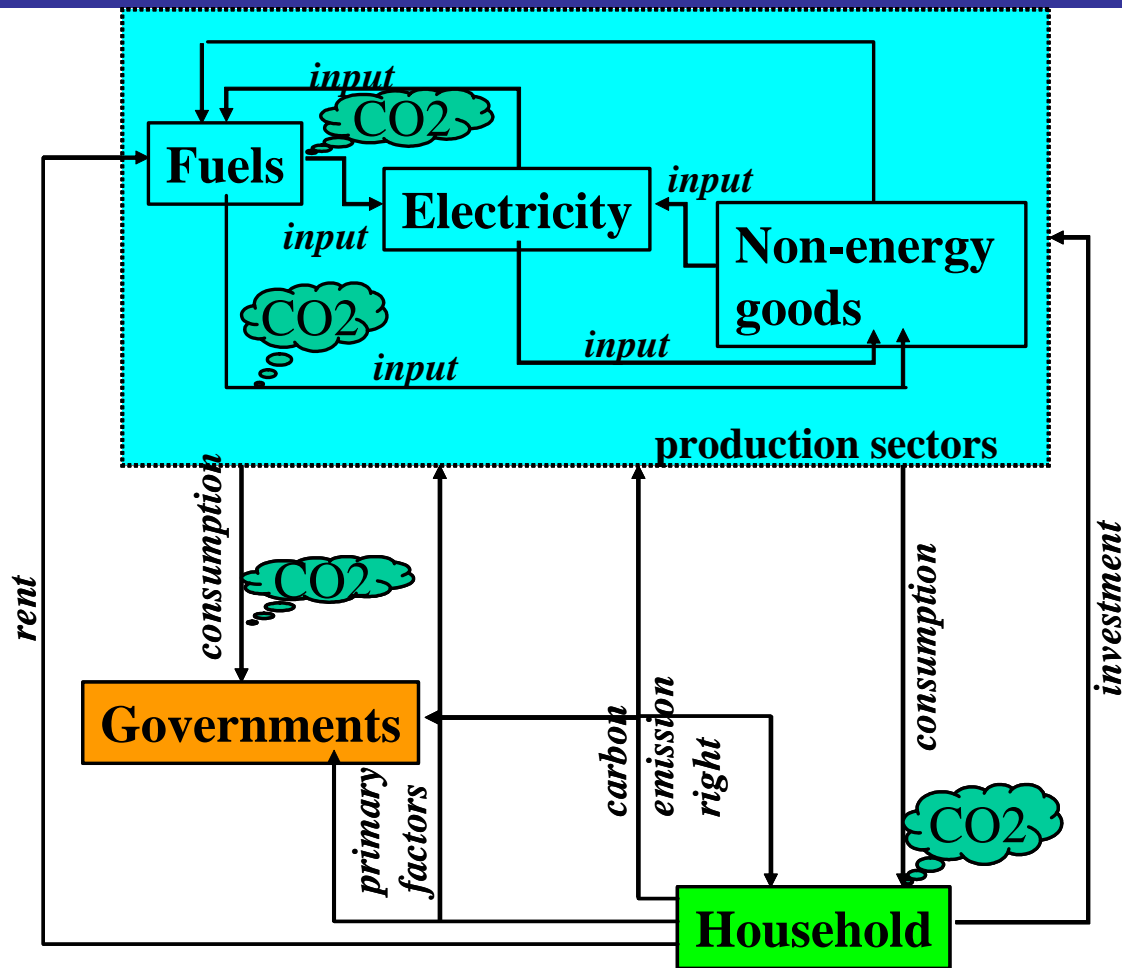
- **Overview of AIM/Top-down model**
 - **Data from GTAP (ver.3) and energy balance table (IEA)**
 - **Computable general equilibrium model with recursive dynamics**
 - **CO2 emissions from fossil fuels**
 - **Time period: 1992-2010**
 - **Region: 21**
 - **Sector: 8**



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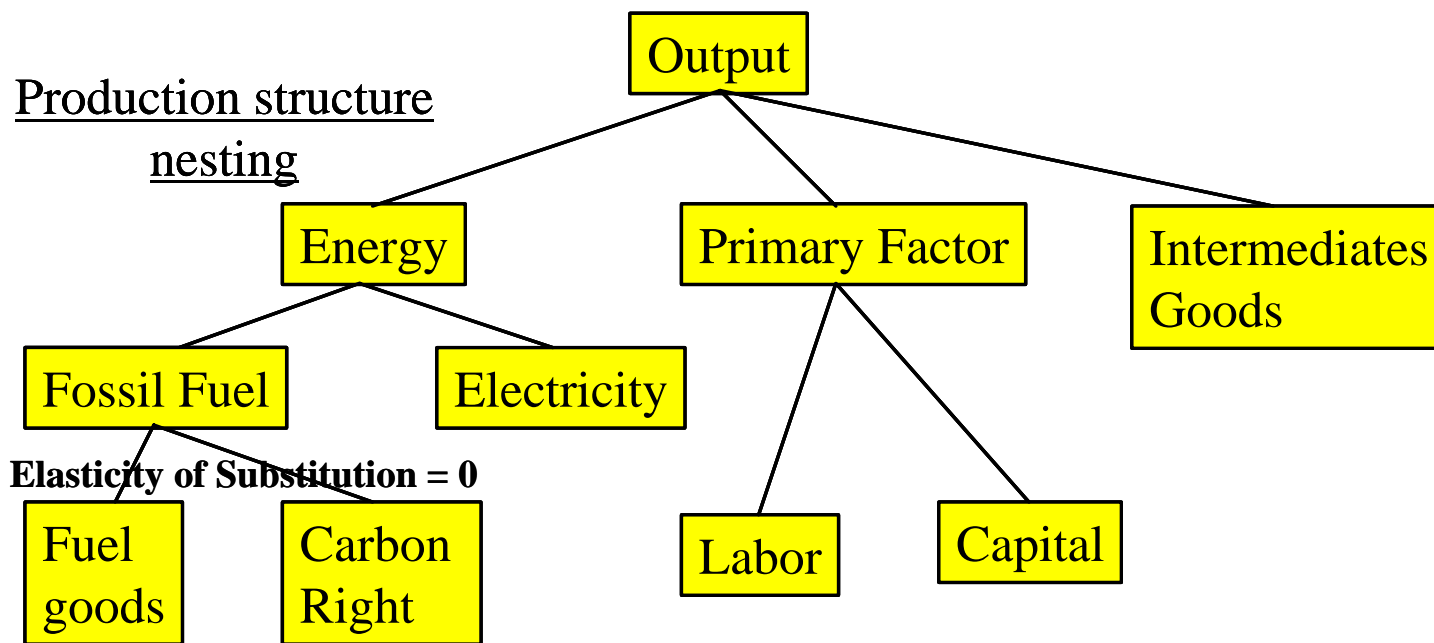


Model structure

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Production structure

Model analysis on CO2 reduction policy

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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

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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		

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Scenarios for analysis

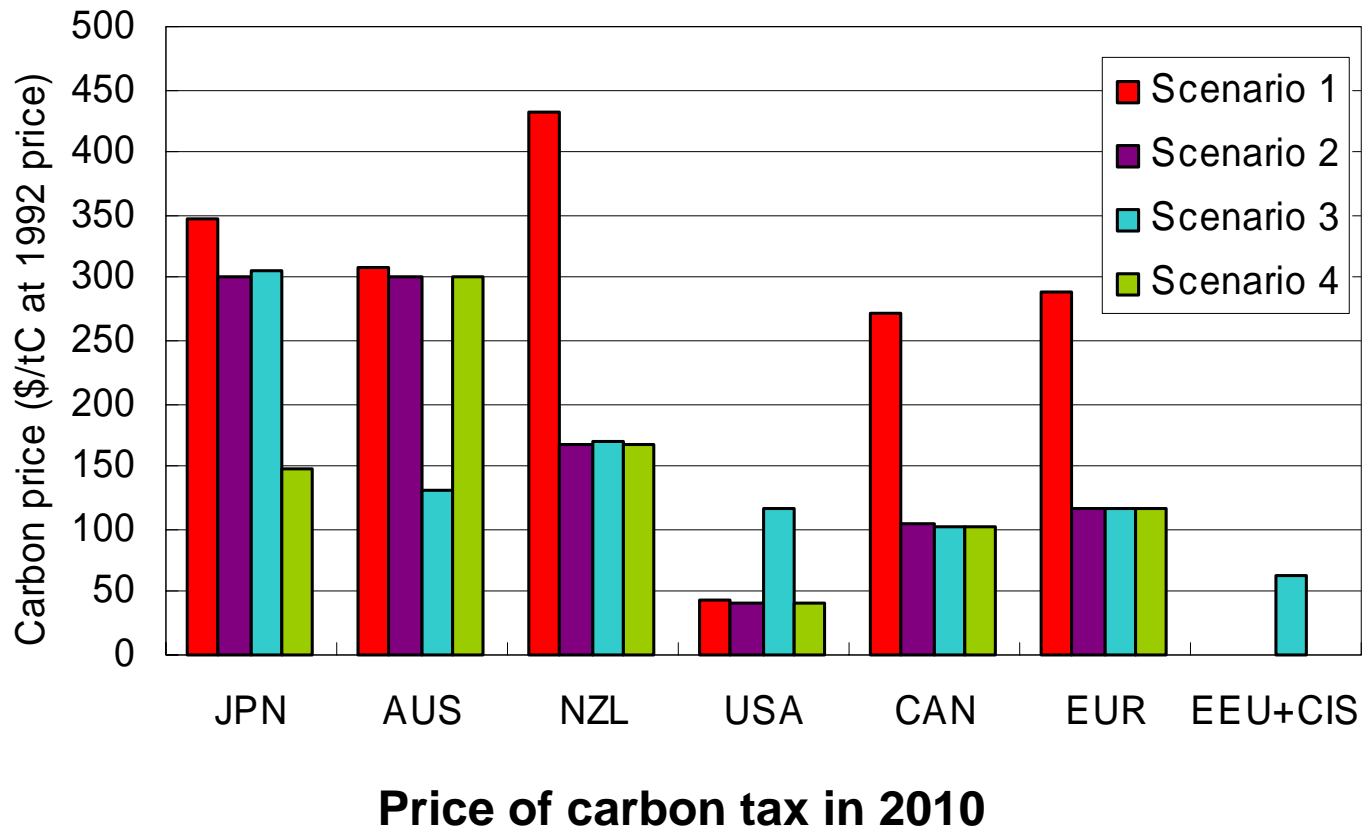
	Climate policy in US and Australia	Emission trade	
		Japan	Others
BaU	No CO2 reduction		
Scenarios reducing CO2 emissions			
Scenario 1	Keep original policy	No trade	
Scenario 2	Keep original policy	1.6% of emissions in 1990	Half of reduction
Scenario 3	Ratify Kyoto in 2008	1.6% of emissions in 1990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

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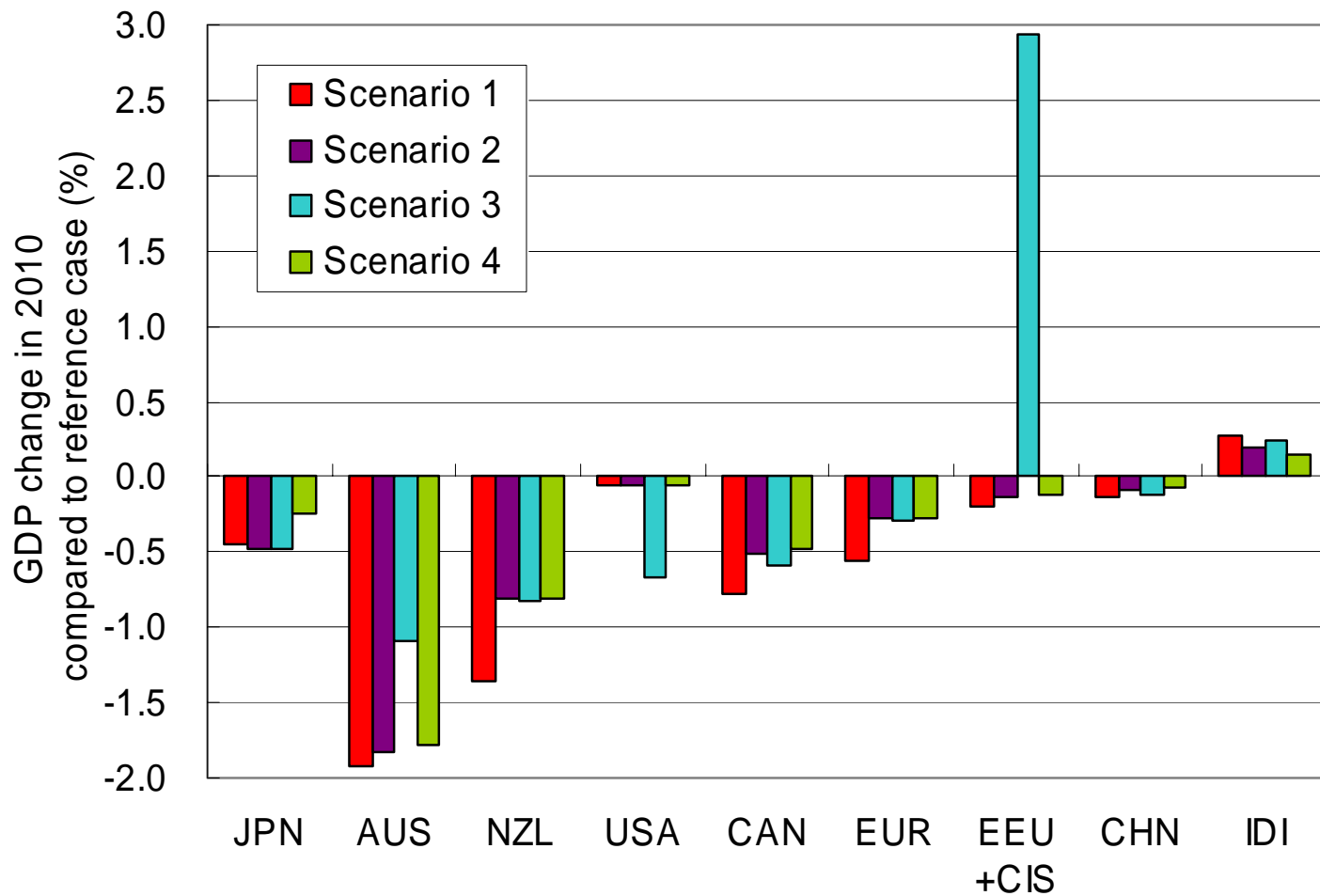
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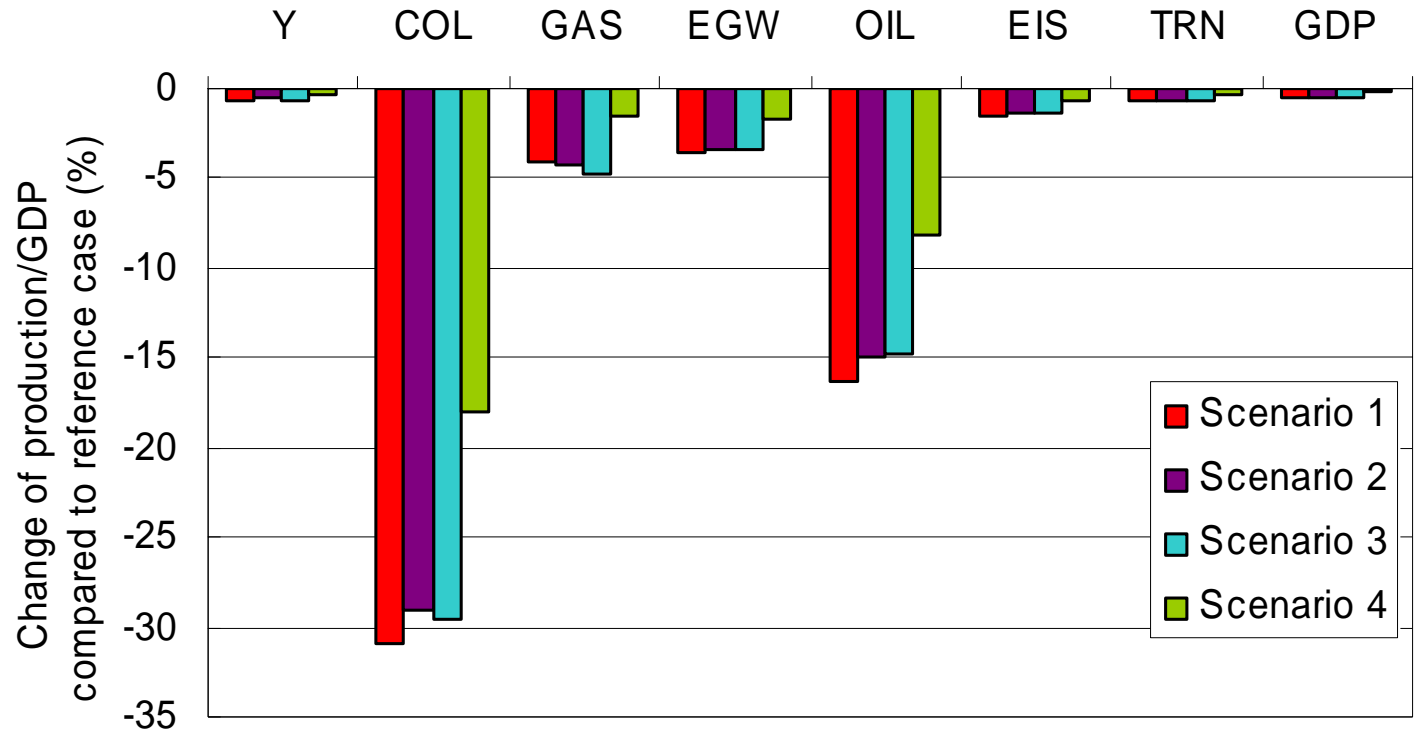
GDP change in 2010 compared to BaU



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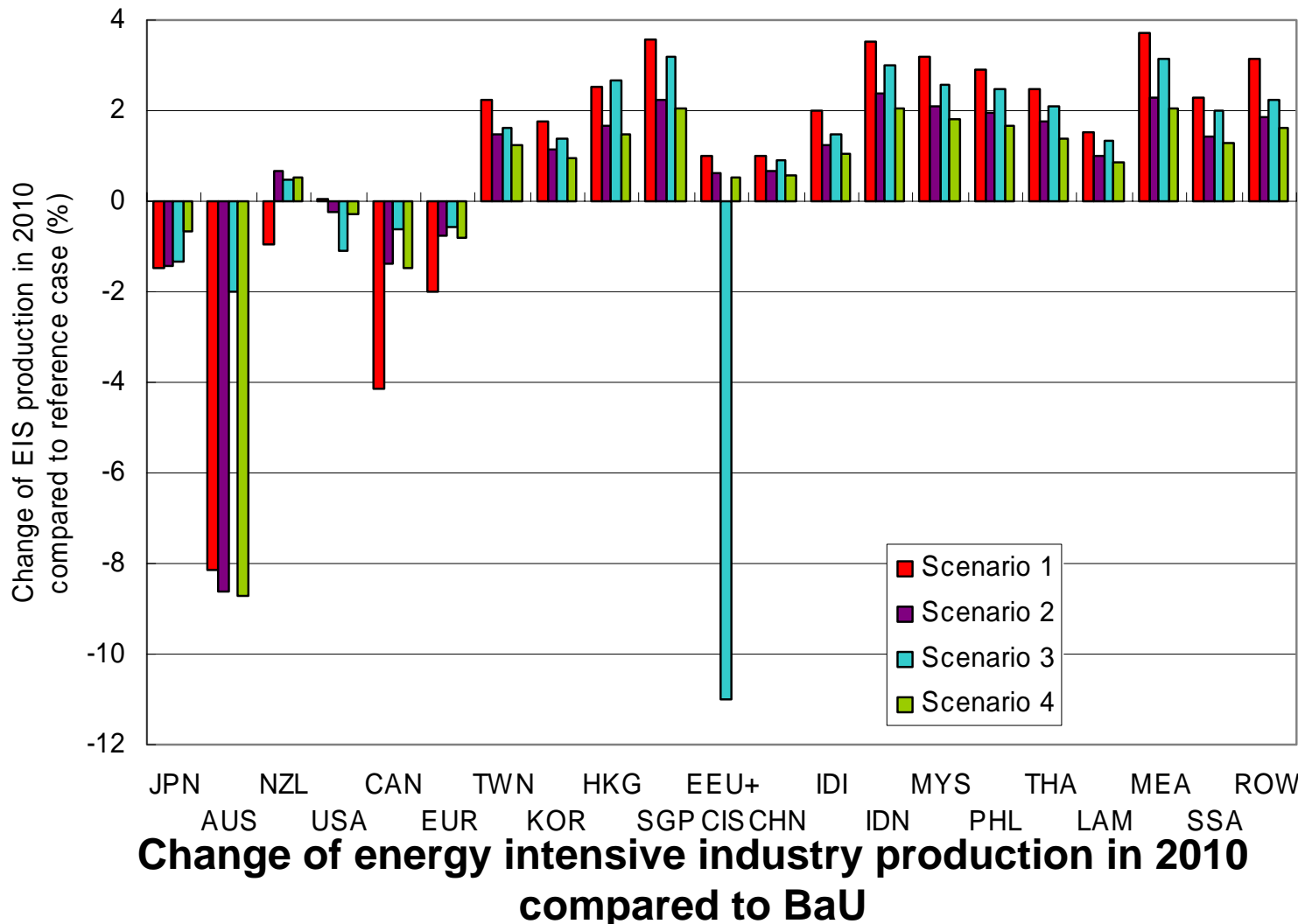


Change of production in each sector and GDP in Japan (2010)

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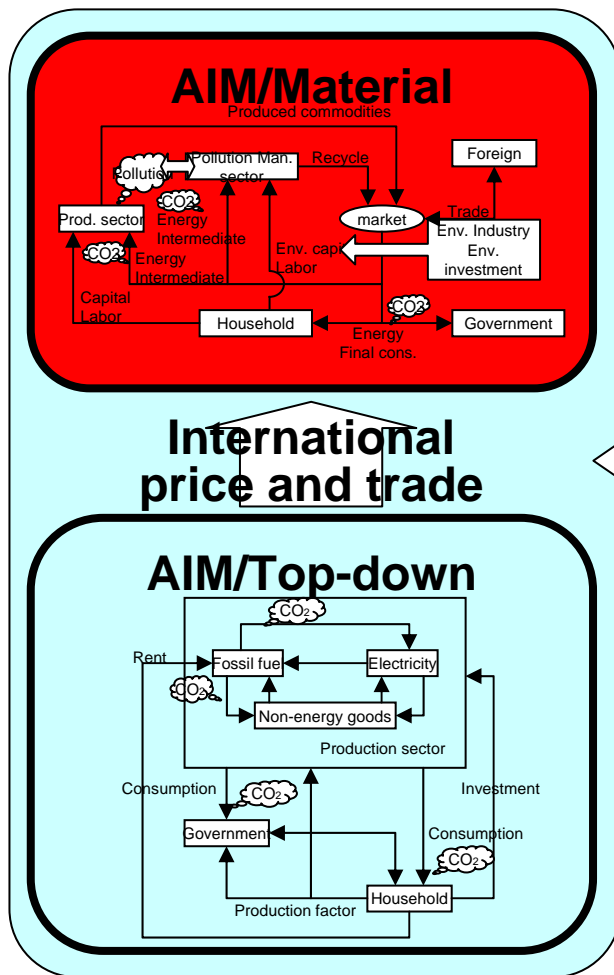
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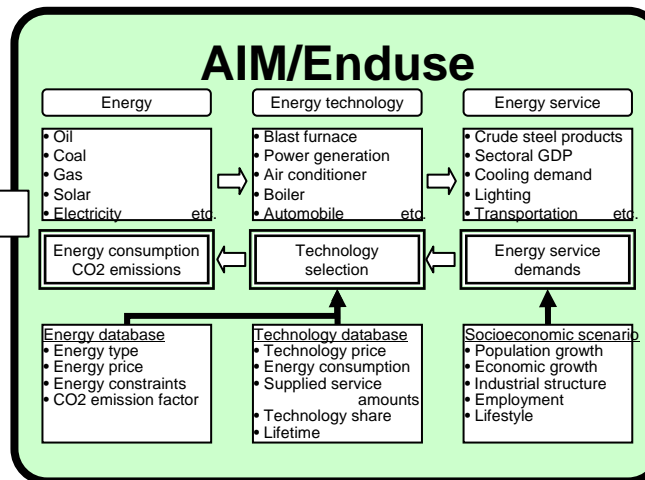
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- **AIM/Material model**
 - **Based on technology and international trade assumption, economic impacts by carbon reduction in Japan can be simulated.**

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



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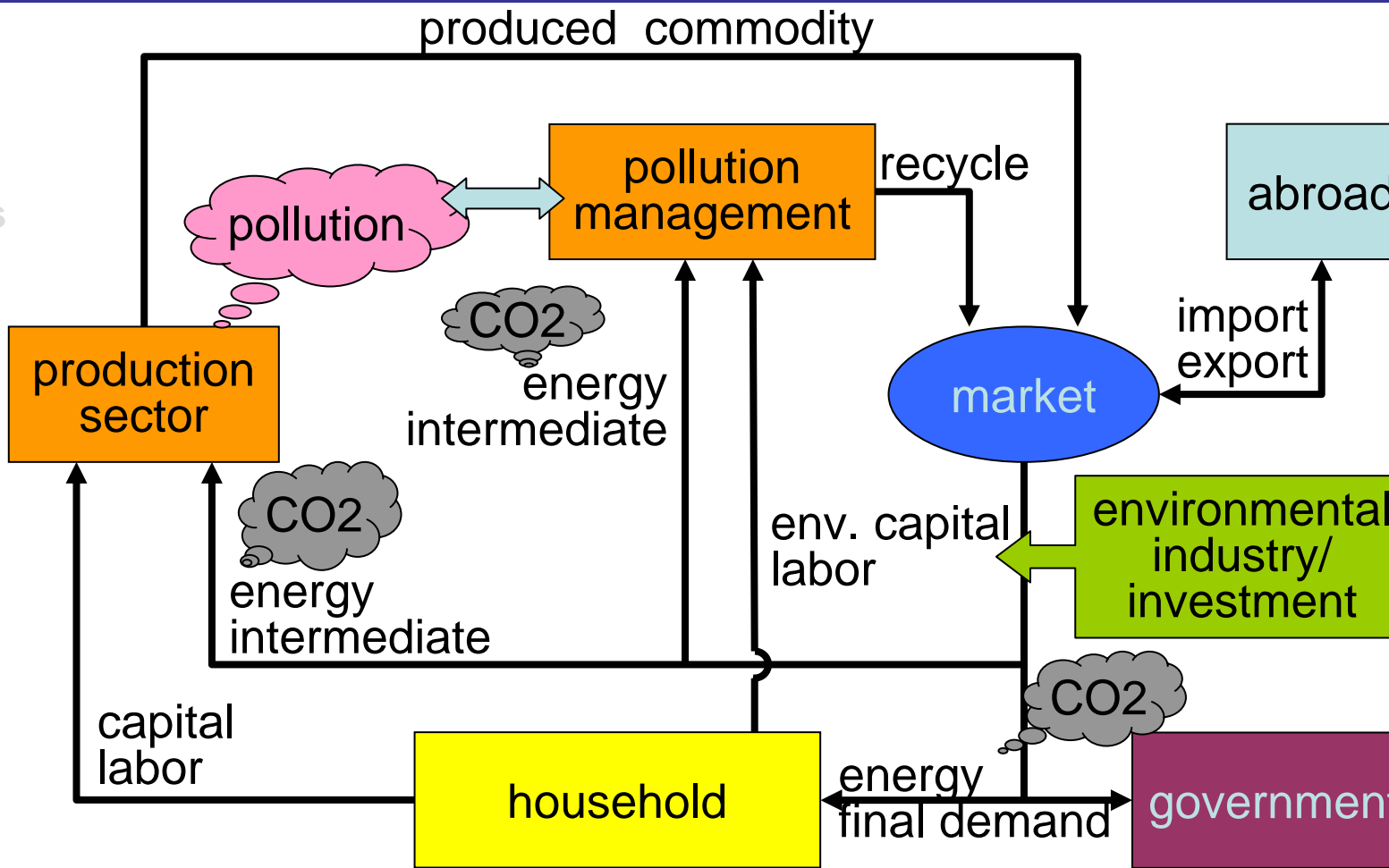
➤ Features of AIM/Material model

- 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.

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Structure of AIM/Material

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Sectors and commodities

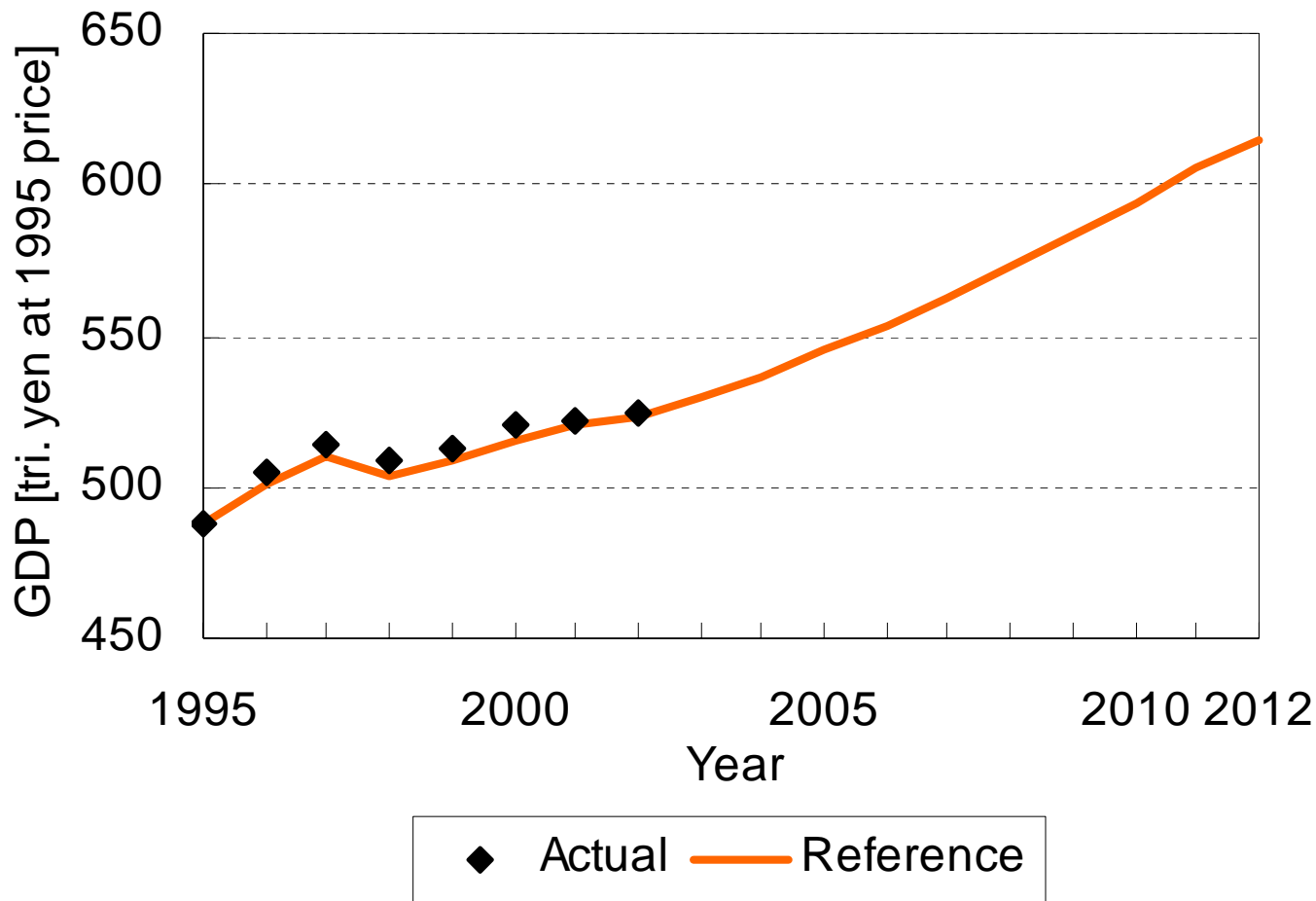
sector	commodity	sector	commodity	
Agriculture, forestry & fisheries		Education, research, medical service, health & hygiene, social welfare		
Mining except energy		Goods renting & leasing		
Coal mining	Coking coal	Car & machine repairing		
	Coal for general use, lignite, anthracite	Other service		
Crude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

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Future GDP estimated from AIM/Material model



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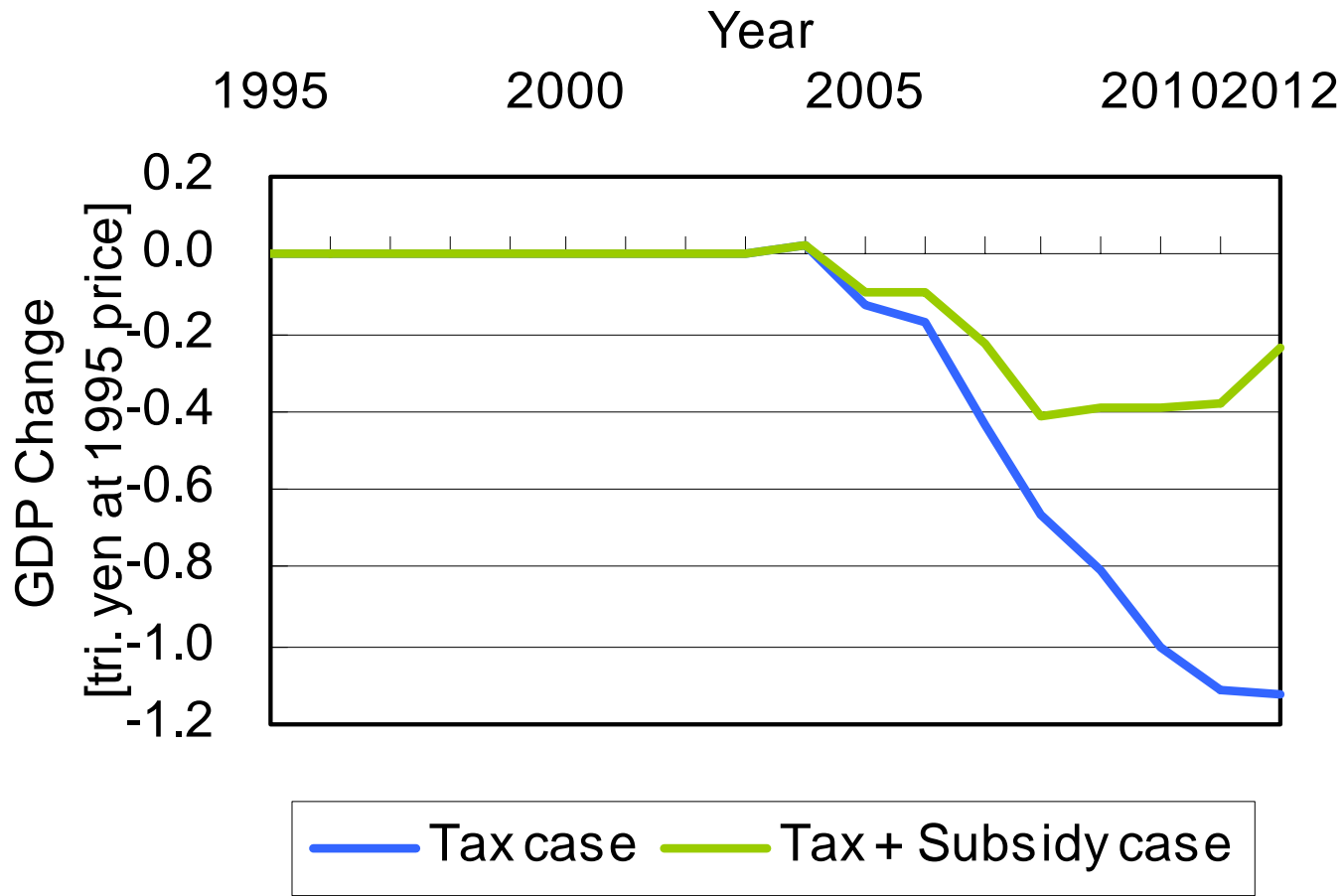


Carbon emissions in Japan

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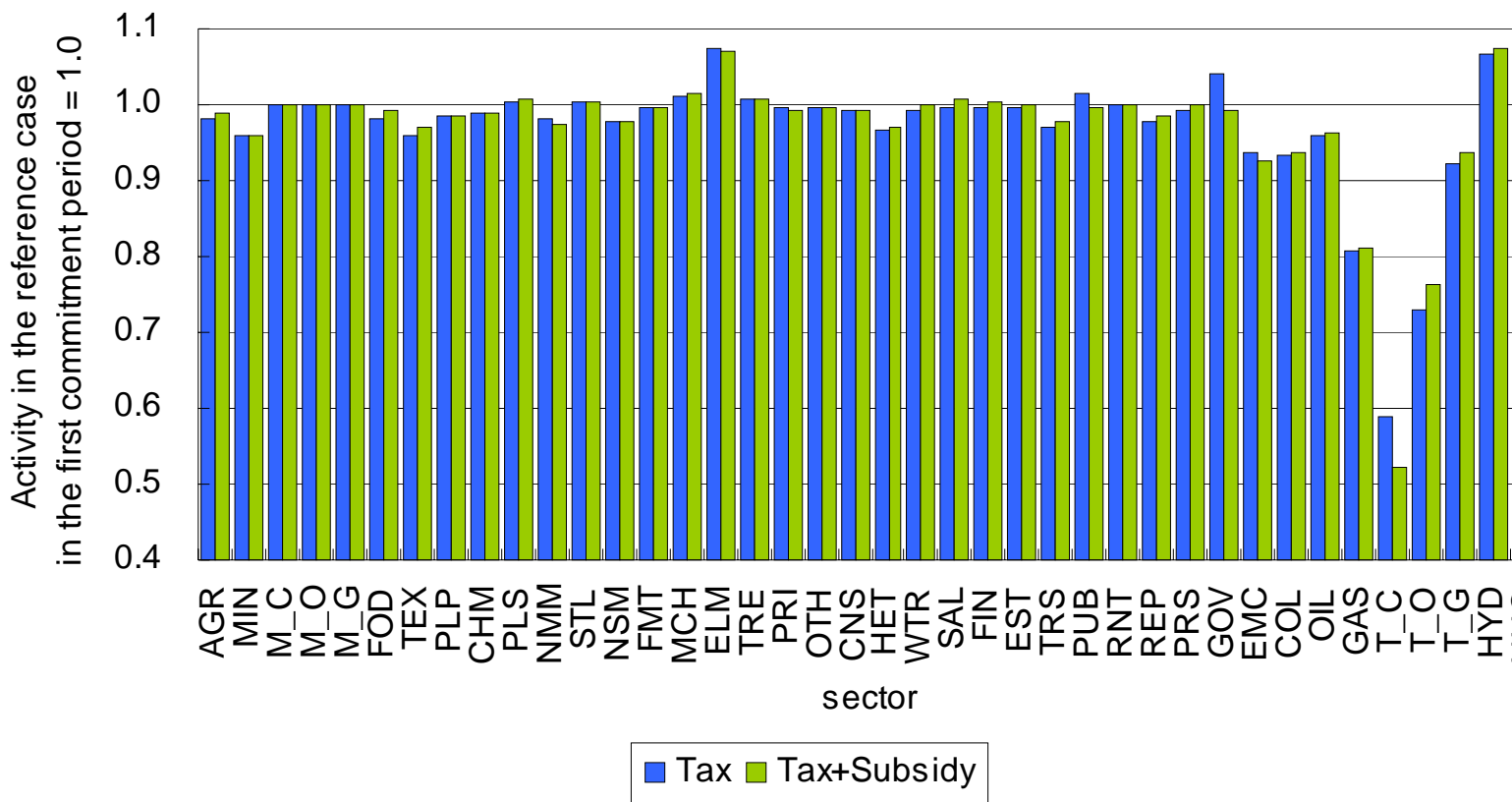


GDP change compared to the reference case

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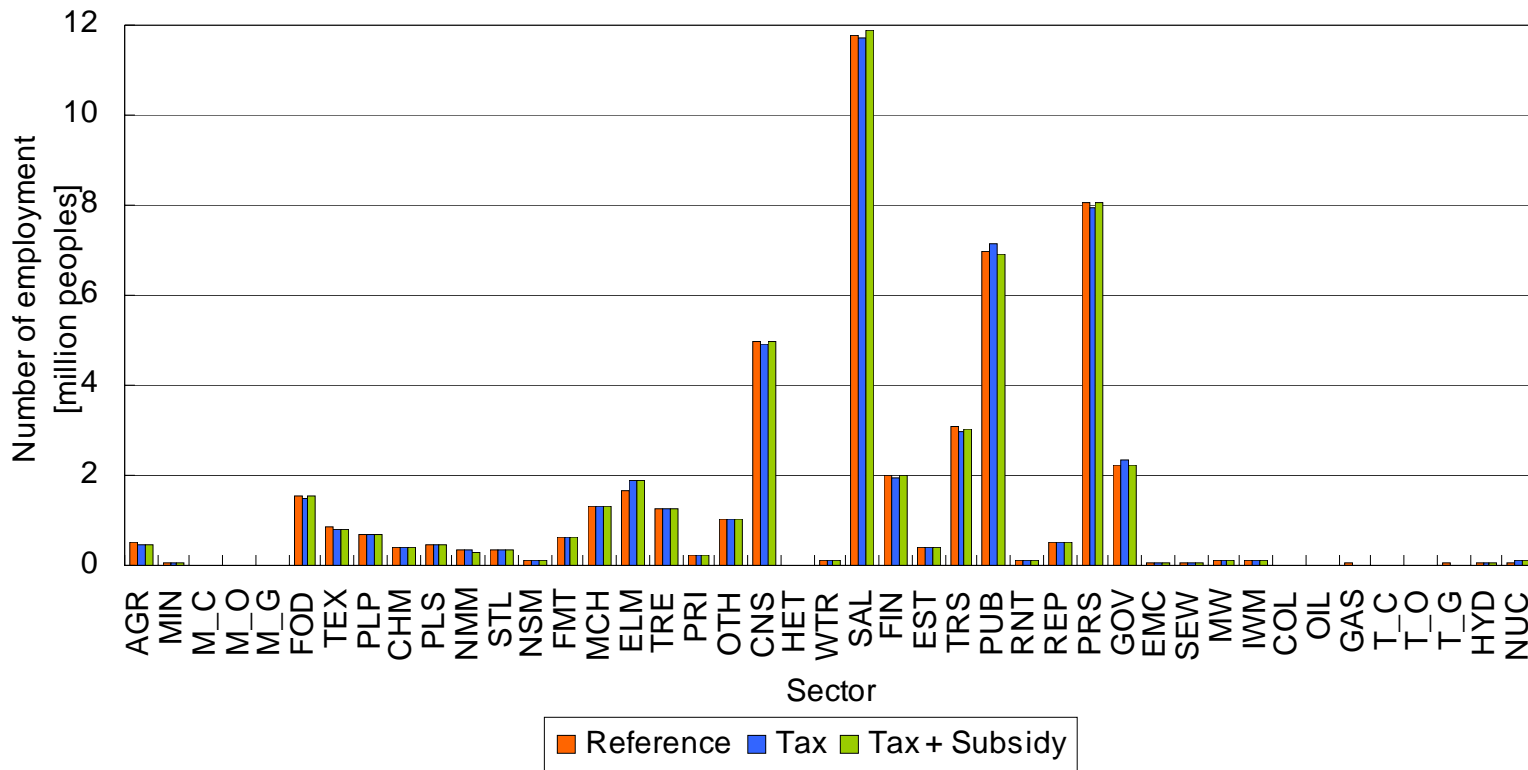


Activity Change of each sector in the first commitment period (compared to reference case)

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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.**