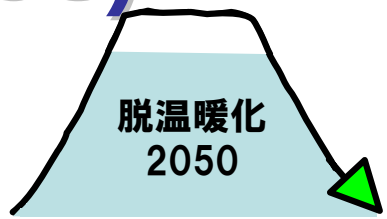
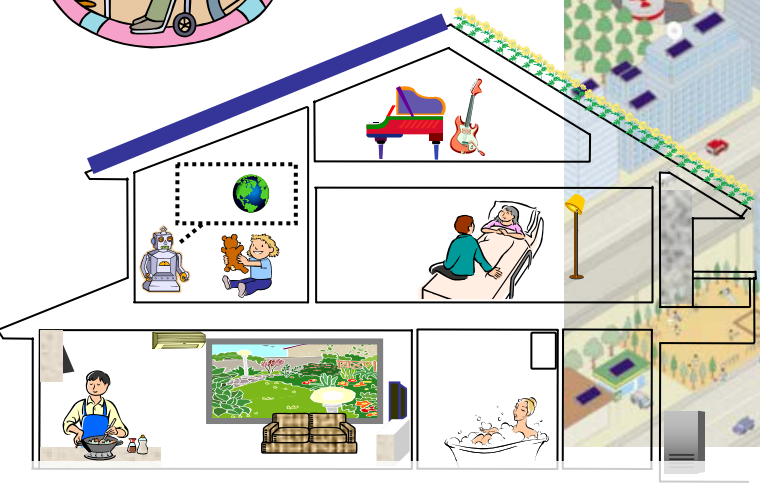
Japan Low Carbon Societies (LCS) Scenarios Study toward 2050



http://2050.nies.go.jp



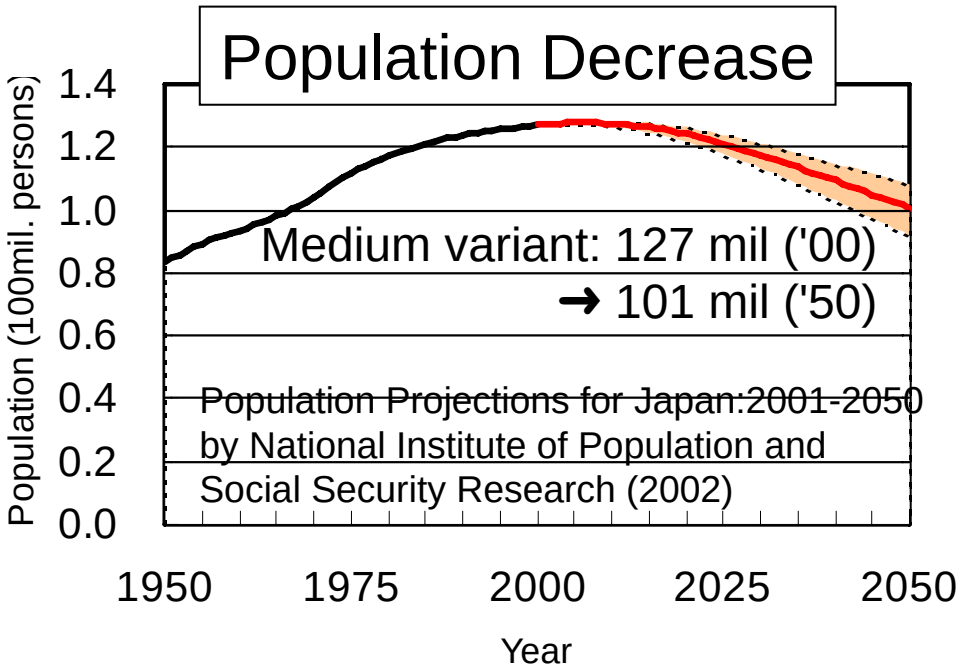
Junichi Fujino (fuji@nies.go.jp)

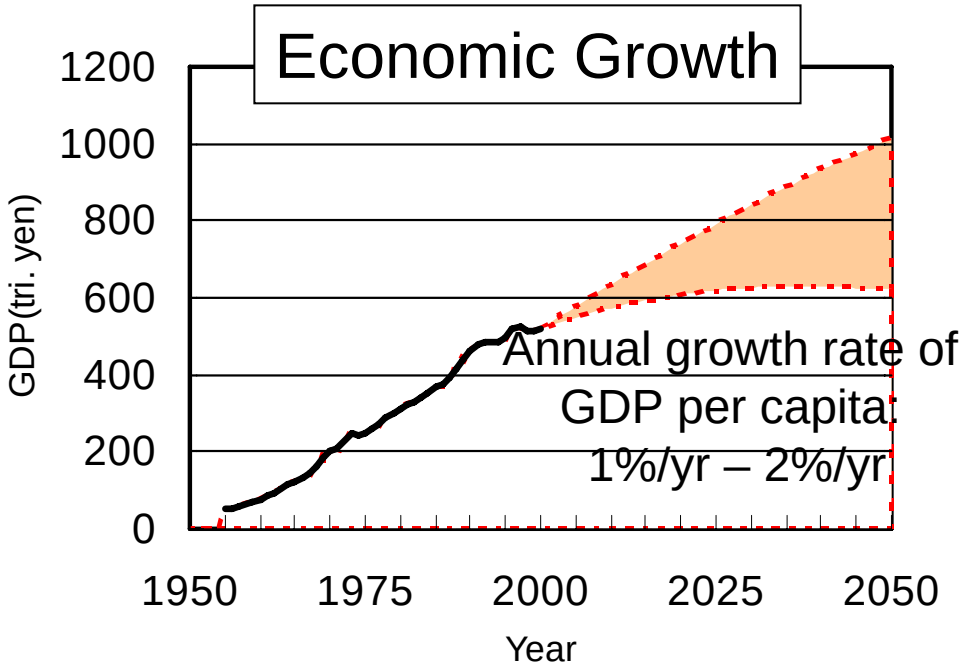
NIES (National Institute for Environmental Studies)

2006 AIM Training Workshop

19th October 2006, Tsukuba, Japan

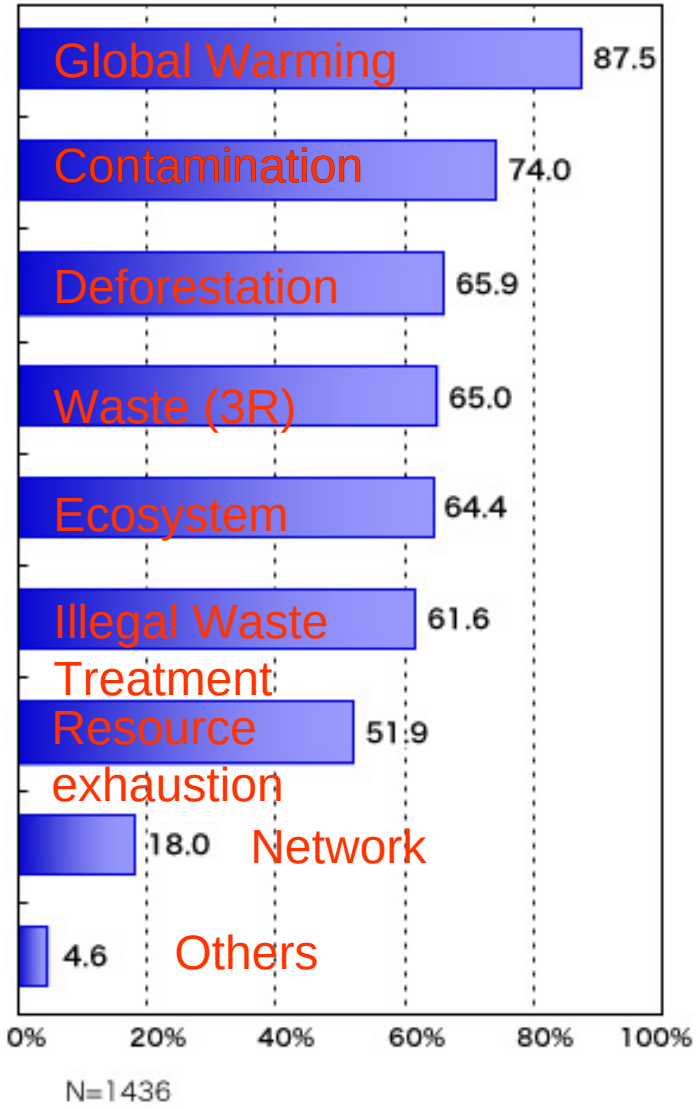
1. Why we need Low-Carbon Societies





Survey of citizens on environmental concerns

(Marks allocated)



http://nikkeibp.jp/style/biz/enquete/051021quick_eco/

Japan White Paper on Environment in 2005

Subtitle
「脱温暖化－
“人”と“しくみ”づくりで築く新時代」

Toward Low Carbon Societies

Structuring New Paradigm
with human resources
and institutions

It has past one and half year since Kyoto Protocol has been enforced, but…

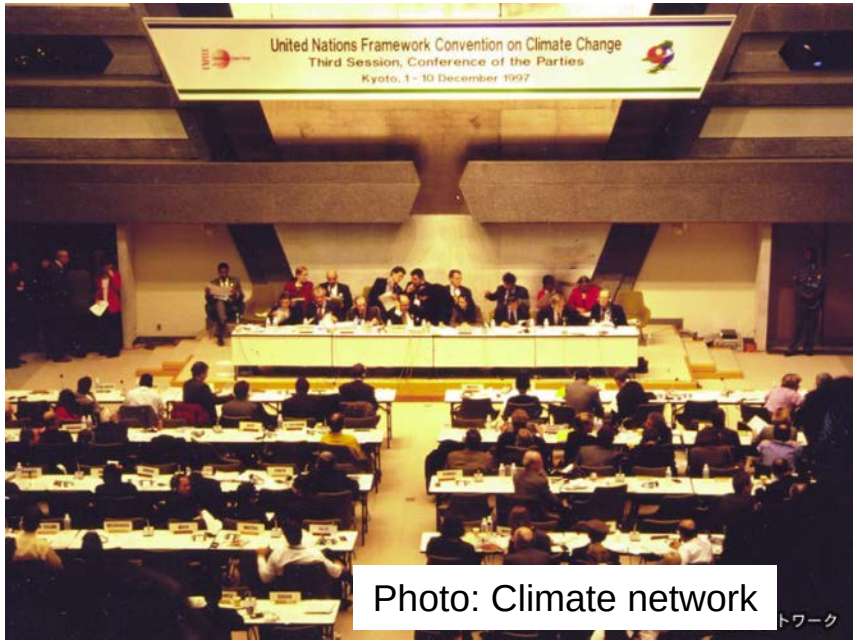


Photo: Climate network

http://www.jccca.org/

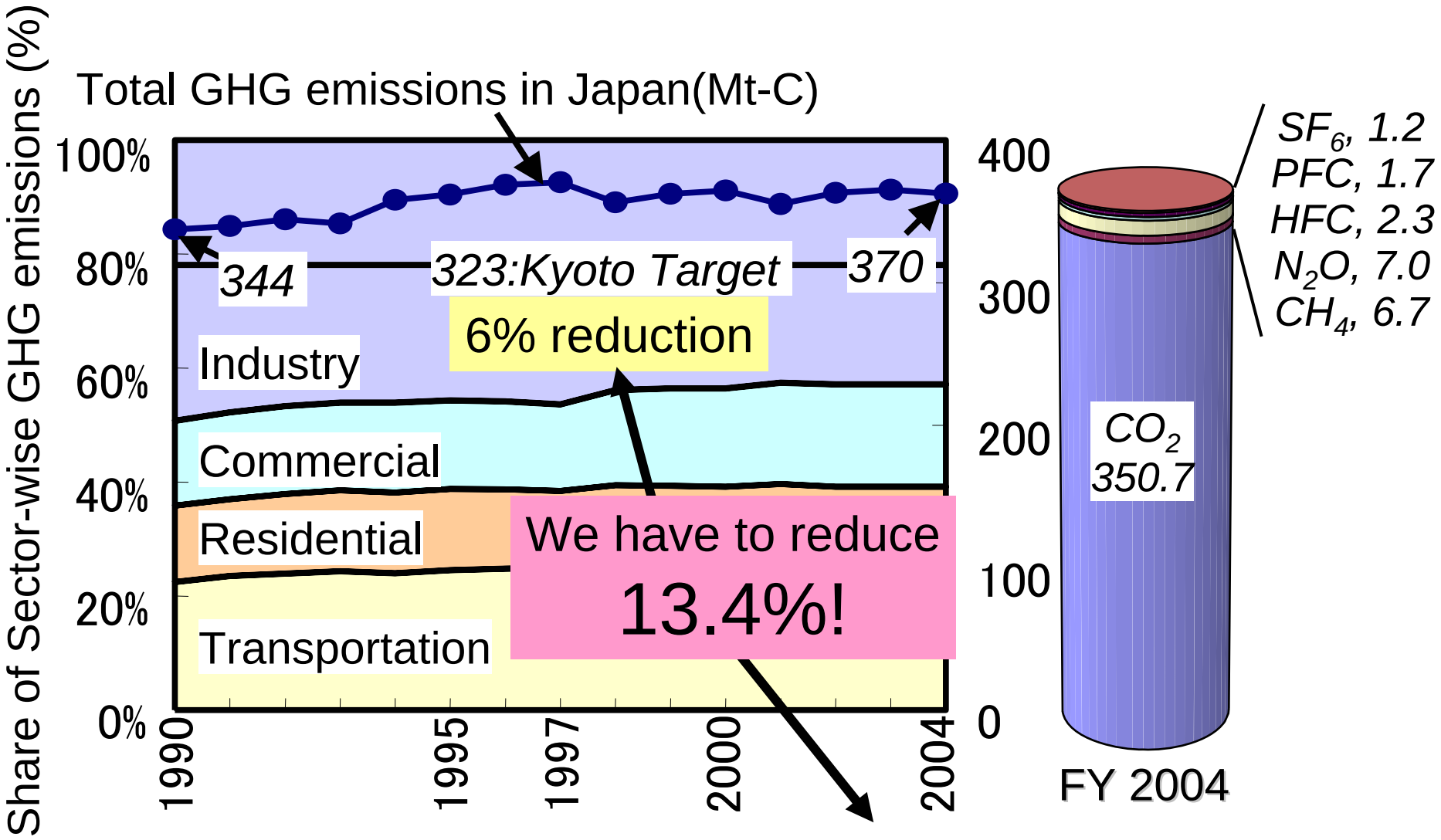
December 1997
Kyoto Protocol Adopted

http://www.nikkei.co.jp/neteye5/shimizu/20050217nd82h000_17.html

February 16 2005
Kyoto Protocol Enforced

Kyoto International Conference Room

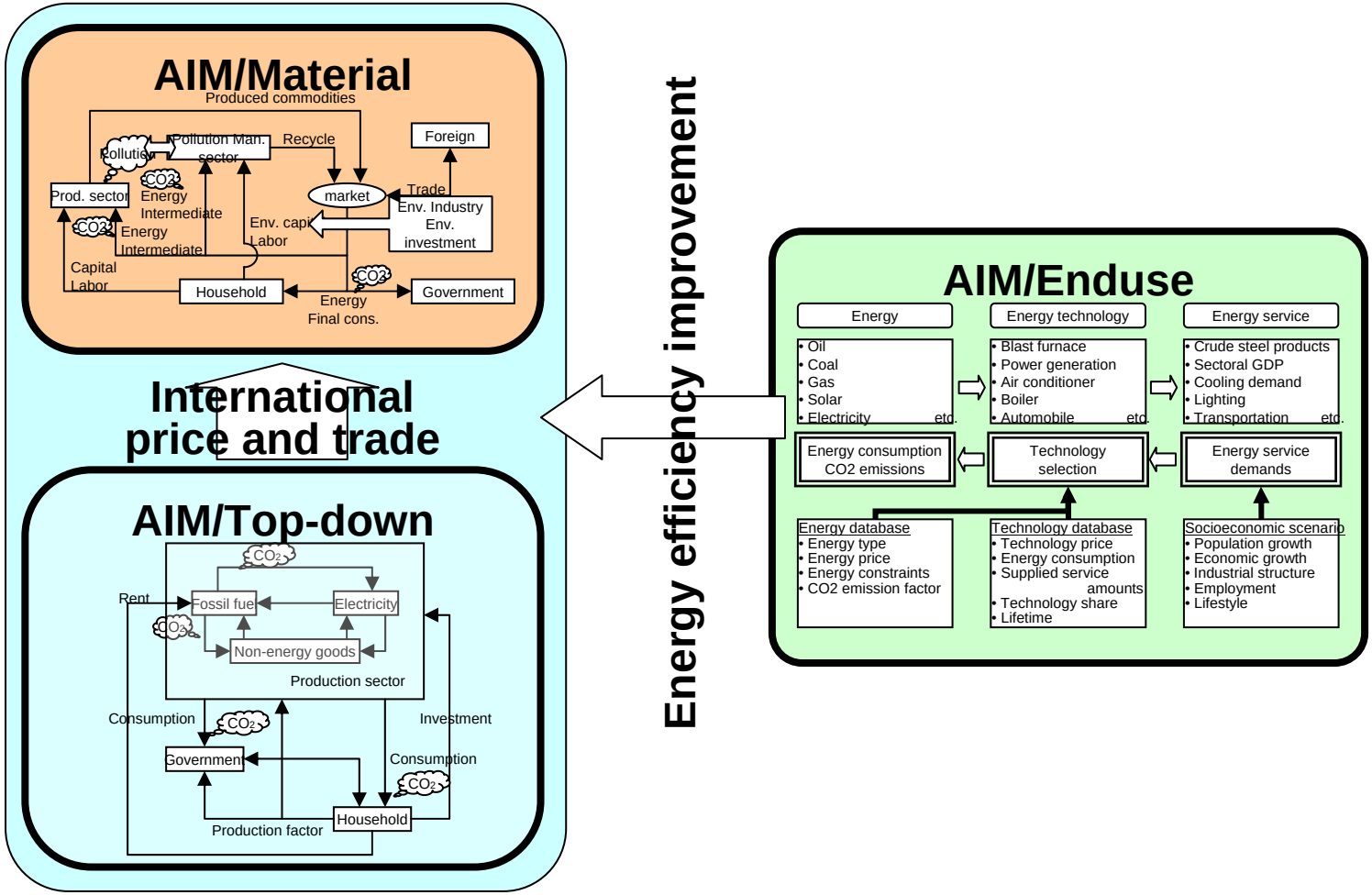
Can Japan observe Kyoto target?



National Greenhouse Gas Inventory Report of JAPAN (2006.8)
Ministry of the Environment, Japan
Greenhouse Gas Inventory Office of Japan (GIO), CGER, NIES

7.4% increase compared with that in 1990

Model analysis on CO2 reduction policy



AIM, NIES

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

AIM, NIES

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

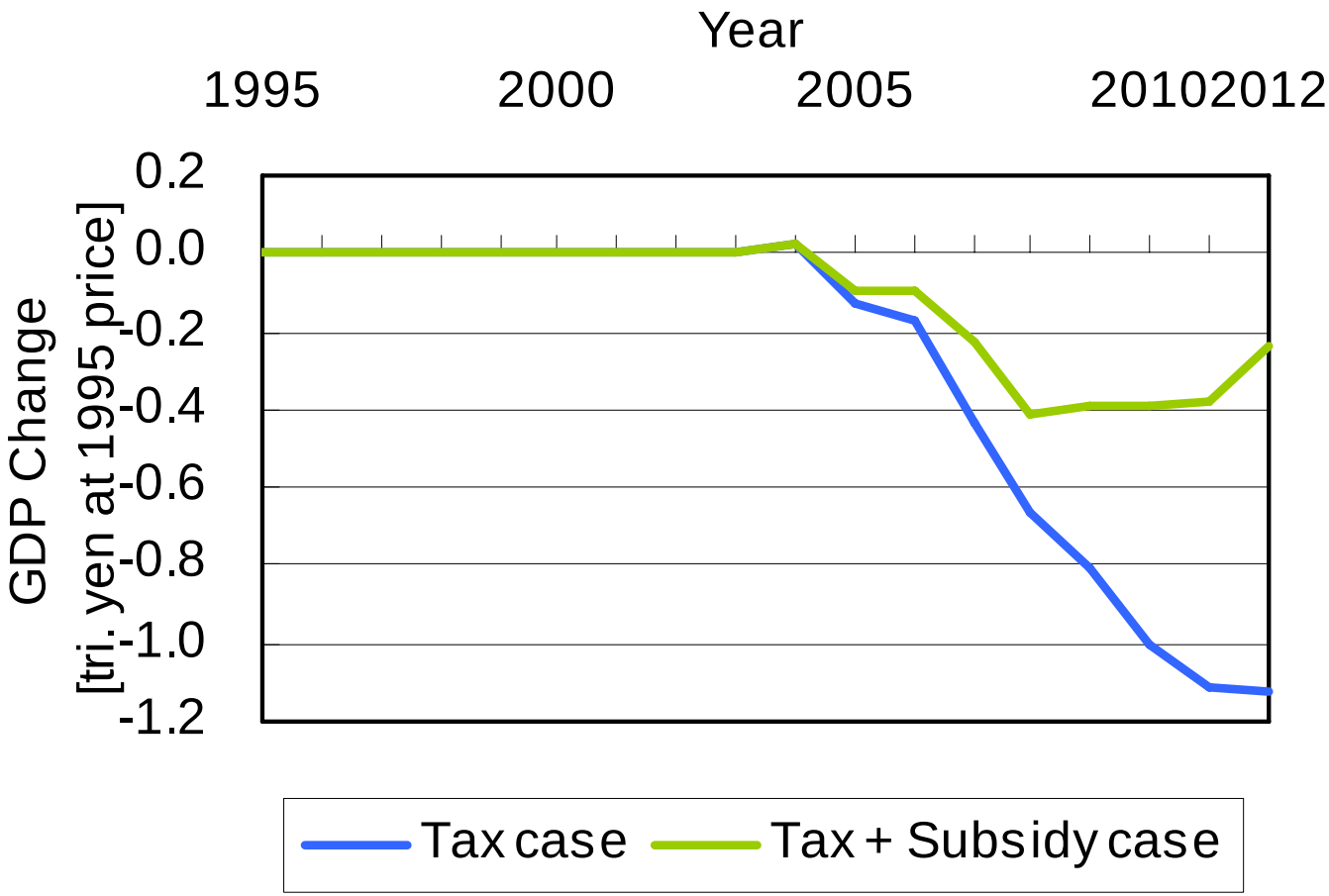
bil. JPY / year

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

Model analysis on CO2 reduction policy

-Country top-down model approach-

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



GDP change compared to the reference case

AIM, NIES

Melting Himalayan Glaciers

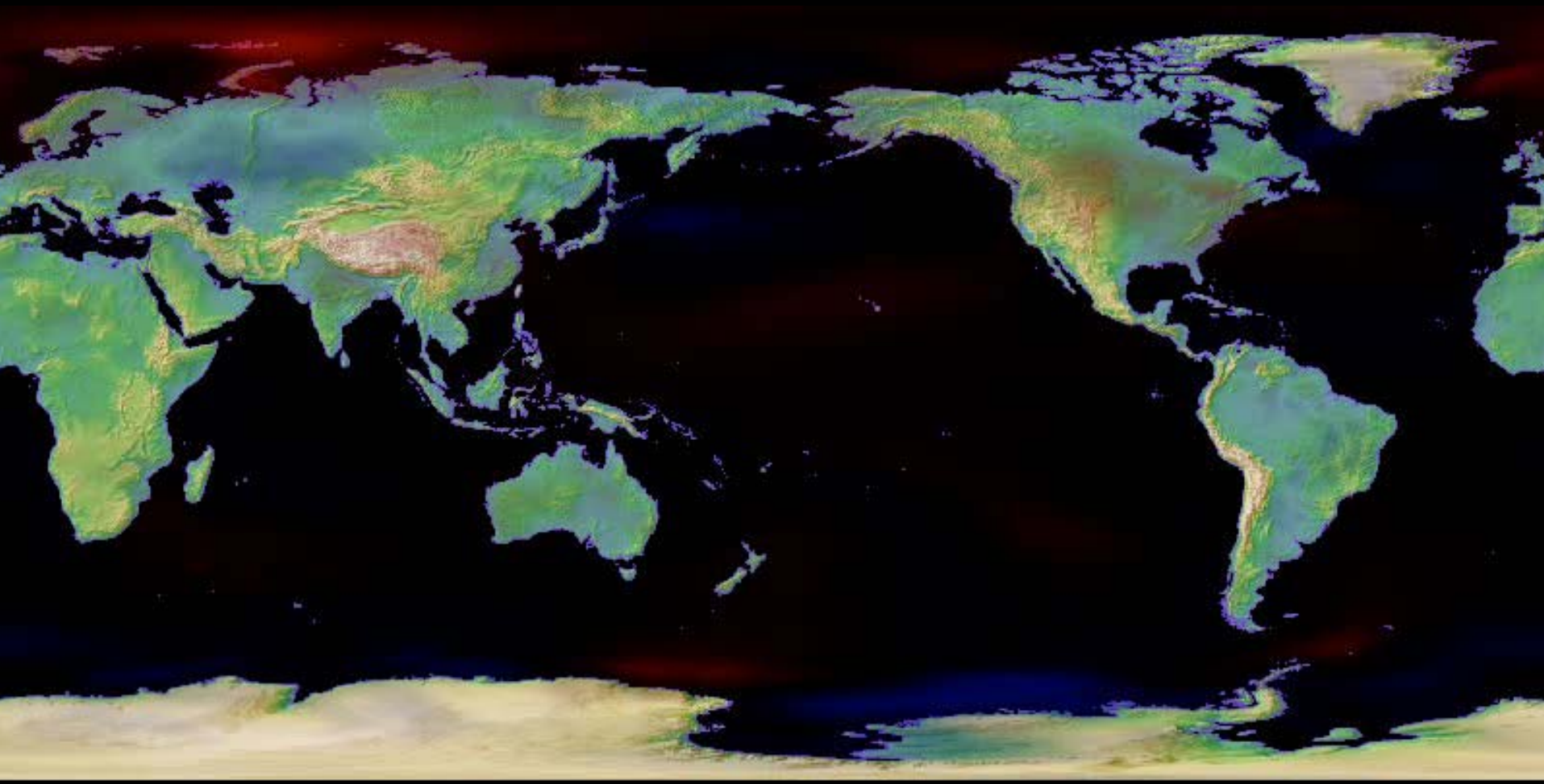
1978

1998

Mountainous glaciers were retreated drastically during 20th century

CCSR/NIES/FRCGC, Japan

Surface Air Temperature Change (1990=0 °C)



Observed Impacts of Global Warming

Retreat of Glaciers

Tianshan Glaciers (disappeared by 22% for the past 40 years)

Tibettian Glaciers (disappeared 4420km^2 (9%) for the past 30 years)

Himalayan Glaciers (500,000 km2 to 100,000 km2 by 2035)

Heat Wave

45-49^{o}C in May, 2003 in India (1600 death)

2-3 ^{o}C increase in July, 2004 in Japan (heat stroke patients more than 600 in Tokyo)

Typhoon

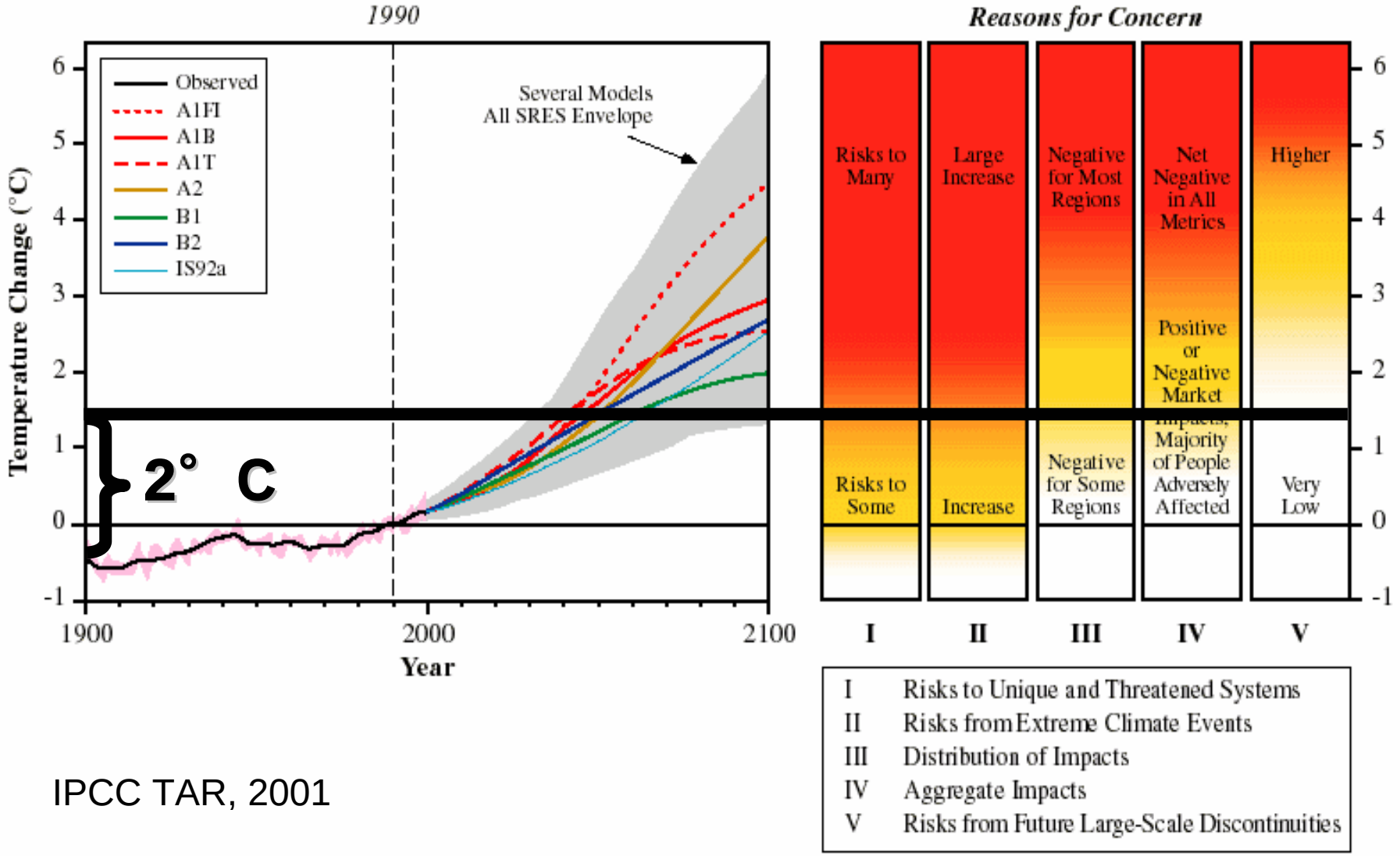
10 typhoon landed in 2004 in Japan (>200 death, 120 billion $ damage)

Increasing damage in Philippines (900 death, Nov. 2004, >500 , Dec. 2004)

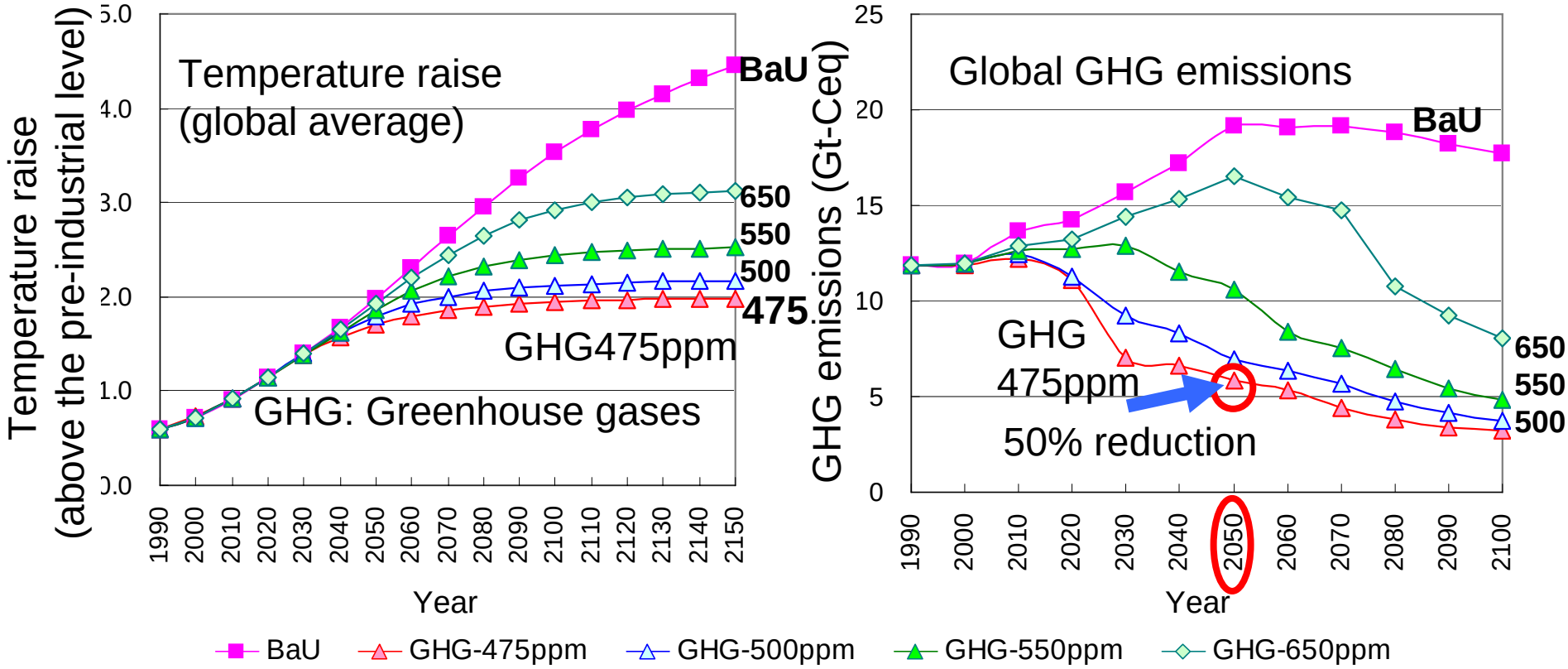
Wind Storm

Increasing wind storm in Mongolia

To avoid serious CC impacts, it is likely to be necessary of temperature raise stabilization below 2 degree compared with pre-industrialized level



IPCC TAR, 2001

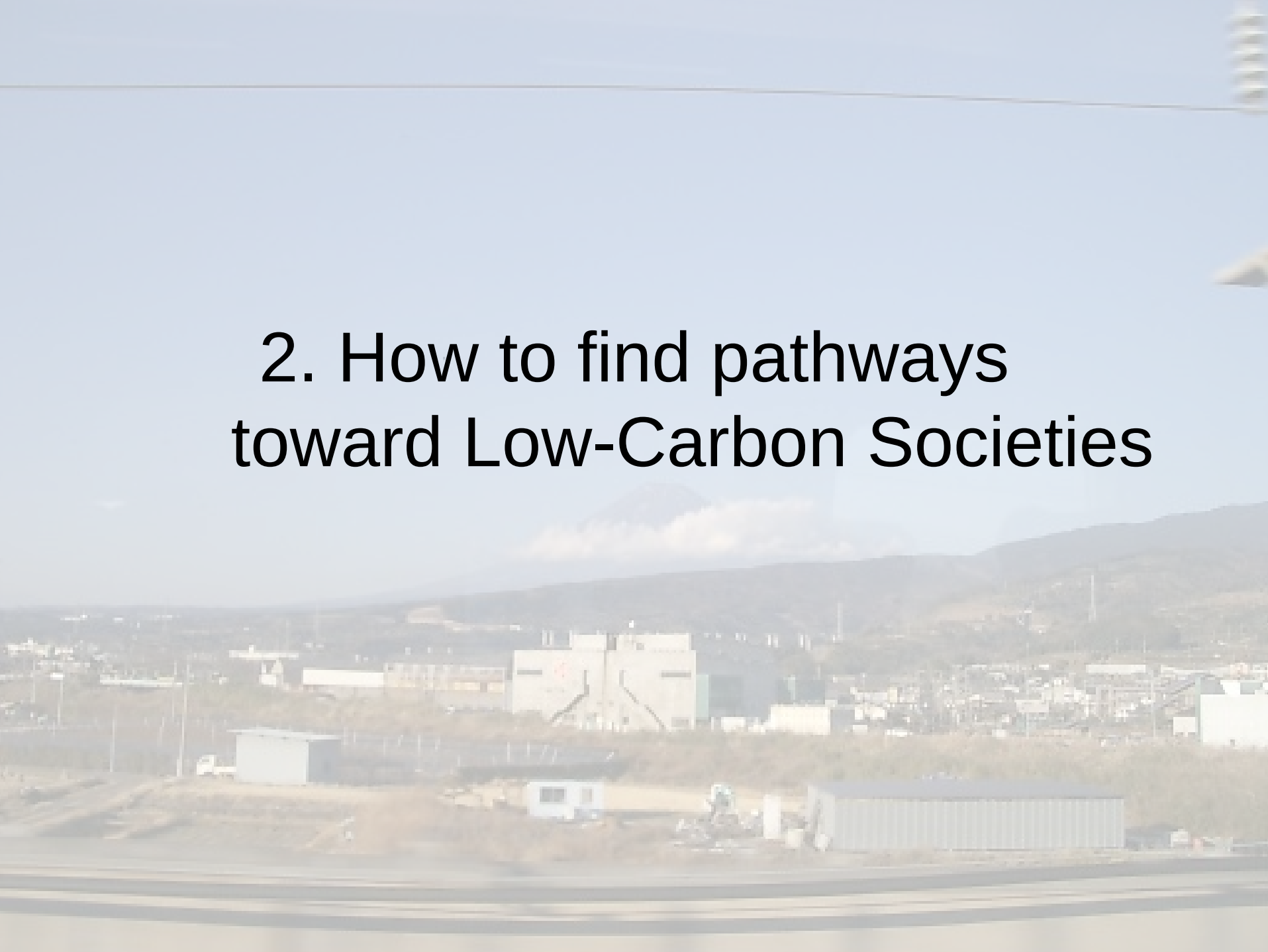


•It is estimated that around 50% GHG reductions in 2050 are required to control temperature raise below 2C

•Japan may be required more reduction (60-80%). Another country-level 2050 scenarios have been studied (UK 60%, Germany 80%, France 75%, and so on).

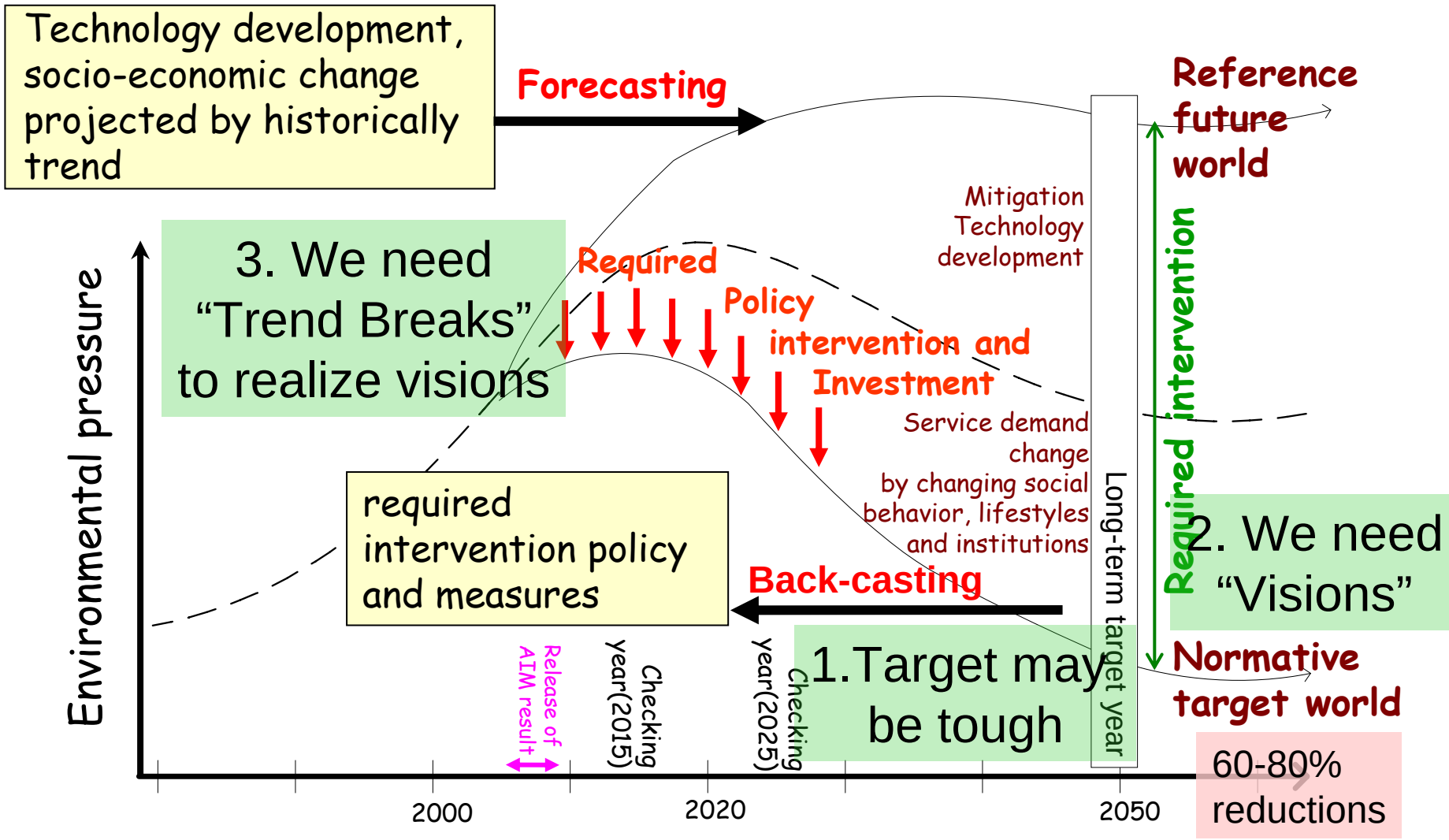
•Impacts will be occurred even in 2C temp control.
•Adaptation is necessary.

Calculated by AIM/Impact[policy] Model

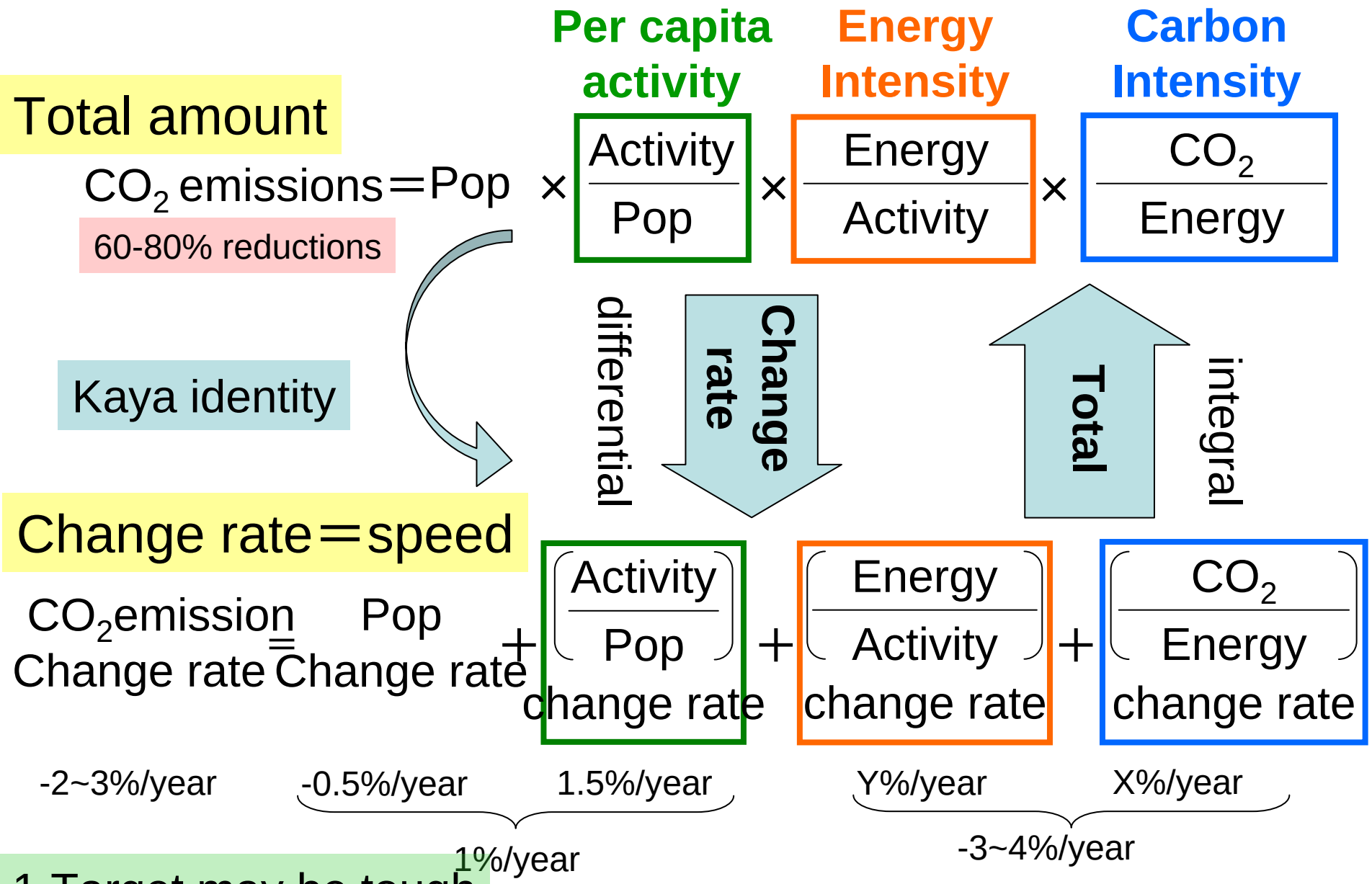


2. How to find pathways toward Low-Carbon Societies

Back-casting from future target world

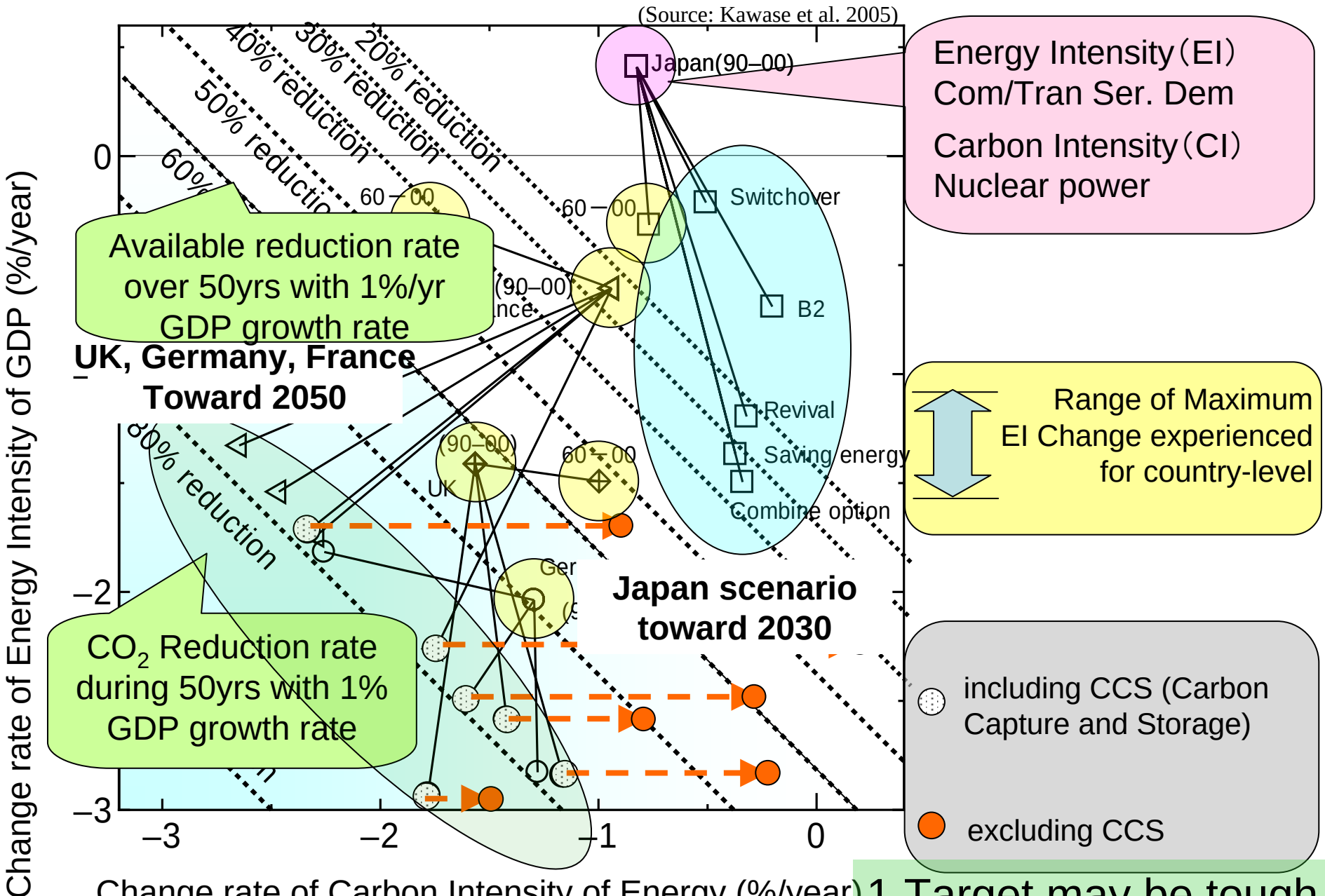


How fast GHG emissions should be reduced?



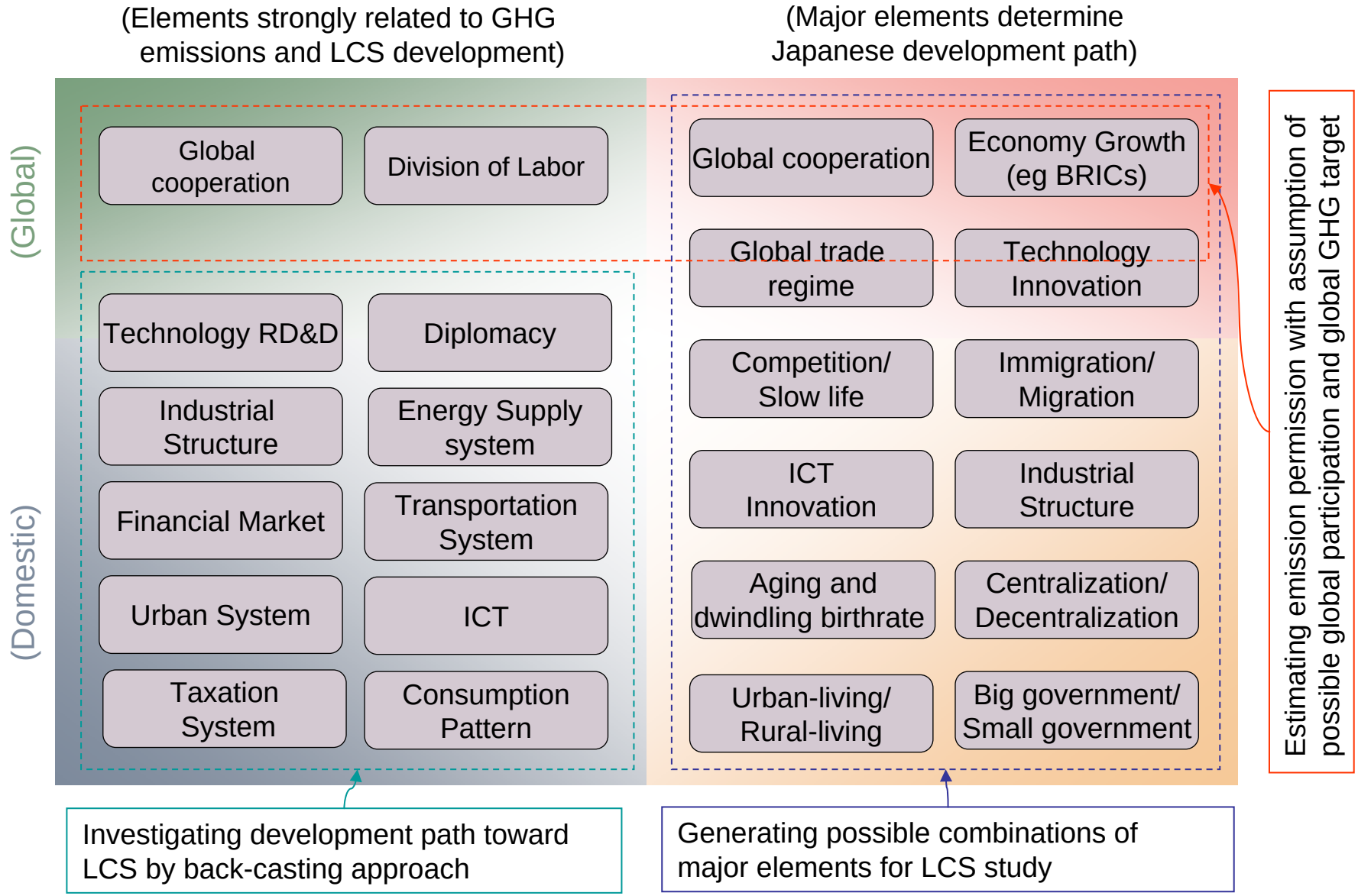
1.Target may be tough

How fast we have to reduce GHG emissions?



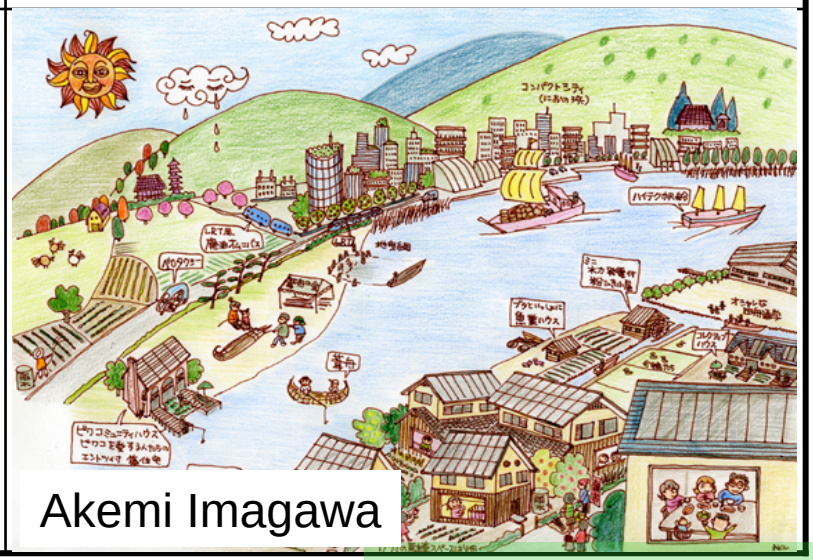
1.Target may be tough

Dominant elements for GHG emissions and national development for Japan



2. We need “Visions”

As for LCS visions, we prepared two different but likely future societies

Vision A	Vision B
Vivid, Technology-driven	Slow, Natural-oriented
Urban/Personal	Decentralized/Community
Technology breakthrough Centralized production /recycle	Self-sufficient Produce locally, consume locally
Comfortable and Convenient	Social and Cultural Values
	

Akemi Imagawa

Key concepts of two scenarios

Keywords		Scenario A	Scenario B
Mindset of people			
	Goal of life	· Social success	· Social contribution
	Residence	· Urban orientation	· Rural orientation
	Family	· Self-dependent	· Cohabitation
	Acceptance of Advanced technology	· Positive	· Prudent
Population			
	Birth rate	· Downslide	· Recover
	Immigration of foreign workers	· Positively accepted	· Status quo
	Emigration	· Increase	· Status quo
Landuse and cities			
	Migration	· Centralization in large cities	· Decentralisation
	Urban area	· Concentration in city centre · Intensive land use in urban area	· Population decrease · Maintain minimum city function
	Countryside	· Significant population decrease · Advent of new businesses for efficient use of land space	· Gradual population decrease · Local town development by local communities & citizens

2. We need “Visions”

Key concepts of two scenarios (2)

Keywords		Scenario A	Scenario B
Life and household			
	Work	- Increase in "Professionals" - High-income & over-worked	- Work sharing - Working time reduction & equalization.
	Housework	- Housekeeping robots & Services	- Cooperation with family & neighbours
	Free time	- Paid - for activity - Improving carrier - Skill development	- With family - Hobby - Social activity (i.e Volunteer activity)
	Housing	- Multi-dwellings	- Detached houses
	Consumption	- Rapid replacement cycle of commodities	- Long lifetime cycle of commodities (Mottainai)
Economy			
	Growth rate	- Per capita GDP growth rate:2%	- Per capita GDP growth rate:1%
	Technological Development	- High	- Not as high as scenario A
Industry			
	Market	- Deregulation	- Adequate regulated rules apply
	Primary Industry	- Declining GDP share - Dependent on import products	- Recovery of GDP share - Revival of public interest in agriculture and forestry
	Secondary Industry	- Increasing add value - Shifting production sites to overseas	- Declining GDP share - High-mix low-volume production with local brand
	Tertiary industry	- Increase in GDP share - Improvement of productivity	- Gradual increase in GDP share - Penetration of social activity

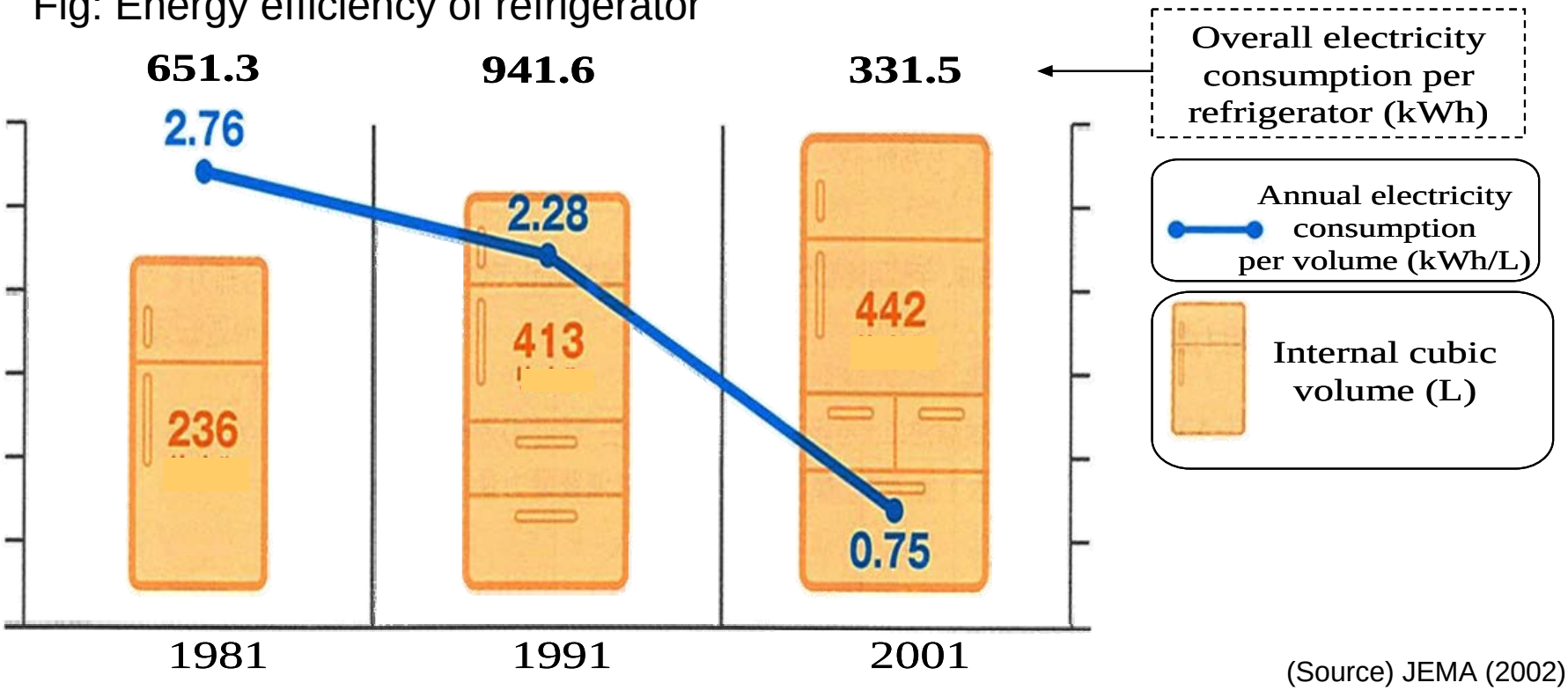
2. We need "Visions"

Top Runner Program: Efficiency Improvement

-The “Top Runner Program” has
  -stimulated competition and innovation in the market,
  -diffused existing technologies, and
  -enhanced industrial competitiveness

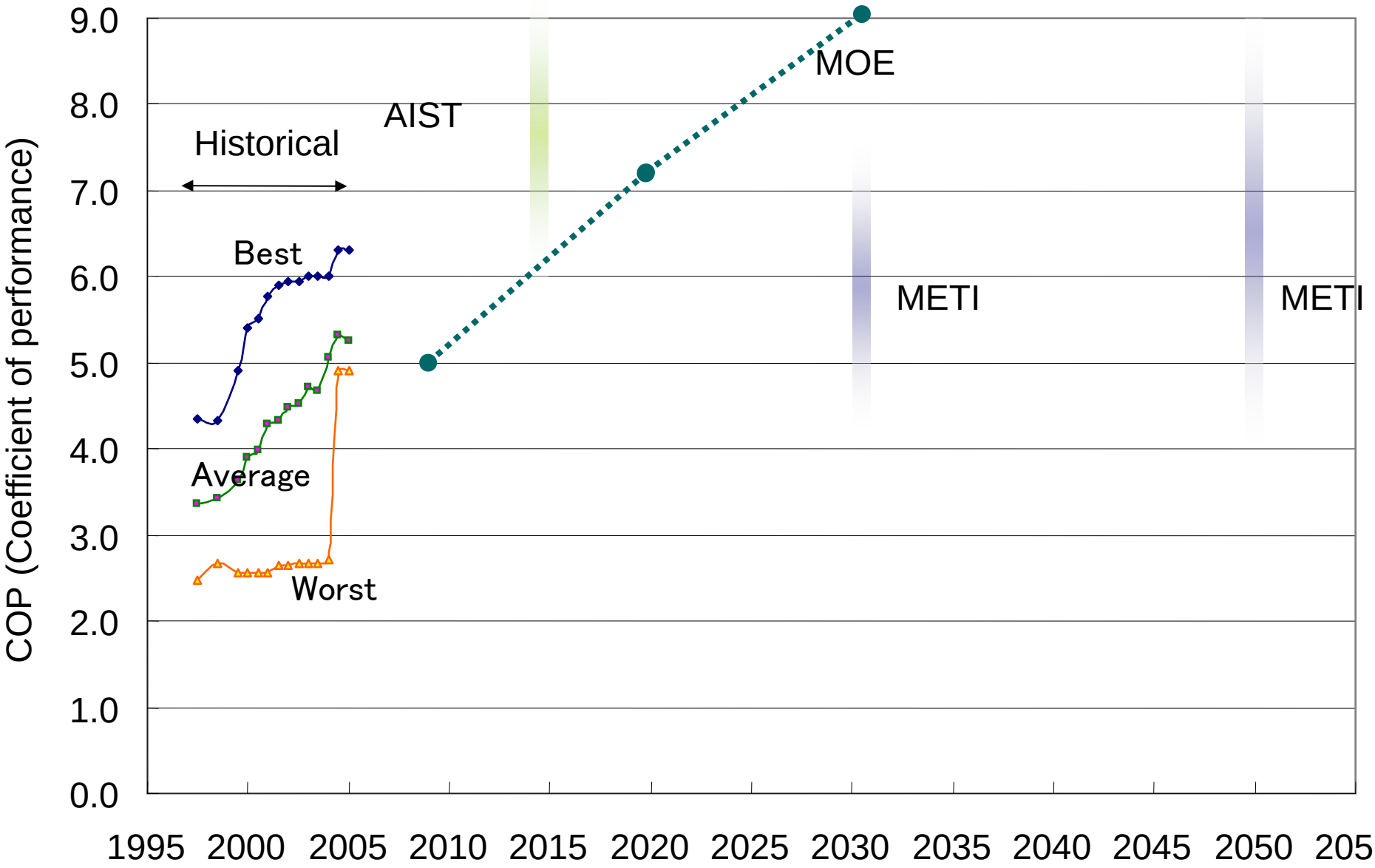
-It created “win-win” situation and virtuous cycle.

Fig: Energy efficiency of refrigerator



(Source) JEMA (2002)

Projected energy efficiency improvement: Air-conditioners for cooling and heating



On these two scenarios, we allocate possible trend-breaking options

Sector	Scenario A	Scenario B
Industry	· Energy efficient production technology	· Energy efficient production technology
Residential and Commercial	· Insulation of the building · Diffusion of all-electric home · Diffusion of high efficiency heat pump air conditioner and water heater · Development and diffusion of fuel cells · Optimal energy control by HEMS	· Insulation of the building · Installing PV (especially in detached houses) · Use of biomass fuels for cooling · Diffusion of solar water heating · Education (Eco life navigation system)
Transportation	· Shortening trip distance for commuting by intensive land use · Modal shift from cars to mass transit systems (buses, railways, LRTs) · Diffusion of motor drive cars such as electric vehicles and fuel cell vehicles	· Urban structures becoming more compact · Infrastructure development for foot and bike passengers (sidewalk, bikeway, cycle parking) · Diffusion of biomass hybrid cars · Modal shift from cars to railways and to ship for freight transportation
Energy supply	· Expansion of nuclear power generation · Electric load levelling and expansion of electric storage (ex. Store the electricity generated in night time and use it for electric vehicles · High efficient fossil fuel technologies+CCS · Hydrogen production from fossil fuel+CCS · Infrastructure development for hydrogen production, transportation, storage, application	· Expansion of renewable energy use (wind, photovoltaic, solar thermal, biomass) · Application of Information technologies (IT) for load adjustment
Stock and waste management	· Less material use for production by technology development · Advancement of recycling technologies	· Expanding lifetime of the goods · Decrease in final demand due to departure from material wealth yardsticks · Recycled product preference of the consumer

3. We need “Trend Breaks” to realize visions

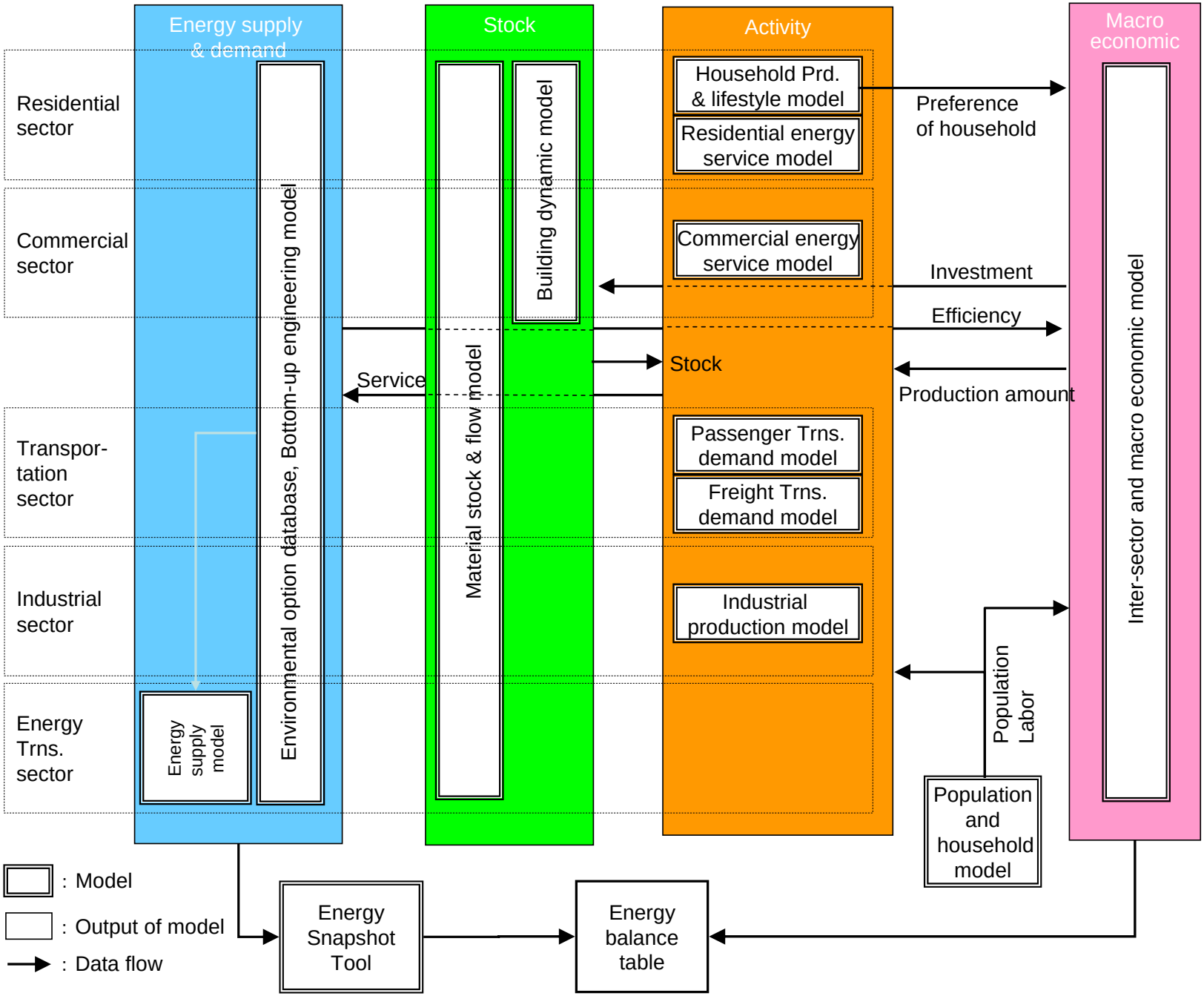
To analyze the feasibility and impacts of interventions with the models

	Items to be considered		Developed Models
Industry	a. Changes in industrial structure and technological development on energy consumption as well as productivity	-	Inter-sector and Macro Economic Model
Domestic and Commercial	b. Changes in building distribution by climatic zone	-	Building Dynamics Model (b-e)
	c. Changes of the share of detached and multidwelling houses	-	Household Production and Lifestyle Model (f)
	d. Diffusion rate of insulated detached and multidwelling houses		
	e. Lifetime changes of the dwellings		
	f. Lifestyle changes on household consumption and allocation of the time		
Transportation	g. Changes in population distribution and local characteristics	-	Passenger Transportation Demand Model (g-i)
	h. Changes in social environment and human activities	-	Freight Transportation Demand Model (j-m)
	i. Changes in selectivity of the mode of passenger transportation by area		
	j. Changes in industrial structure		
	k. Dematerialization		
	l. Changes in producing/consuming area		
	m. Changes in selectivity of the mode of transportation by distance		
Energy supply	n. Function of load management and uncertainties of both energy supply and demand	-	Energy Supply and Demand Balance Model (n-p)
	o. Combination of small consumer and small energy sources + Electricity/Hydrogen		
	p. Feasibility of local production for local consumption		
Social system	q. Relationship between economic activities and stock/flow of the materials	-	Material Stock and Flow Model (q-s)
	r. Amount of waste derived from the stock		
	s. Effectiveness of recycling and its impacts		
Cross-sectional	t. Ensuring consistency among the sectors in terms of energy demand and supply	-	Menoco Model (t)
	u. Impacts of future technological choices on social energy efficiency	-	EDB (u)
	v. Ensuring economical consistency of LCS	-	Inter-sector and Macro Economic Model (v)

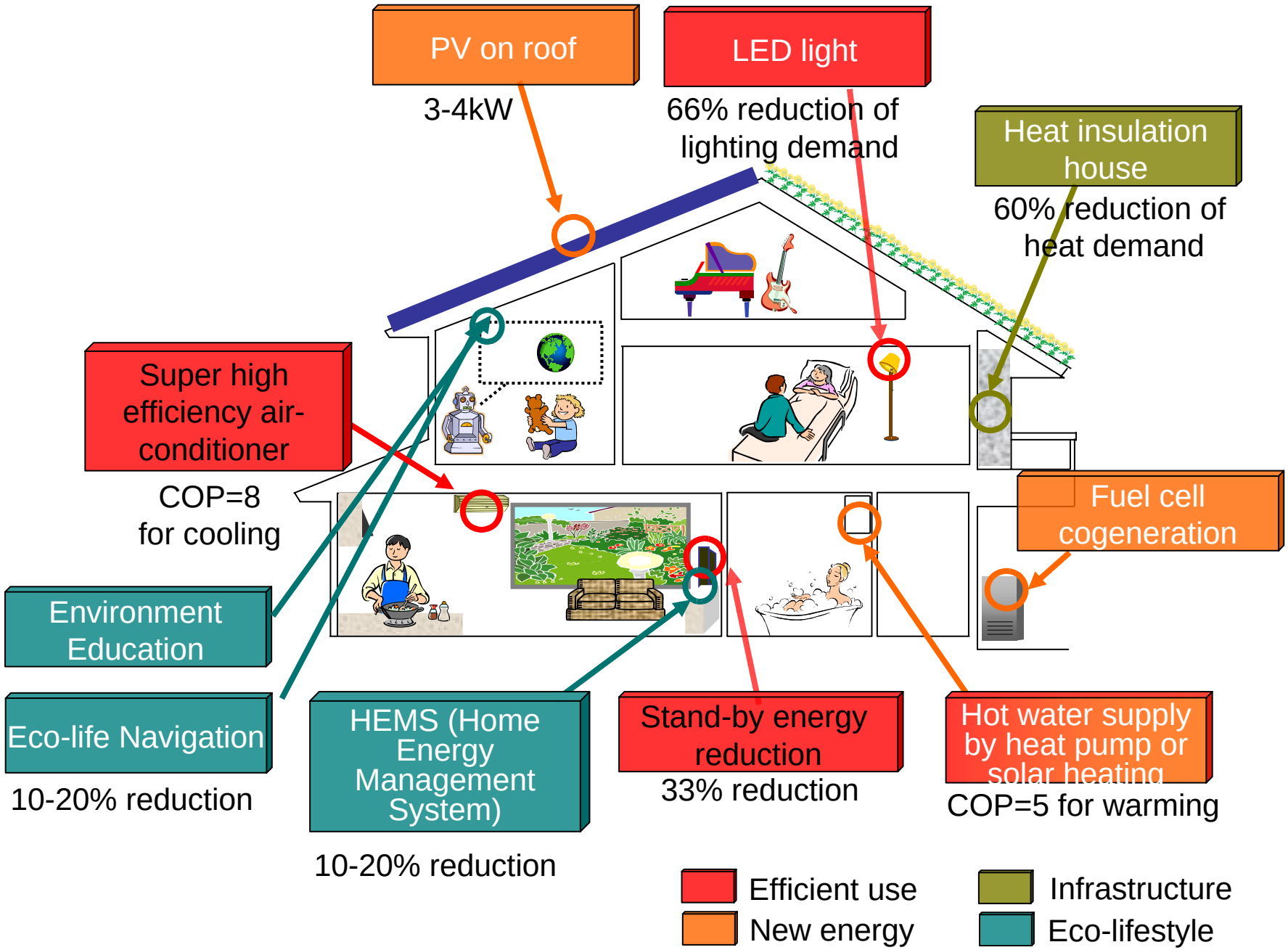
3. We need “Trend Breaks” to realize visions

Technology details: example of Hybrid vehicle

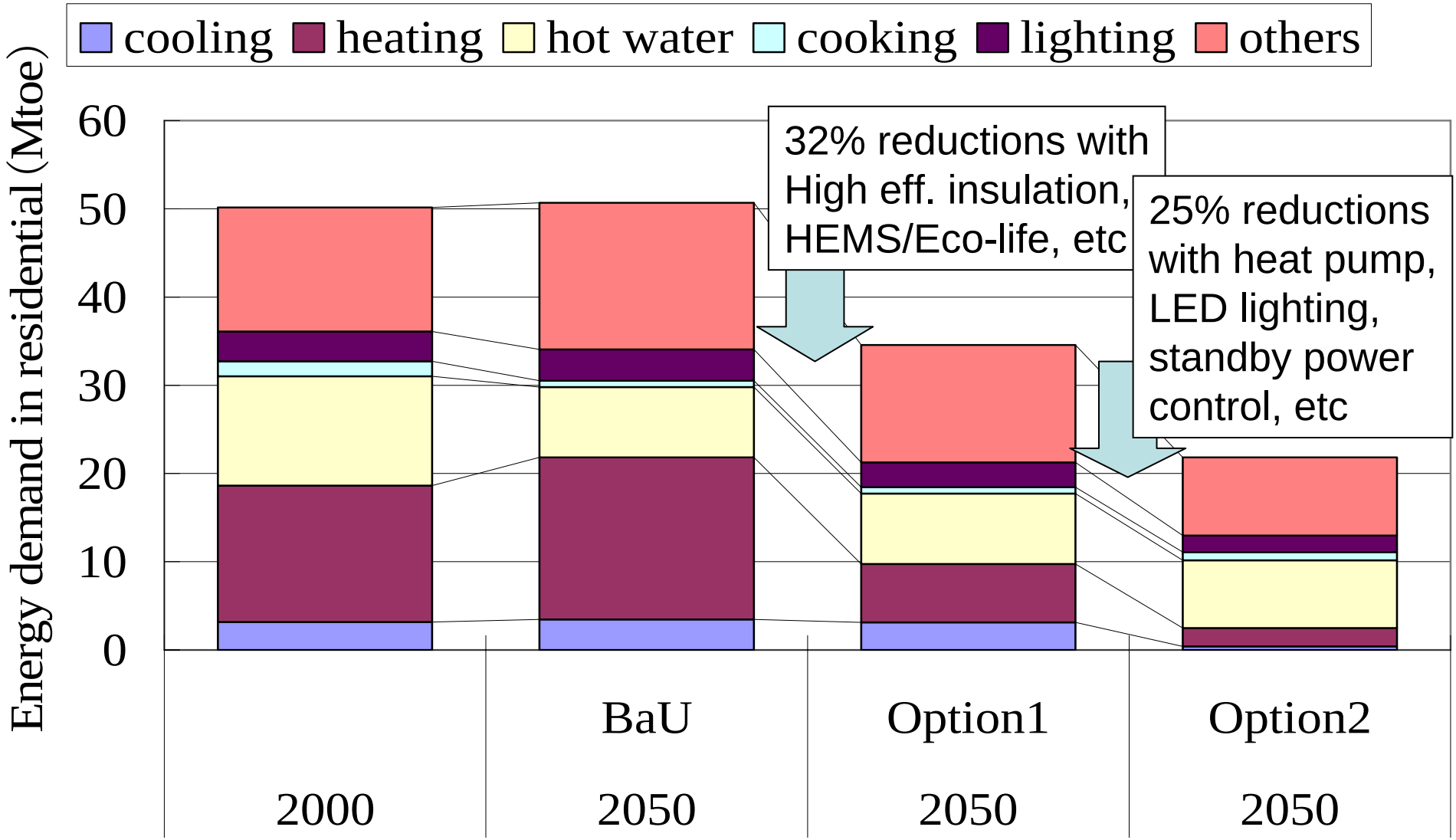
Hybrid vehicle


Energy supply & demand
Stock
Activity
Macro economic
Residential sector
Commercial sector
Transpor-tation sector
Industrial sector
Energy Trns. sector
Household Prd. & lifestyle model
Residential energy service model
Commercial energy service model
Passenger Trns. demand model
Freight Trns. demand model
Industrial production model
Building dynamic model
Material stock & flow model
Environmental option database, Bottom-up engineering model
Energy supply model
Inter-sector and macro economic model
Preference of household
Investment
Efficiency
Stock
Service
Production amount
Population
Labor
Population and household model
: Model
: Output of model
: Data flow
Energy Snapshot Tool
Energy balance table

Depict Future Image: Residential sector in 2050



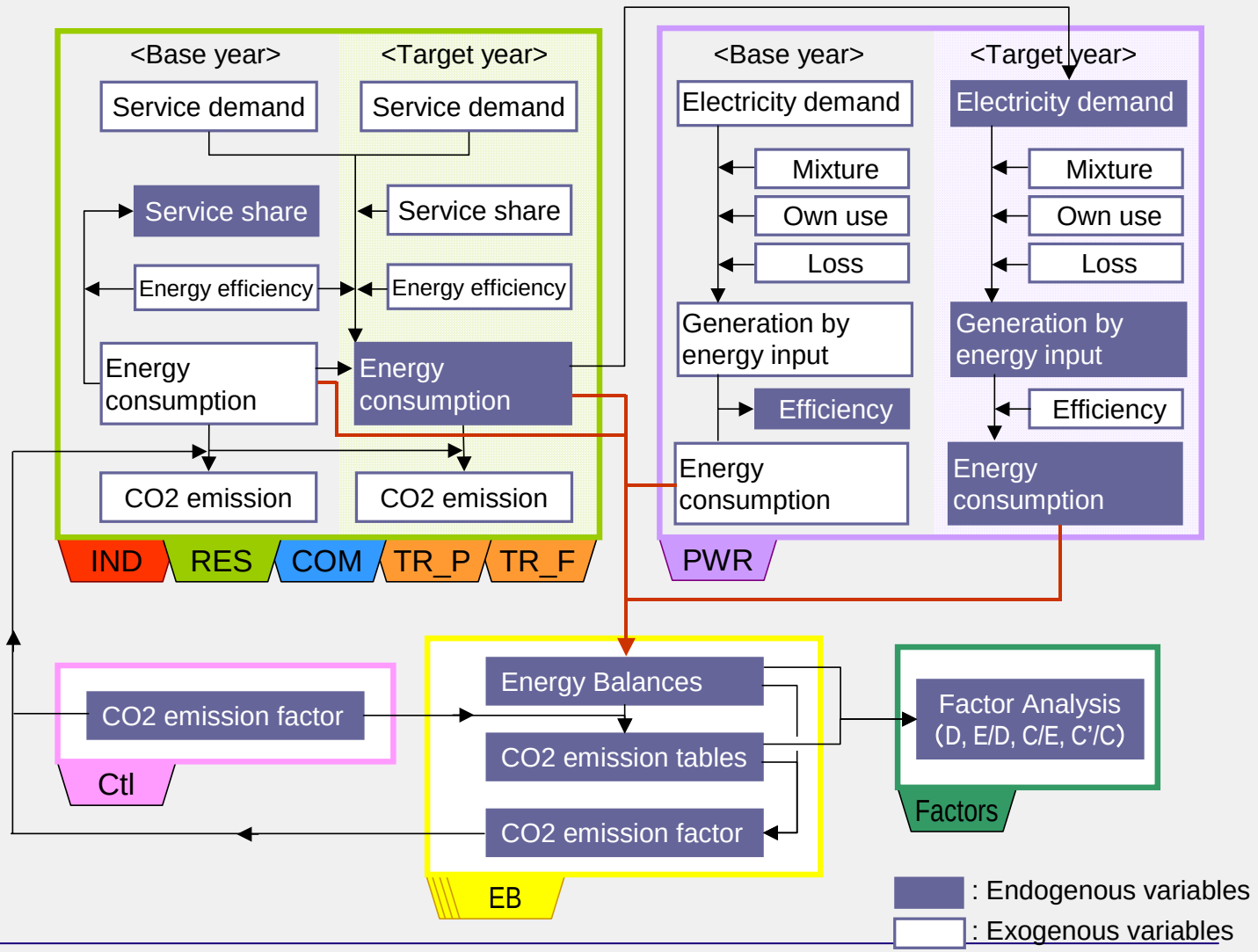
Energy demand in residential sector in Japan, 2050



UK, February 2005
"40% House"
60% reductions

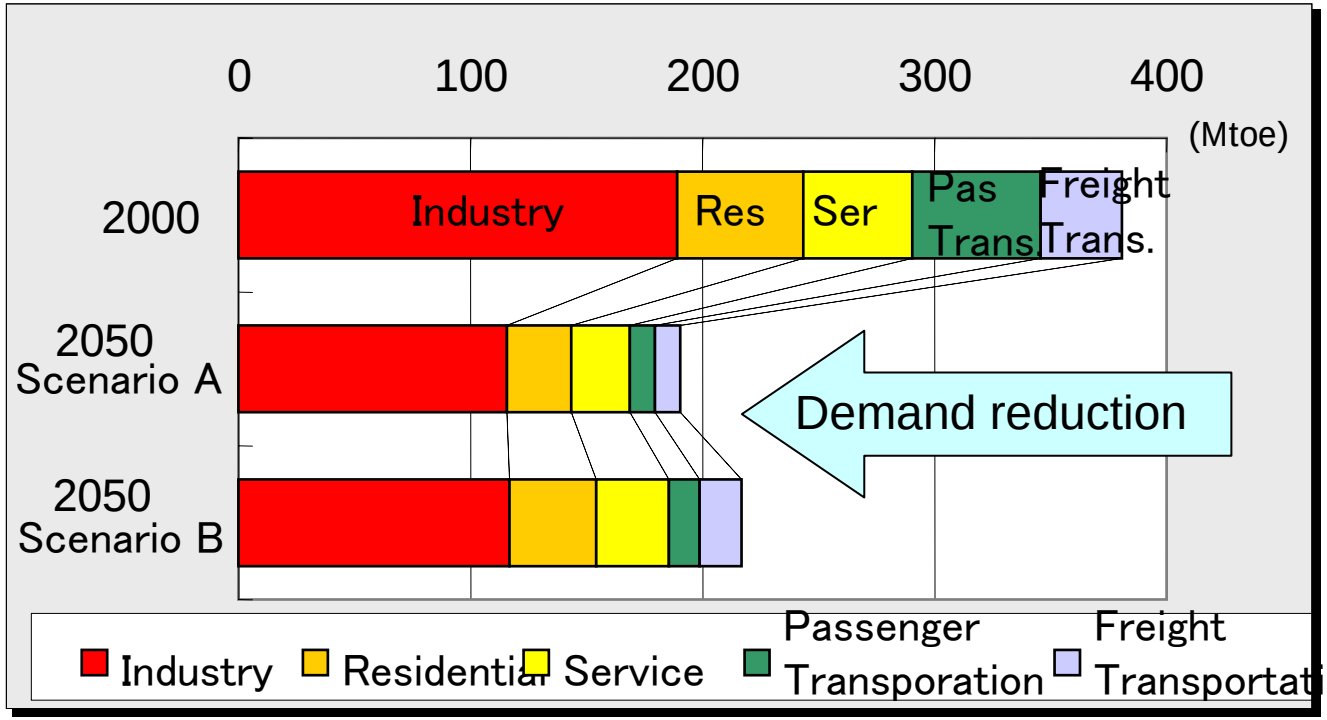
Japan, June 2005
Guidance for Self-sustained
Residential, 50% reductions

Structure of the model

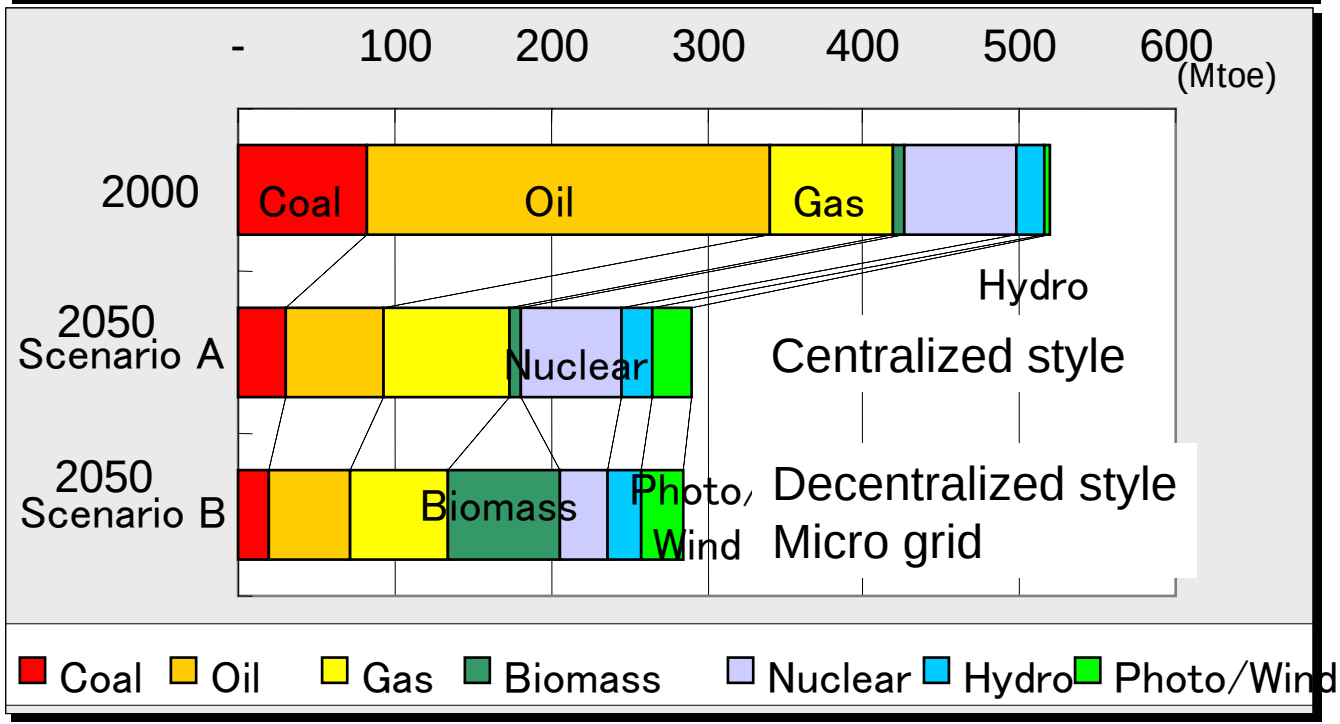


$CO_2$70% reductions

Energy demand structure

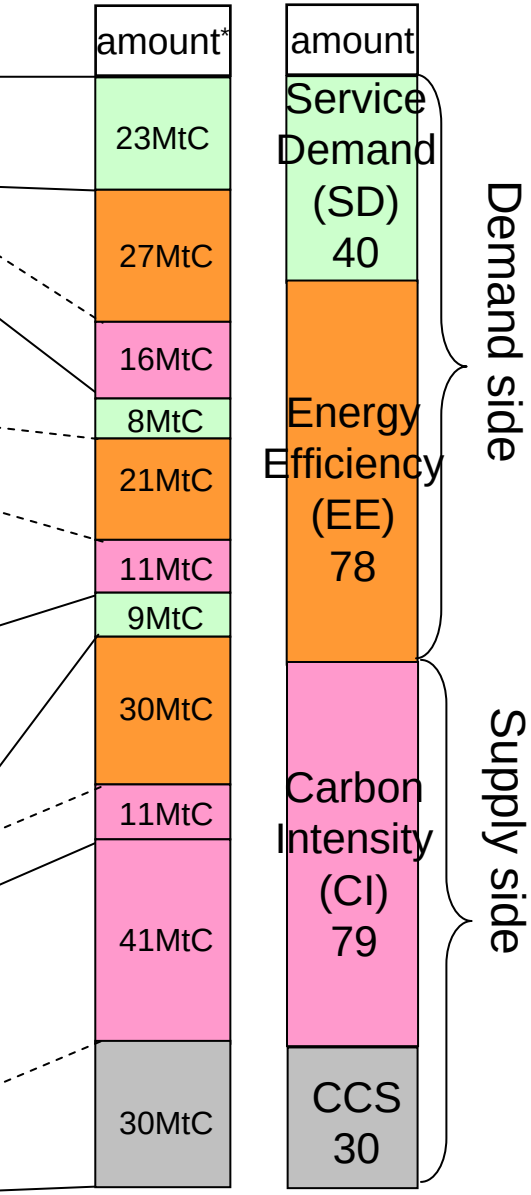


Energy supply structure



Countermeasures to achieve 70% reductions toward 2050 (A)

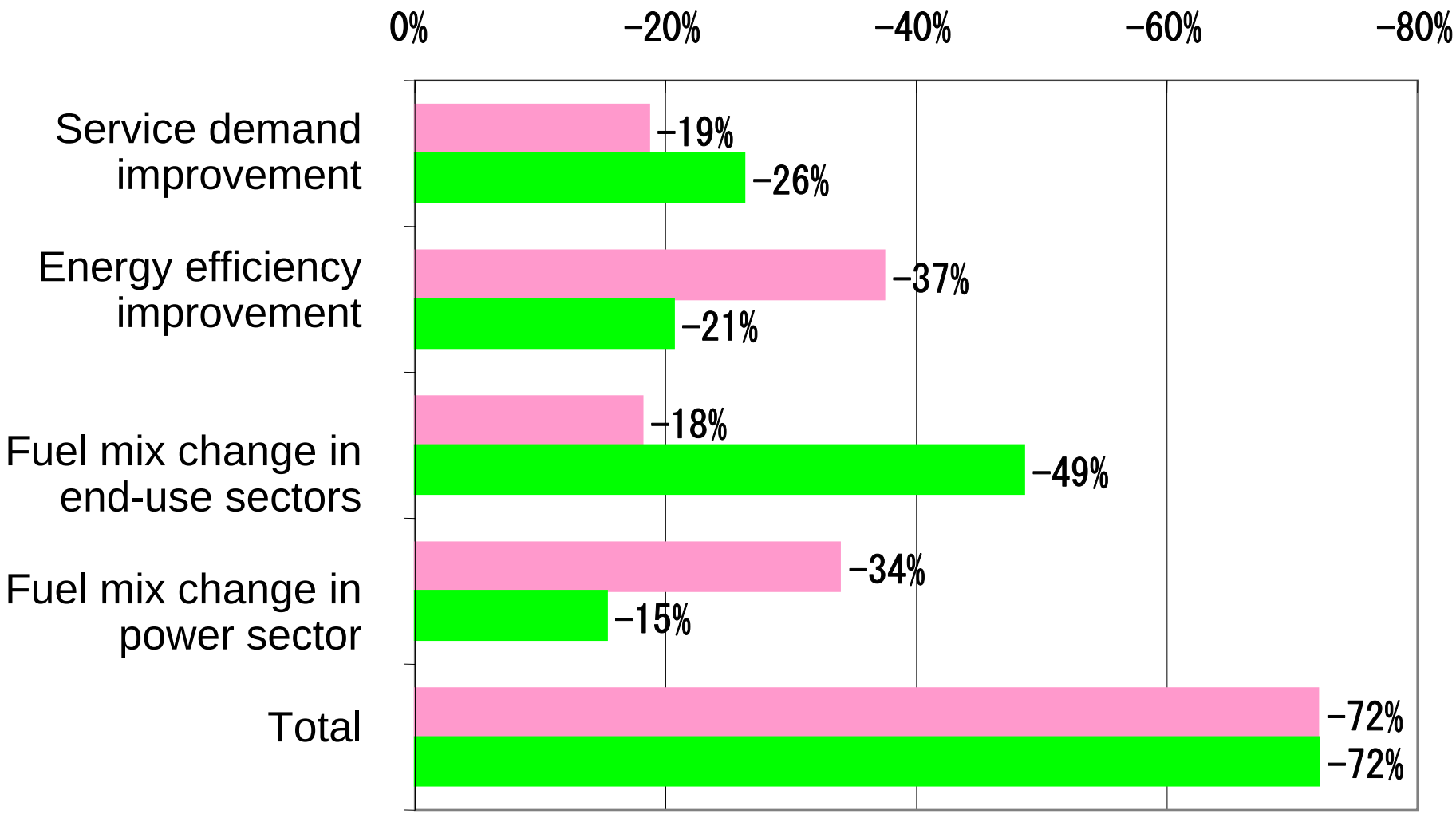
	Main driving forces to reduce CO2 emissions	Category	amount*
Society	・reduce raw material production ・decrease numbers of population/household	Activity	23MtC
Industry	・Production efficiency improvement	EE	27MtC
	・Increase rate of natural gas use	CI	
Residential	・Use of high insulation system ・Control of home energy system	SD	16MtC
	・High efficiency hair-conditioner, hot water heater, lighting system	EE	8MtC 21MtC
	・Fuel cell system, Photovoltaics on the roof	CI	11MtC 9MtC
Transportation	・Replacement of working/living place ・Public transportation	SD	30MtC
	・Motor-driven mobiles: Electric Battery Vehicles, Fuel Cell Battery Vehicles	EE	11MtC
		CI	41MtC
Energy supply	・Nuclear energy ・Use of electricity in night time, Electric storage ・CO2-free hydrogen supply	CI	
	・Advanced fire plant + CCS ・Hydrogen supply using fossil fuel + CCS	CCS	30MtC

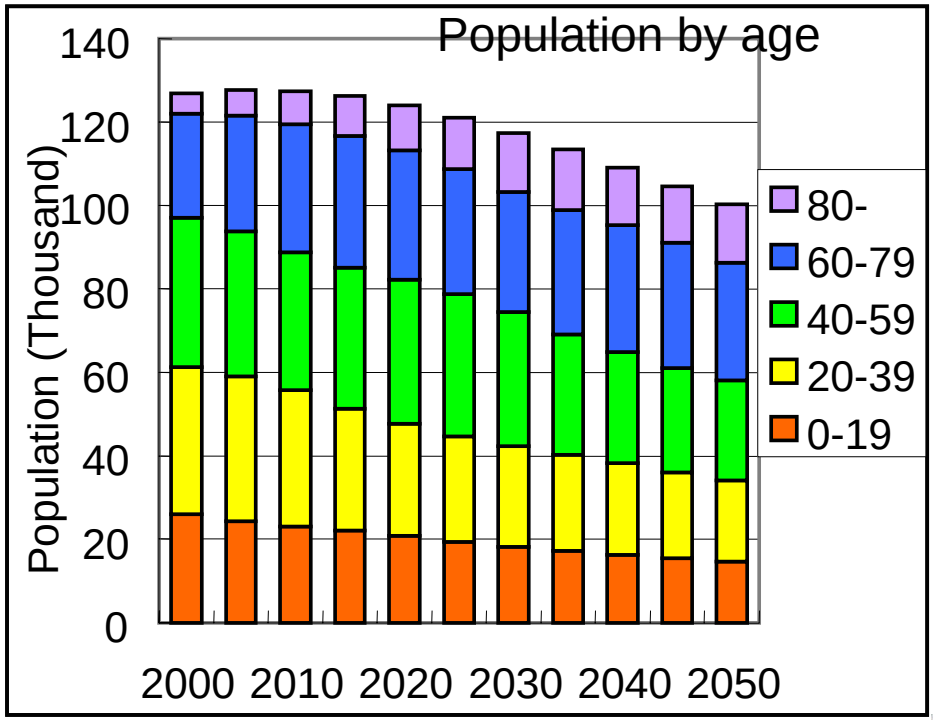


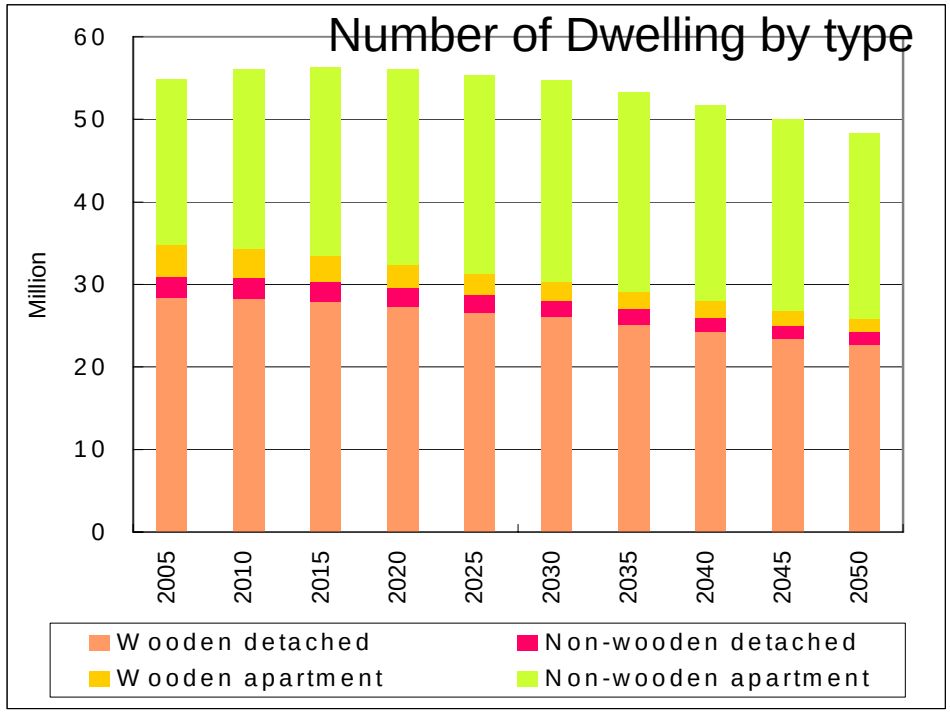
* CO2 reduction amount compared with the emissions in 2000

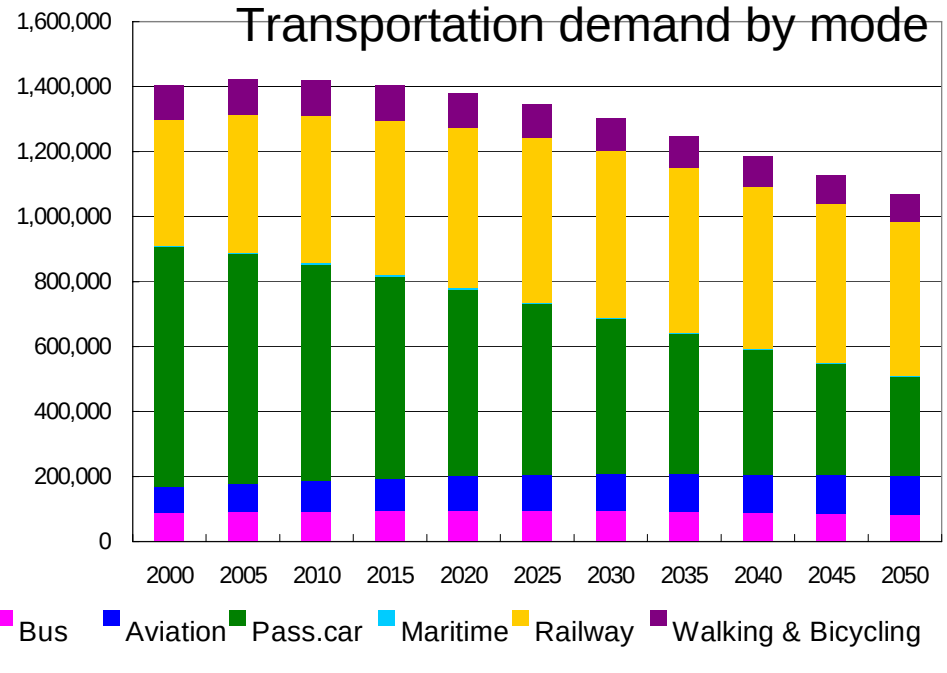
CCS: Carbon Capture Storage

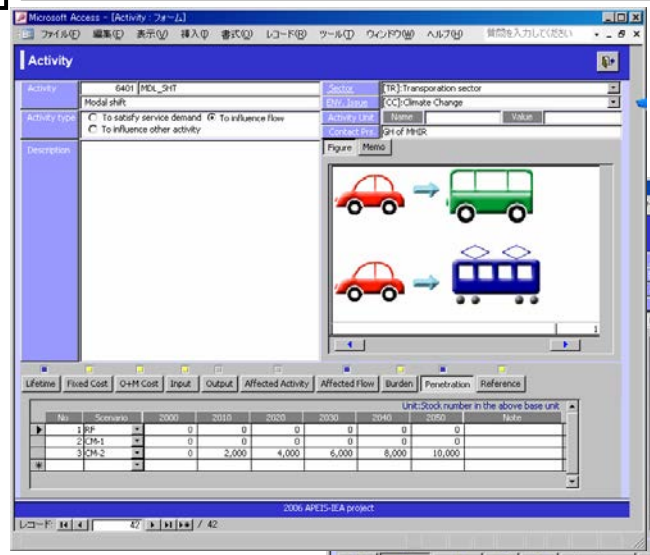
Factor decomposition of CO_2 emission reduction in 2050, Japan

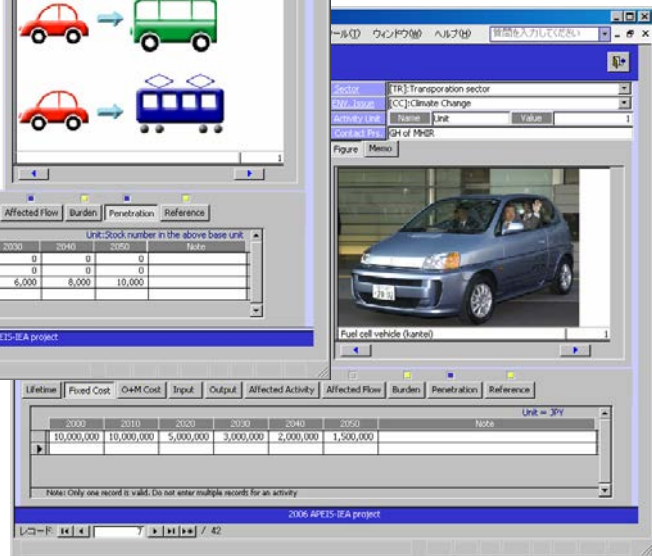



Population by age
Population (Thousand)
140
120
100
80
60
40
20
0
2000 2010 2020 2030 2040 2050
80-
60-79
40-59
20-39
0-19

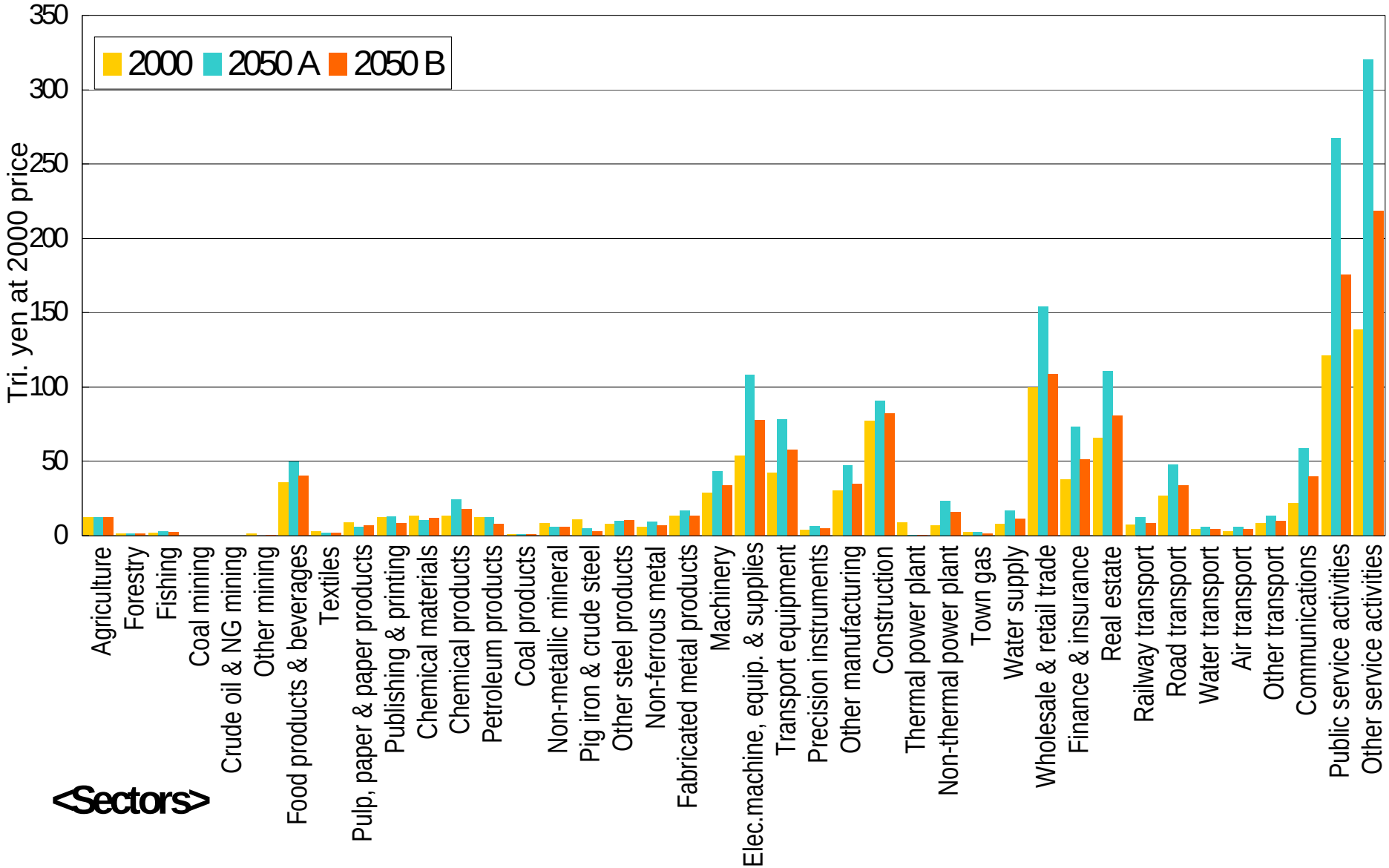

Number of Dwelling by type
Million
60
50
40
30
20
10
0
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Wooden detached
Non-wooden detached
Wooden apartment
Non-wooden apartment


Transportation demand by mode
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Bus
Aviation
Pass.car
Maritime
Railway
Walking & Bicycling

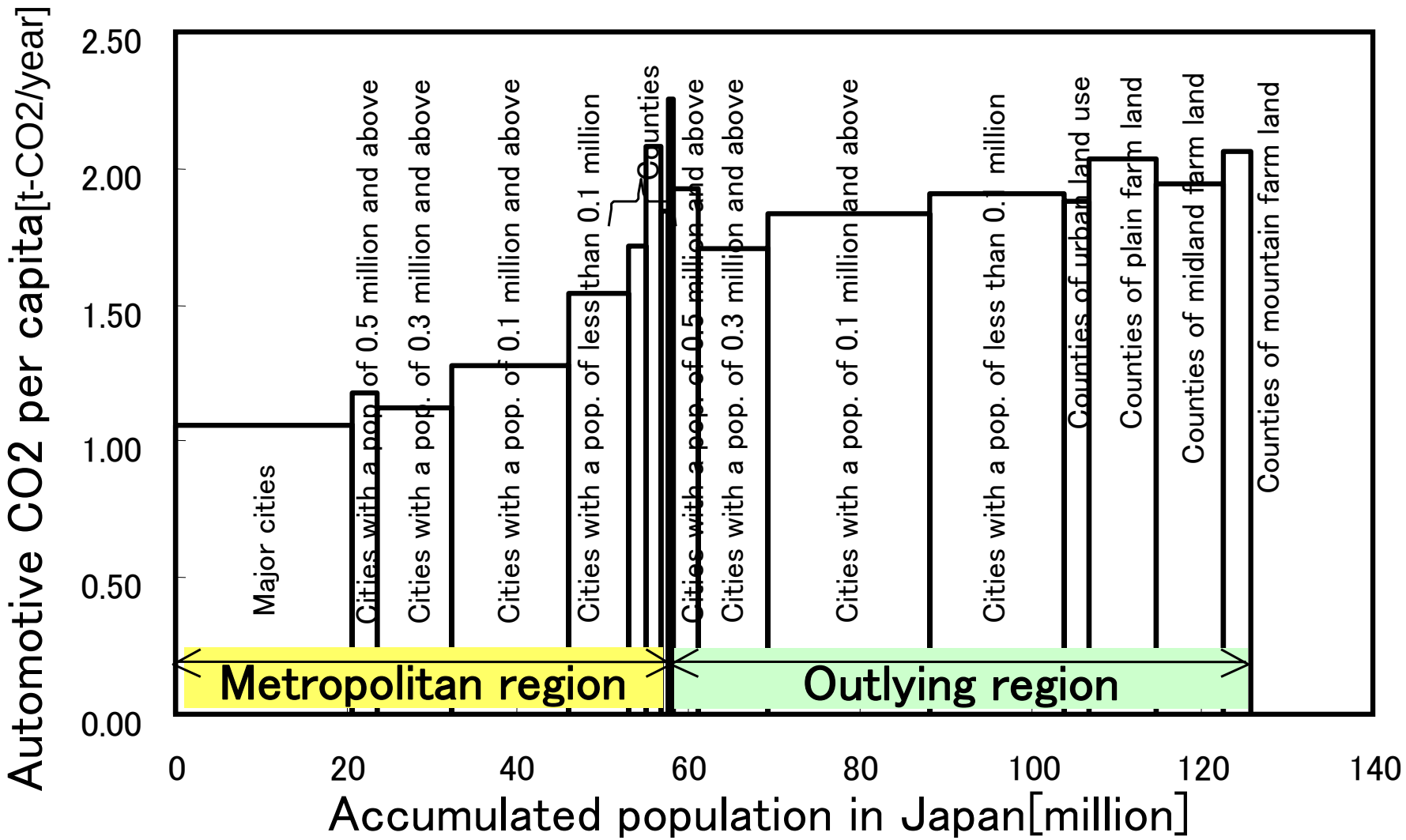

Activity
2006 APEIS-IEA project


Fuel cell vehicle (kanto)
2006 APEIS-IEA project

Economic impact analysis using CGE model



Estimated automotive CO_2 emissions by different regions in Japan



Moriguchi & Matsuhashi, 2005

Shiga Prefecture Visions

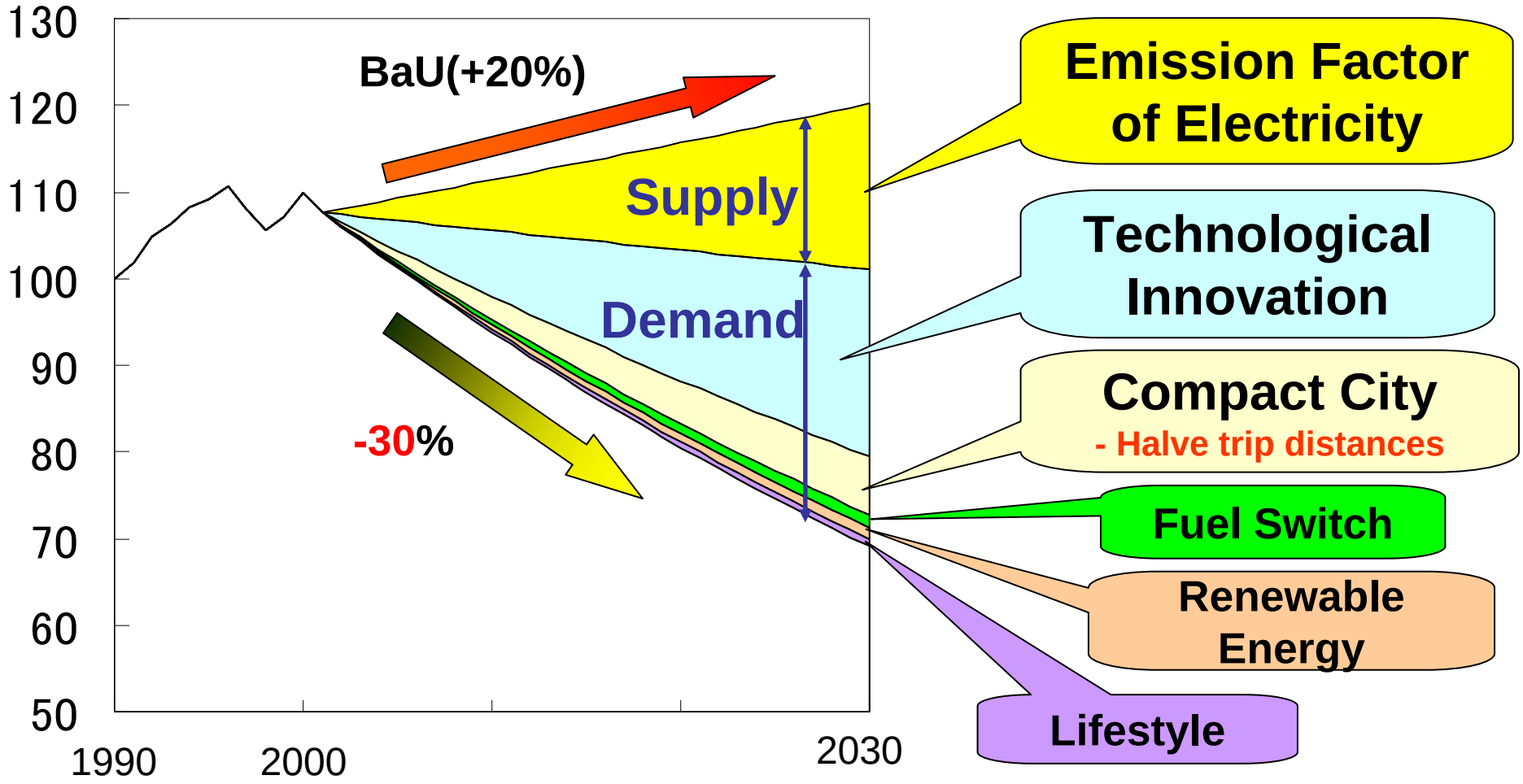
http://www.pref.shiga.jp/koho/2006-01/03.html

Location of Shiga Prefecture

Case A

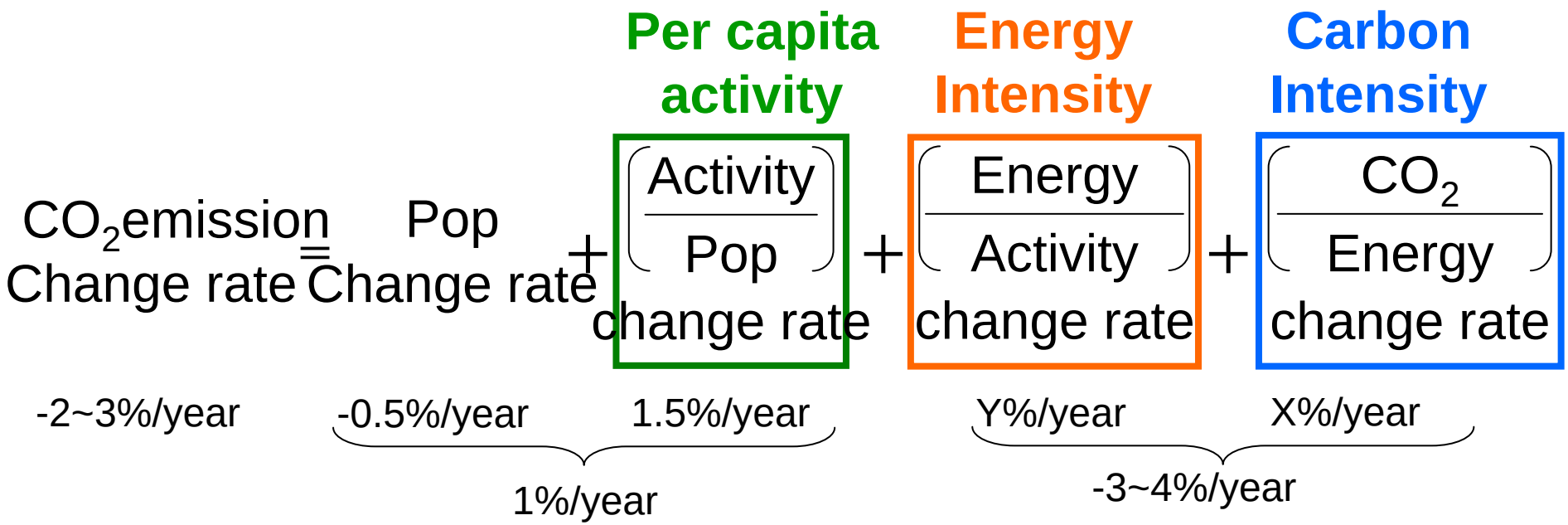
CO2 Emission Transitions (1990 level=100)

Shimada (2006)



1. Both supply & demand measures necessary to reduce CO_2 emission by 30%
2. Substantial contribution of compact city

How can we reduce GHG emissions?



Change of growth pattern

Green GDP
SD index
Lifestyle change

Enhance/Keep service level, use less energy

Energy Efficiency
Energy Saving
Eco-industry
Env. sound transpiration
Compact city

Use less GHG intensive fuel

Fuel switching
Renewables
Nuclear
CCS
Hydrogen/Fuel cell

3. We need global participation to realize low-carbon societies

NIES COP11 and COP/MOP1 side event
on December 3rd in Montreal

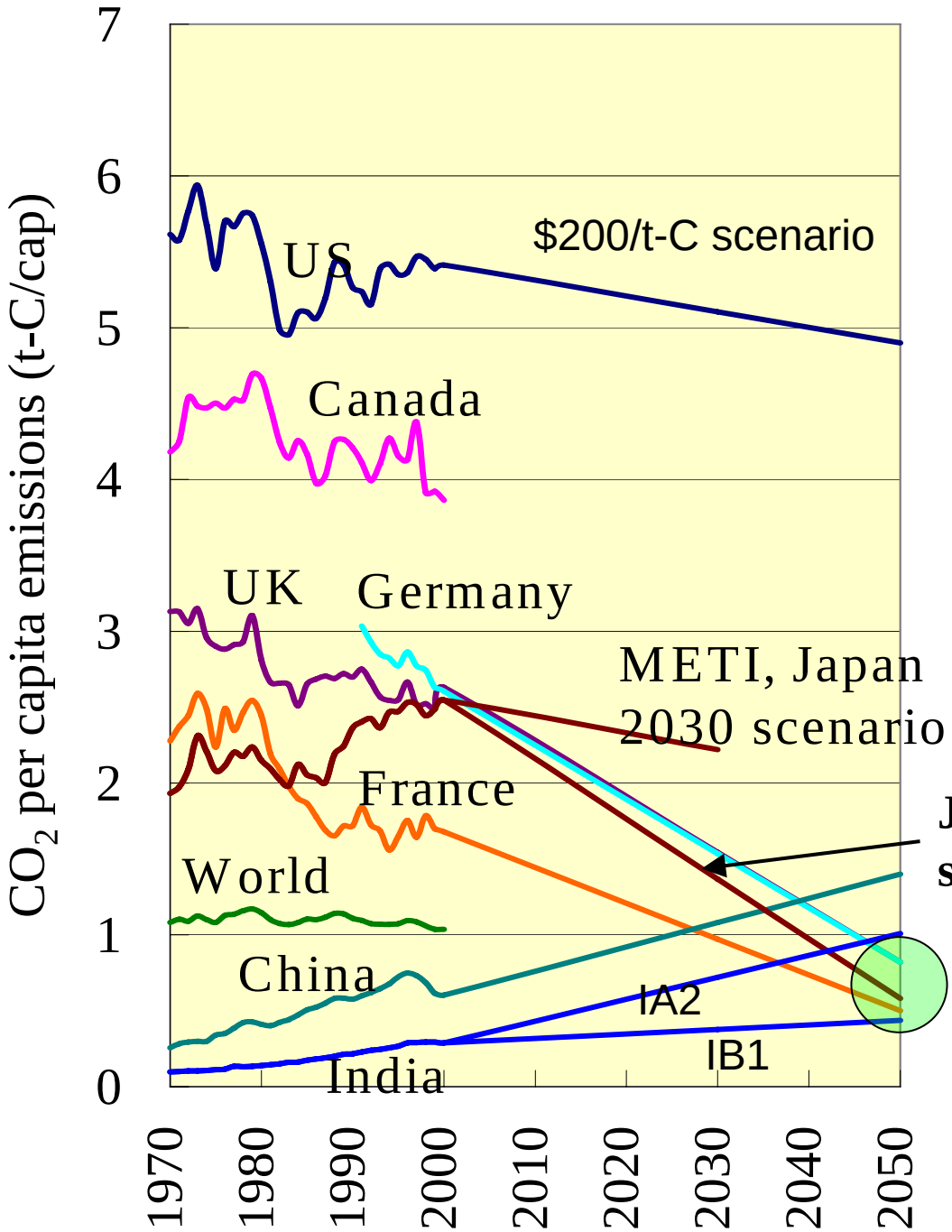
Japan Low Carbon Society 2050

Global Challenges Toward Low-Carbon Economy (LCE)

-Focus on Country-Specific Scenario Analysis-

Scenarios from 8 countries

Current per capita CO_2 emissions and Target



US: delay for tech development, global warming business

EU: Initiatives toward LCS
Japan: Need long-term vision

Developing countries: earlier guidance toward LCS is key

Target for Low Carbon Society

Shuzo Nishioka, Junichi Fujino;
NIES COP11 and COP/MOP1 side event
Global Challenges Toward
Low-Carbon Economy (LCE), Dec.3, 2005

Japan–UK Joint Research Project
Developing visions for a Low Carbon Society (LCS) through sustainable development

Organized by MoEJ, Defra, NIES, UKERC, Tyndall Centre for Climate Change Research

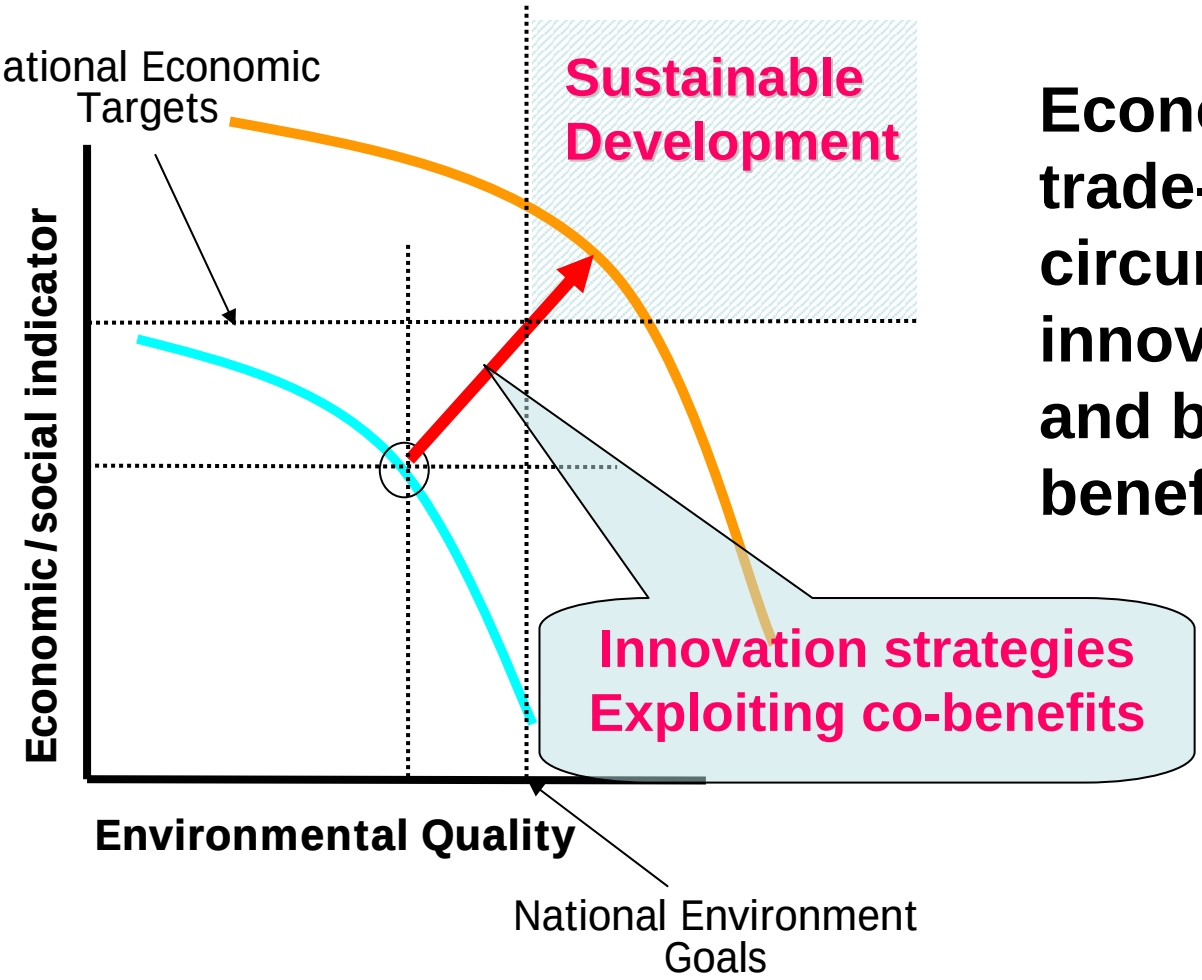
Japan and UK promote studies toward achieving a **Low Carbon Society (LCS) by 2050** in collaboration, encourage other countries to engage in LCS studies, and jointly hold series of international workshops.
The first workshop was held in June 2006 in Tokyo **involving researchers and governmental officials from about 20 countries,** and international organizations.

1st workshop on Japan – UK Joint Research Project Developing visions for a Low Carbon Society (LCS) through sustainable development on June 2006

Participants from 19 countries;
Asia: Japan, China, India, Thailand, Taiwan (China)
Africa: South Africa, Nigeria
Europe: UK, France, Germany, Denmark, Spain, Netherlands, Russia
Latin America: Brazil, Mexico, Chile
North America: US, Canada

A second workshop will be held in UK, 2007.

"Aligning sustainable development & climate change actions can reduce the burden and facilitate the transition to stabilization. LCS is technologically and economically feasible."



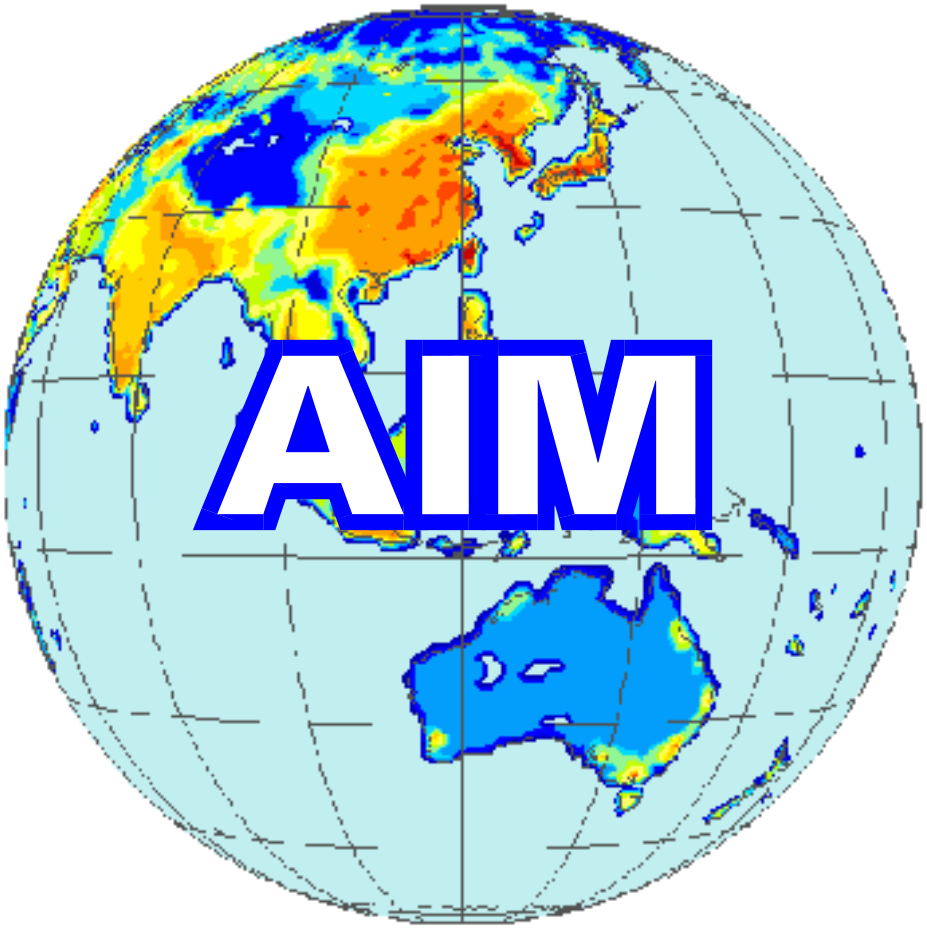
Economy-environment trade-off can be circumvented with innovative strategies and by exploiting co-benefits

We appreciate your participation!

1) Aligning climate change and sustainable development actions will facilitate cost-effective transition to stabilization of climate change.
2) A variety of tools (e.g. models) & methods (e.g. backcasting, scenarios) are required to delineate options for cost-effective transition to low carbon pathways
3) Cooperation for LCS involves a long-term policy framework, a wider range of issues and actors (domestic & international) and a comprehensive range of technologies and policy measures. Political vision and leadership are vital to generate signals, prompt activities and deploy resources to achieve LCS goals.

AIM always supports your modeling activity!

AIM is model, AIM is team, AIM is human network



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