Future Direction of LCS study
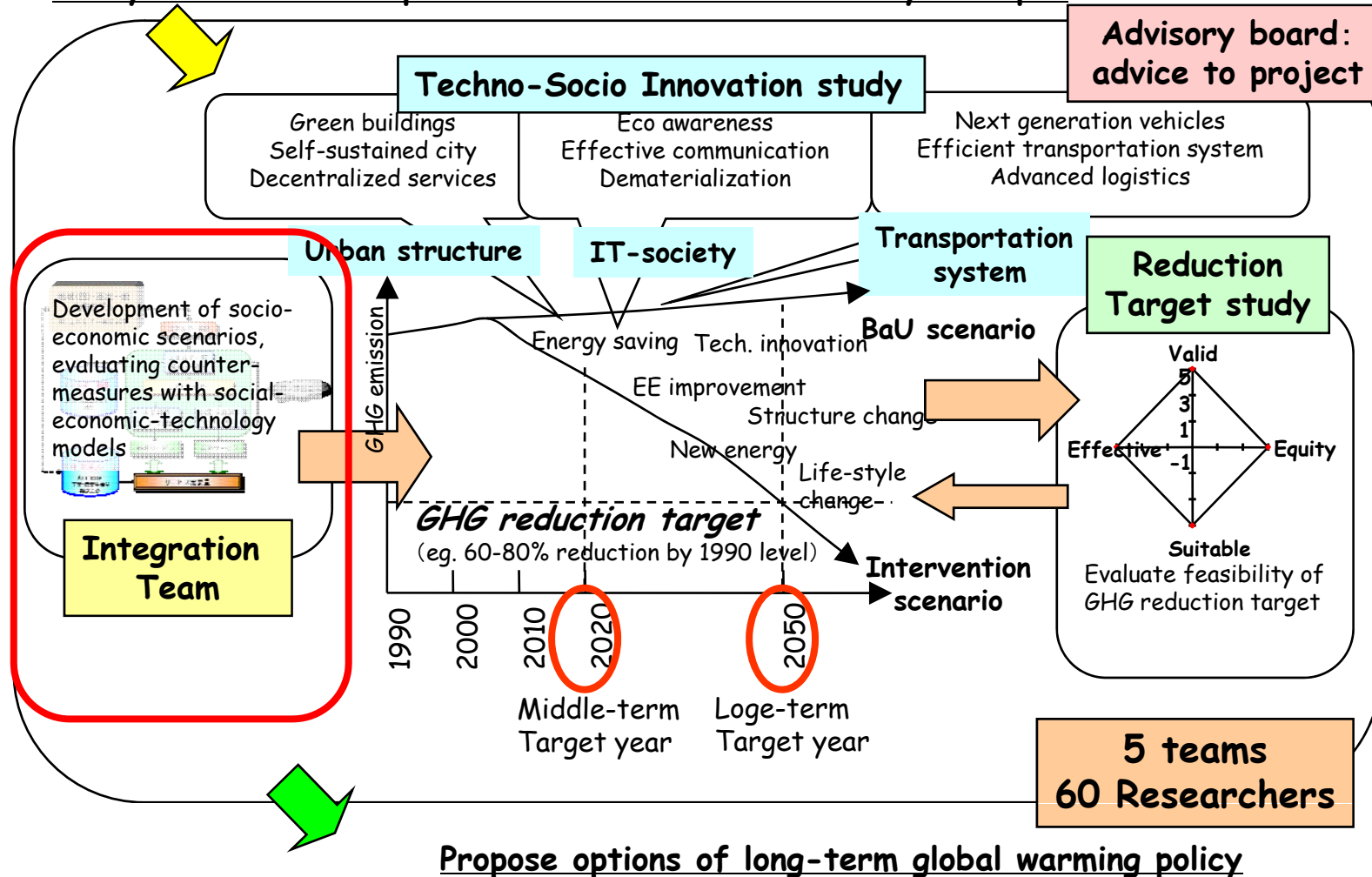
2008 AIM Training Workshop, Tsukuba, Oct 27, 2008
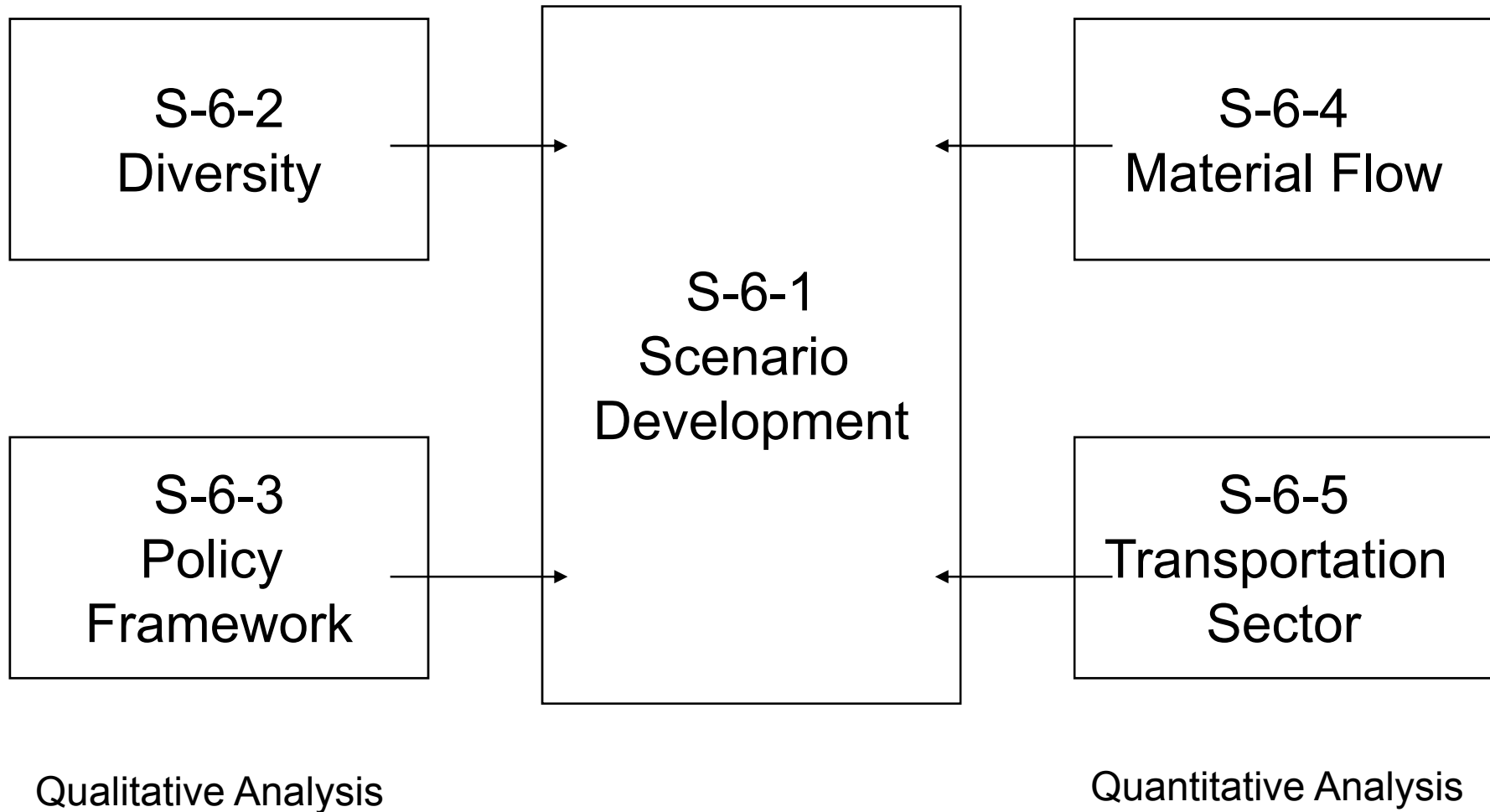
Japan Low Carbon Society Scenarios toward 2050 (S-3)

[FY2004-2008, Global Environmental Research Program, MOE]

**Study environmental options toward low carbon society in Japan**

Advisory board: advice to project

Techno-Socio Innovation study

Green buildings
Self-sustained city
Decentralized services

Eco awareness
Effective communication
Dematerialization

Next generation vehicles
Efficient transportation system
Advanced logistics

Urban structure **IT-society** **Transportation system**

Reduction Target study

Development of socio-economic scenarios, evaluating counter-measures with social-economic-technology models

Integration Team

GHG emission

Energy saving Tech. innovation BaU scenario

EE improvement

Structure change

New energy

Life-style change

GHG reduction target
(eg. 60-80% reduction by 1990 level)

Intervention scenario

Valid
5
3
1
Effective -1 Equity
Suitable

Evaluate feasibility of GHG reduction target

1990 2000 2010 2020 2050

Middle-term Target year Loge-term Target year

**5 teams
60 Researchers**

Propose options of long-term global warming policy

Asian Low-Carbon Society Scenarios toward 2050 (S-6)

[FY2009-2013, Global Environmental Research Program, MOE]

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┌──────────────┐      ┌──────────────┐      ┌──────────────┐
│   S-6-2      │ ───▶ │   S-6-1      │ ◀─── │   S-6-4      │
│   Diversity  │      │   Scenario   │      │ Material Flow│
└──────────────┘      │ Development  │      └──────────────┘
┌──────────────┐      │              │      ┌──────────────┐
│   S-6-3      │ ───▶ │              │ ◀─── │   S-6-5      │
│   Policy     │      │              │      │Transportation│
│   Framework  │      │              │      │   Sector     │
└──────────────┘      └──────────────┘      └──────────────┘
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Qualitative Analysis   Quantitative Analysis

What are the Asian low carbon societies?

◆ **By the middle of this century (2050), societies which satisfy the followings;**

- Accepting drastically transfiguring Asian society and economy,
- conforming each country's reduction target that consists with the global low carbon target,
- under the global, national and regional constraints on fossil fuel and renewal energy resources, and land resource,
- developing various LCS policies based on each country characteristic,
- also utilizing effectively the co-benefits of LCS policies and neighboring policies.
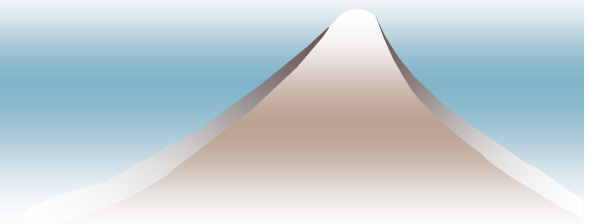
What are the peculiar and diverse characteristics of the target regions (country)?

1. Expansion and resolution of urban and rural disparity.
2. Development and specialization of industrial structure.
3. Deployment of urban and inter-urban traffic systems.
4. Regional climate characteristics, building and social infrastructure characteristics.
5. Potentials of renewable energy resources, and developments of their utilizing facilities.
6. LULC and consequent GHG emissions.
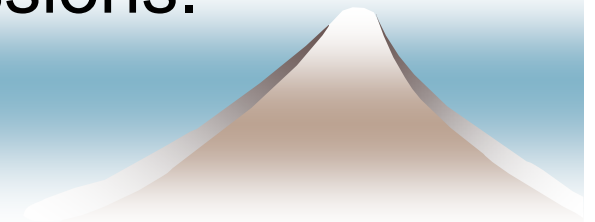
Five domestic factors and the global trade environment that decide the realization of Asian low carbon societies

(1) Energy production, consumption facilities, equipment, and technology: Energy supply facilities, energy-saving technology, and their production system

(2) Social infrastructure: Traffic infrastructure/system for LCS

(3) Human capital: Human resource for developing, managing, and maintaining low carbon societies. Proxy index by number of technocrats, engineers and people's potential to accept related innovation.

(4) Institution: Creation and existence of efficient market systems for energy and technology. Decentralized governance and privatization of related organization, international and domestic funding system, carbon-emission tax, emissions trading, etc.

(5) Social capital on reliability, custom, and norm: Social environmental efficiency of individual level, community level and commercial markets. Energy efficient lifestyle and low material type lifestyle.
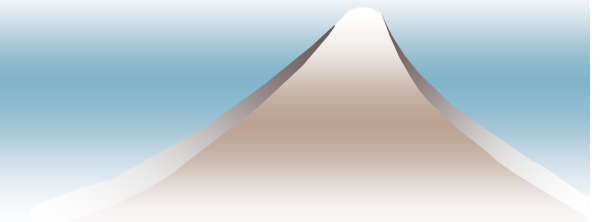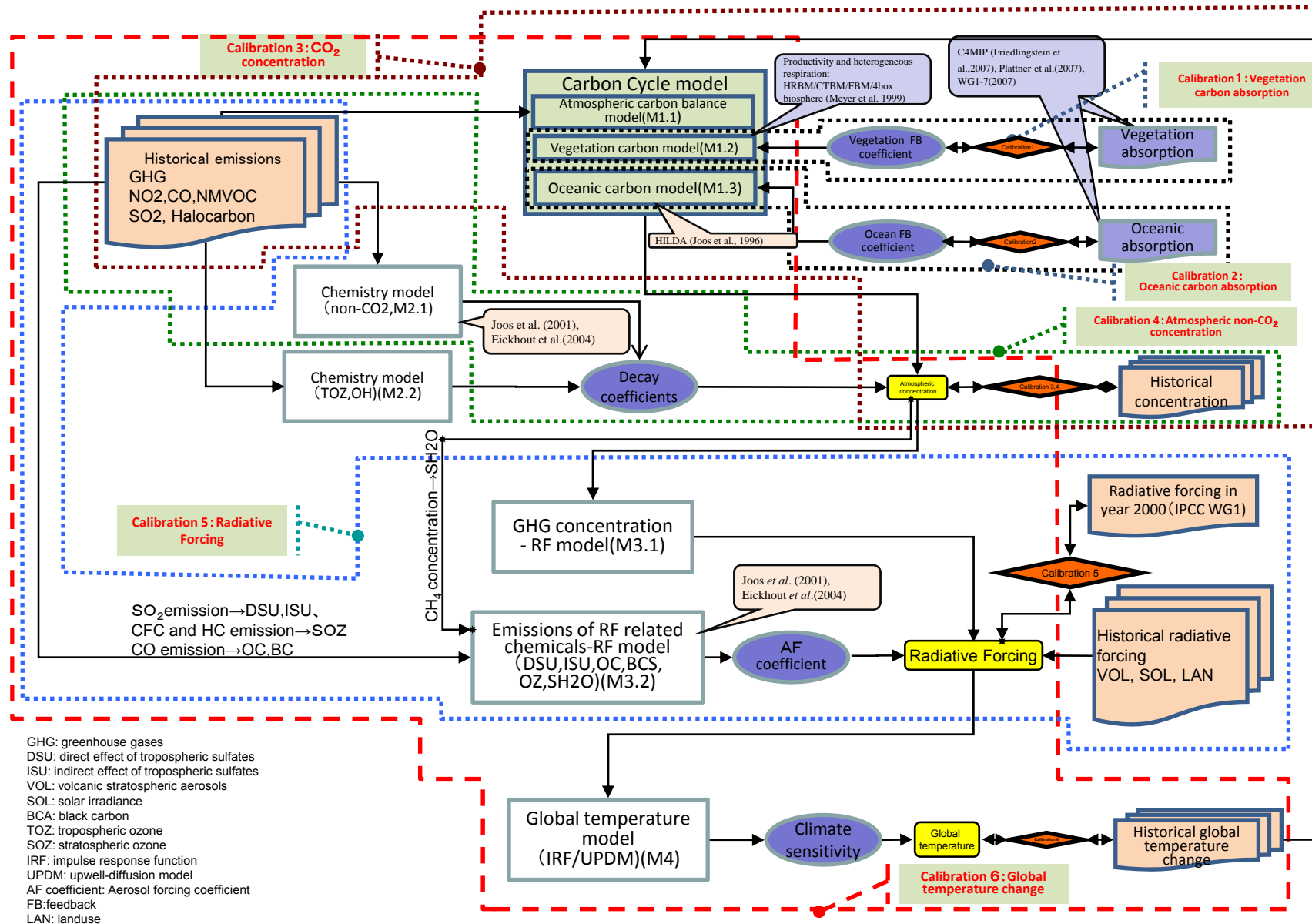
Development, maintenance and application of multi-layered modeling system (1)

(1) Climate change+ long-term optimized capital investment model, AIM/Impact policy, now in operational stage, world-wide and ranging from 2000 to 2300.

(2) The world energy, economy, and GHG emission model. Multi-regional, multi-sectional CGE model, world-wide and ranging from 2000 to 2300. By the end of 2008, becomes operational. Using for IPCC 5AR. Enhancement of a biomass production module, a land use module, and an energy resource modules, etc.

(3) AIM/enduse[global], world-wide and ranging from 2000 to 2050. To the operation stage within this year. Econometrics modules for energy-service, bottom-up engineering type modules for regional GHG emissions.
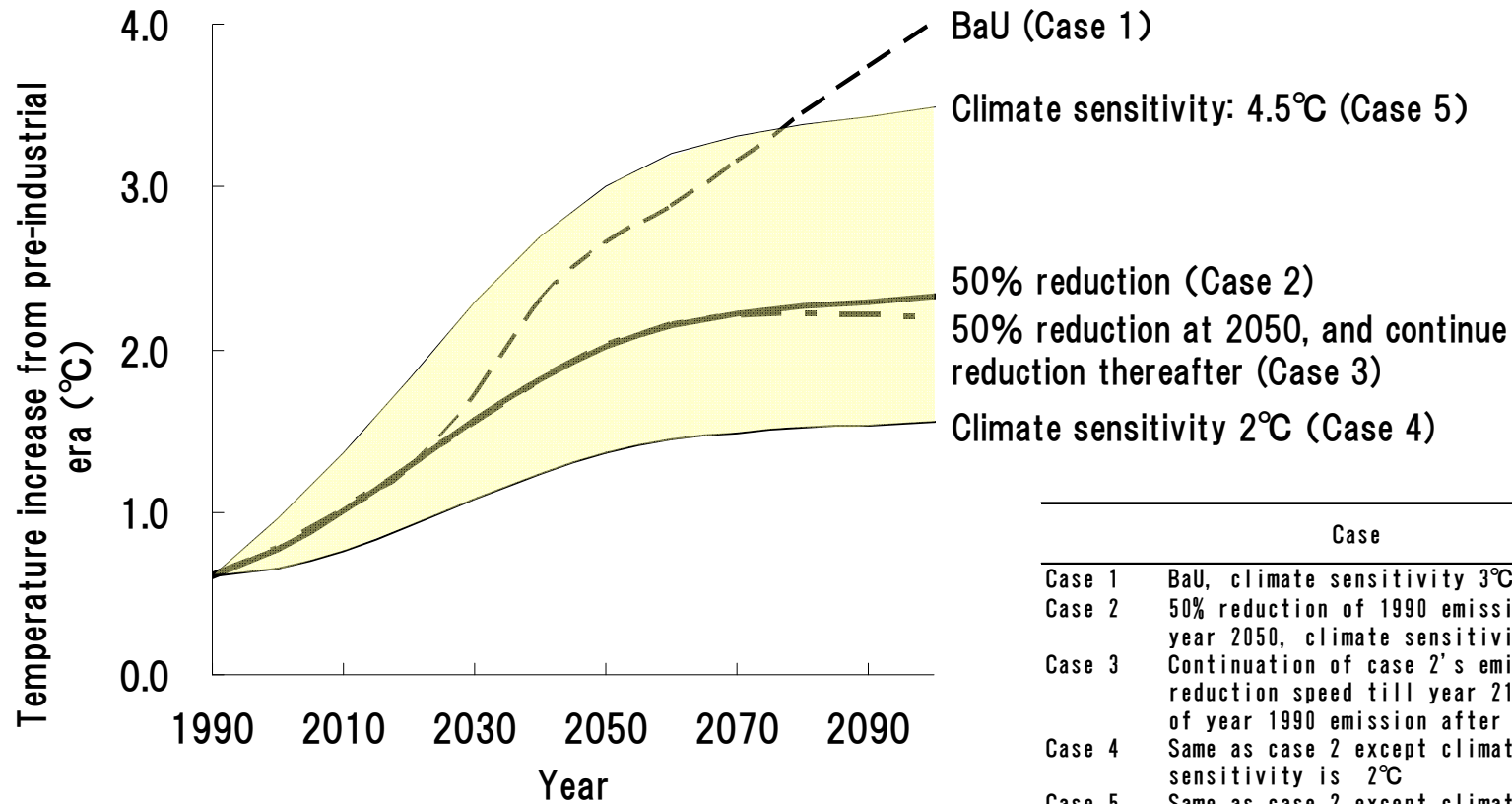
AIM/Impact[Policy]

- Global and Long-term climate-economic-energy integrated model
   multi-regions (< 10), year 2000 to year 2200

- Dynamic global model consisted with;
   Dynamic economic CGE module maximizing social utility
     + Simplified climate module (global surface energy balance model)
     + Carbon cycle module with feedback mechanism
     + Simplified chemical reaction module
     + Climate impact module

- Gases : CO_2, CH_4, N_2O, BC, SO_2, and F gases

- Now refining: 1)to multi-regional, 2) inclusion of climate feedback mechanism, 3) systematic and organized methodology of impact assessment.

Including climate feedbacks

GHG: greenhouse gases
DSU: direct effect of tropospheric sulfates
ISU: indirect effect of tropospheric sulfates
VOL: volcanic stratospheric aerosols
SOL: solar irradiance
BCA: black carbon
TOZ: tropospheric ozone
SOZ: stratospheric ozone
IRF: impulse response function
UPDM: upwell-diffusion model
AF coefficient: Aerosol forcing coefficient
FB:feedback
LAN: landuse

Effects of 50% GHG emission reduction in year 2050 on long-term temperature change

BaU (Case 1)

Climate sensitivity: 4.5℃ (Case 5)

50% reduction (Case 2)
50% reduction at 2050, and continue reduction thereafter (Case 3)

Climate sensitivity 2℃ (Case 4)

Temperature increase from pre-industrial era (℃)

Year

	Case	Temperature change [1]
Case 1	BaU, climate sensitivity 3℃	5.7
Case 2	50% reduction of 1990 emission after year 2050, climate sensitivity 3℃	2.8
Case 3	Continuation of case 2's emission reduction speed till year 2100, keep 25% of year 1990 emission after then	2.0
Case 4	Same as case 2 except climate sensitivity is 2℃	1.9
Case 5	Same as case 2 except climate sensitivity is 4.5℃	4.2

[1] Temperature increase in year 2200 above pre-industrial period

[2] Using same socio-economic assumptions as SRES B2. Compliance with Kyoto target in year 2010 is assumed, and reduction will start after year 2010. Controlled gases are those denoted in Kyoto Protocol.

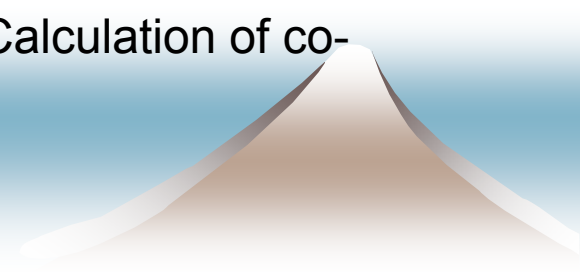# Countries' reduction rates for world 50% emission reduction in year 2050

Country/Region	Equal per capita		Equal emission intensity	Equal velocity of intensity reduction
	emission Mil.tC/y	reduction ratio based on 1990	reduction ratio based on 1990	reduction ratio based on 1990
United States	207	89%	49% (2%～63%)	85% (75%～88%)
Canada	22	87%	61% (33%～65%)	87% (77%～89%)
Japan	53	85%	35% (-23%～44%)	91% (87%～93%)
Australia	14	89%	66% (44%～73%)	80% (65%～83%)
New Zealand	3	89%	70% (51%～75%)	83% (70%～87%)
Western Europe	343	74%	50% (37%～62%)	88% (87%～92%)
Eastern Europe	49	87%	83% (75%～92%)	72% (64%～82%)
Russia	55	94%	91% (75%～94%)	69% (60%～77%)
Other CIS	72	89%	90% (87%～93%)	59% (49%～67%)
South Korea	22	75%	36% (-104%～75%)	68% (62%～78%)
China	728	34%	29% (-69%～46%)	-1% (-46%～12%)
India	852	-97%	48% (-168%～66%)	-36% (-57%～2%)
Other Asia	644	-45%	8% (-27%～49%)	-8% (-15%～22%)
Mexico	68	52%	19% (-13%～59%)	57% (44%～60%)
Brazil	130	37%	5% (-23%～80%)	40% (33%～49%)
Other Latin America	197	29%	12% (-12%～71%)	40% (38%～44%)
Middle East	232	35%	34% (20%～84%)	26% (22%～48%)
Africa	1028	-68%	51% (17%～92%)	-18% (-49%～37%)
World	4719	50%	50% (50%～50%)	50% (50%～50%)
Annex B	705	87%	63% (37%～67%)	82% (78%～84%)
Non-annex B	4014	-2%	35% (29%～66%)	12% (9%～16%)

Projections of GDP in 2050. We used 6 SRES scenarios of AIM (IPCC, 2001), A2r scenario (Grubler et al., 2006), Wilson and Purushothaman (2003), and Poncet (2006).

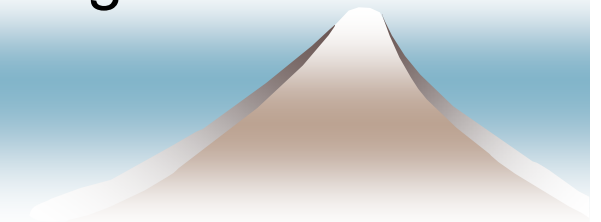# Relation of reduction rates between different sharing schemes
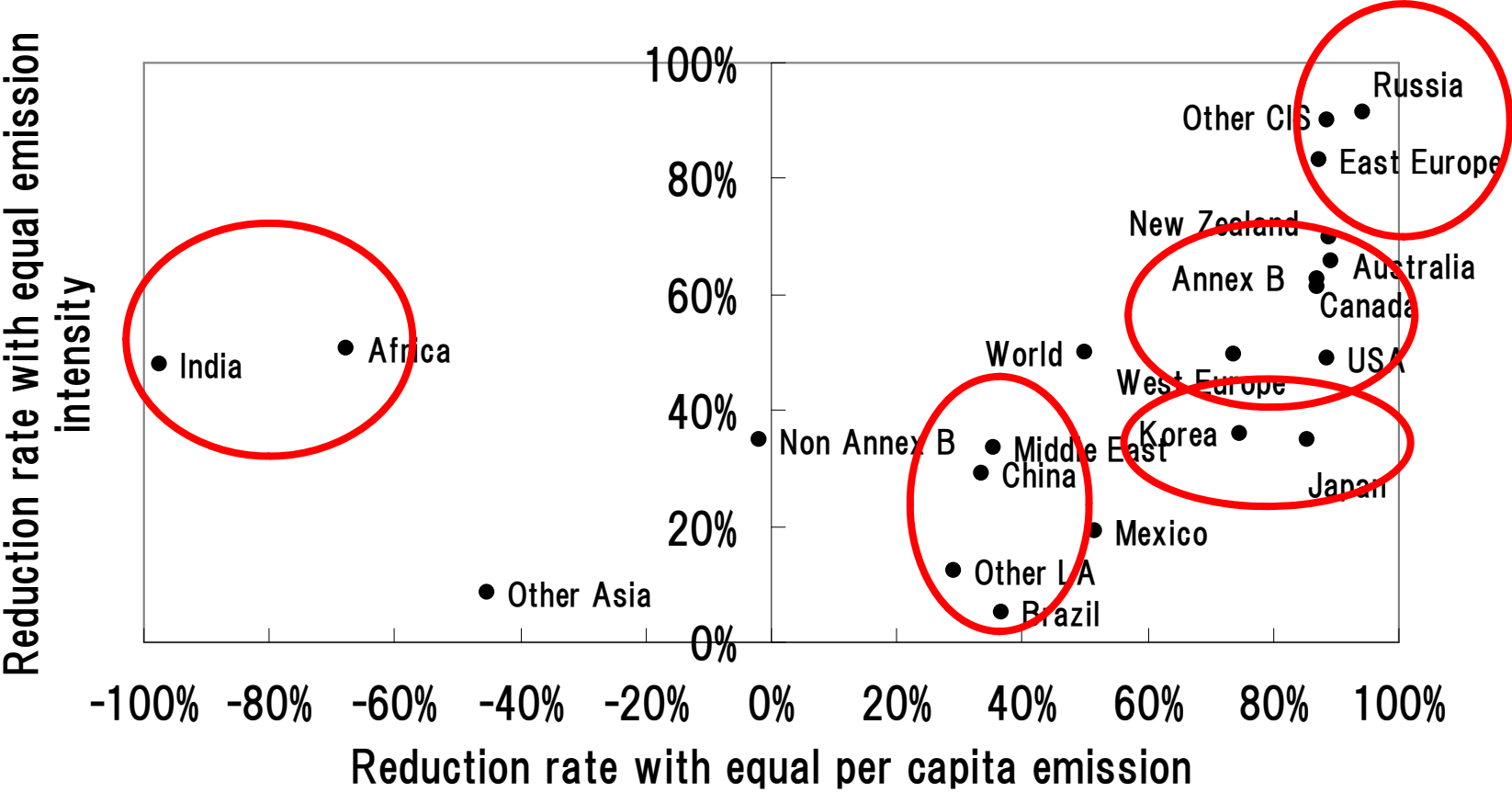
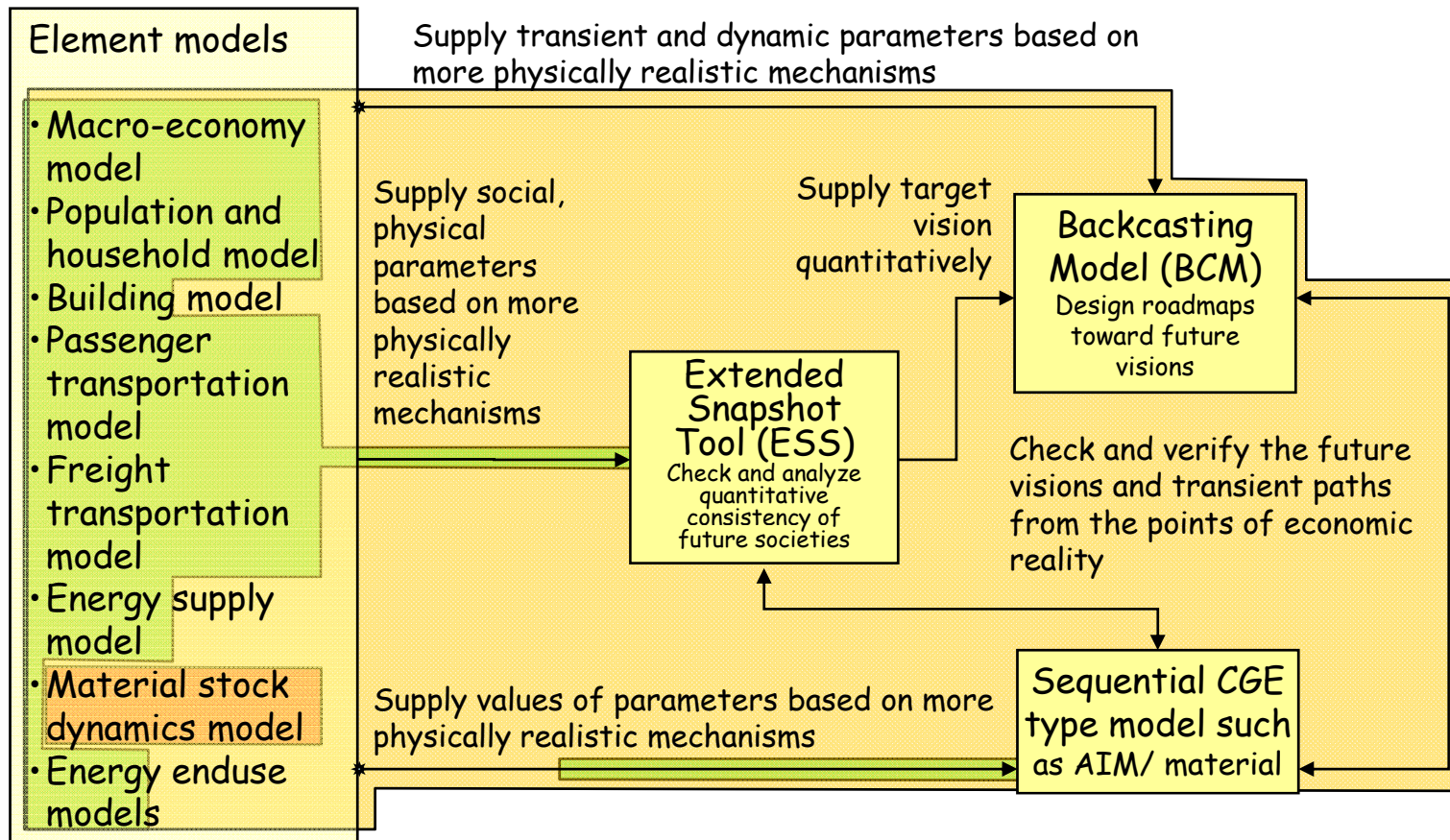# Development, maintenance and application of multi-layered modeling system (2)

(4) Element models for projecting energy services. Country level, ranging from 2000 to 2050.

- AIM/endues[country]
- Population/Household dynamics model (PHM): How to describe each country's decrease of birthrates, internal migrations, propagations of individualism?
- House and building dynamics model (BDM): description of transition and renovation dynamics toward modern and highly insulated buildings.
- Traffic demand model (TDM): passenger and freight transports. Can the Asian concentrated city structure survive?
- Material stocks and flow model (MSFM): Are the low material societies necessary for LCS? Interface with the Material team.
- Energy supply model (ESM): Scenarios of biomass production, electric power infrastructure development, and nuclear power put?
- Household production and lifestyle model (HPLM): Transition of household consumption, oriental lifestyle and so on.
- Atmospheric environmental model (AIM/enduse[air]): Calculation of co-benefits caused by low carbon policies.

Development, maintenance and application of multi-layered modeling system (3)

(5) One country multi-sectional CGE model, AIM/CGE[country]: An integration platform with which the above-mentioned element models are properly linked according to an analytical object. Country level, ranging from 2000 to 2050.

(6) Extended snapshot tool (ExSS): An tool to estimate a social accounting matrix, an energy balance table, a GHG emission table of the target year. Interactive and simple evaluation of the effects of low carbon policies. Multi-regional, static model.

(7) Back-casting model (BCM): A model for designing roadmaps toward low carbon societies. Integration tool. One regional, dynamic model.

Linkage among ESS, BCM, and Element models

Element models

- Macro-economy model
- Population and household model
- Building model
- Passenger transportation model
- Freight transportation model
- Energy supply model
- Material stock dynamics model
- Energy enduse models

Supply transient and dynamic parameters based on more physically realistic mechanisms

Supply social, physical parameters based on more physically realistic mechanisms

Supply target vision quantitatively

Backcasting Model (BCM)
Design roadmaps toward future visions

Extended Snapshot Tool (ESS)
Check and analyze quantitative consistency of future societies

Check and verify the future visions and transient paths from the points of economic reality

Supply values of parameters based on more physically realistic mechanisms

Sequential CGE type model such as AIM/ material

We have completed most of element models, ESS and the 1st version of BCM.

Now preparing the operational version of BCM and also material stock model.

After completing them, we will assemble them to one Integrated Model for Sustainable Society.

Solid, realistic and reliable applications to whole Asian area and various regions

(1) Target regions of the following three scales:

1）Whole world (23 regions. Asia is divided into Japan, China, India, Indonesia, South Korea, Thailand, other Southeast Asia, and other South Asia. (need repartition).

2）Country level: Japan, China, and India. In addition, ...

3）Domestic regional level

(2) Two target periods:

1）2005 - 2030 (middle term)

2）2005 - 2050 (long term)

(3) Target gases and emission activities

Carbon dioxide, methane, nitrous oxide, and F gas, etc.

Energy production, energy consumption, agriculture, forestry, waste, and land use change.

(4) Closer joint study with domestic institutes that are well informed of regional peculiarity.
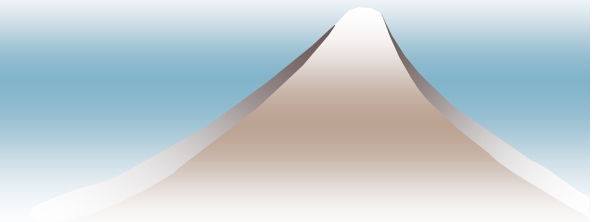
What are other important problems related with LCS issue?

1) Various problems related to MDG, such as poverty eradication, education, health improvement, and diffusion of water supply and sanitary services.

2) Quantification of ancillary benefits caused by LCS policies, such as acceleration of electrification rate and regional atmospheric environment.
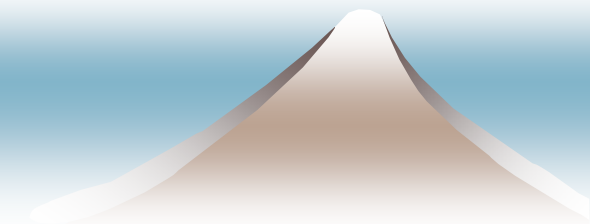
Asian Low-Carbon Societies Study

(1) In order to realize Asian Low Carbon Societies,

(2) We focus on some domestic and international factors which control the realization of LCS,

(3) describe the process of development, accumulation, and deepening of these factors with multi-layered, spatial, and integrated quantification tools,

(4) applying the tools to whole Asian area and various regions in the Asia.

(5) Taking account of regional distinctive diversified characteristics of the region, appropriately,

(6) and also cooperated with the policy options for other important problems in the Asian region in the 21st first half of the century,

(7) We design positive Asian low carbon societies in each country with a back-casting methodology, and also road maps toward the societies.
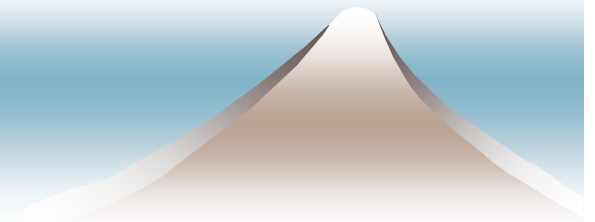
Let's develop LCS scenarios through sustainable development together!

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

2008 AIM Training Workshop
Oct 27-31, 2008 at Tsukuba