AIM (Asia-Pacific Integrated Assessment) project team
National Institute for Environmental Studies (NIES), Japan

# Modeling Sustainable Low-Carbon Asia

Keywords: LCS Scenario,
Low-carbon City,
Action plans towards LCSs


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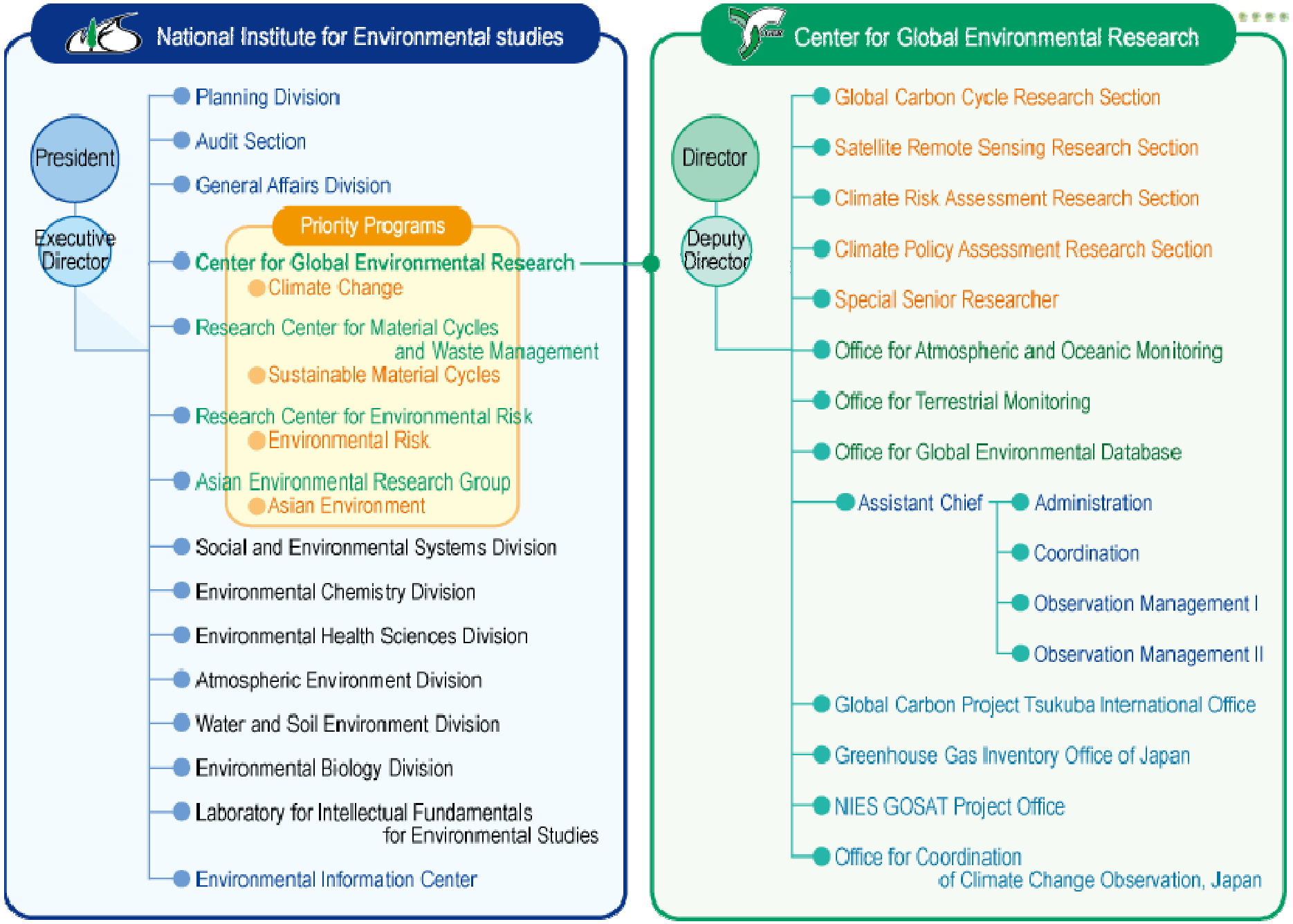
Researchers Meeting, International Research Network for Low Carbon Societies, - LCS-RNet-
1 – 2 April 2009, New Congress Center, AREA Science Park, Trieste Italy




**NIES was established in 1974 in Tsukuba, Ibaraki Japan.** http://www.nies.go.jp

# LCS study in NIES, Japan

- FY1990- start AIM (Asia-Pacific Integrated Model) project
- FY1995- start AIM International Workshop
- FY2000  AIM provided SRES/A1B marker scenario

- FY2004-2008 NIES has coordinated Japan LCS research project funded by MOEJ
- FY2006-2008 Japan-UK joint LCS research project in collaboration with MOEJ, UK Defra, UKERC, Tyndall Centre for Climate Change

- FY2009-2013 NIES coordinates Asia LCS research project funded by MOEJ

# 1. Japan LCS scenarios study

# Japan Low Carbon Society Scenarios toward 2050

Japan Low Carbon Society 2050

## 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**

Develop socio-economic scenario, evaluate counter-measures using econ-techno models

**Long-term Scenario Development Study**

GHG emission

Energy saving Tech. innovation
EE improvement
Structure chang
New energy
Life-style change

**BaU scenario**

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

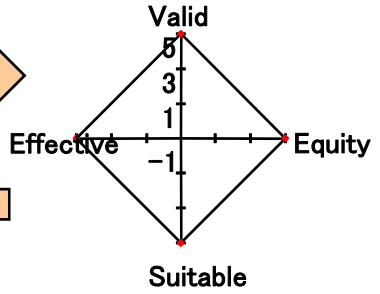
**Intervention scenario**

1990 2000 2010 2020 2050

Middle-term Target year

Loge-term Target year

**Reduction Target study**




Evaluate feasibility of GHG reduction target

**60 Researchers**

**Propose the direction of long-term global warming policy**

**[FY2004-2008, Global Environmental Research Program, MOEJ]** http://2050.nies.go.jp

NIES has coordinated this Japan LCS research project during FY2004-2008 in collaboration with around 60 researchers from Tokyo Univ, Kyoto Univ, TIT, TSU, Forest Research Institute, etc.

# Path toward Low-Carbon Society: Japan and Asia -Results from Japan Low-Carbon Society (LCS) Scenarios Study- on February 12, 2009 in Tokyo Organized by MOEJ and NIES

**1st session "The results of 'Japan Low-Carbon Society Scen**

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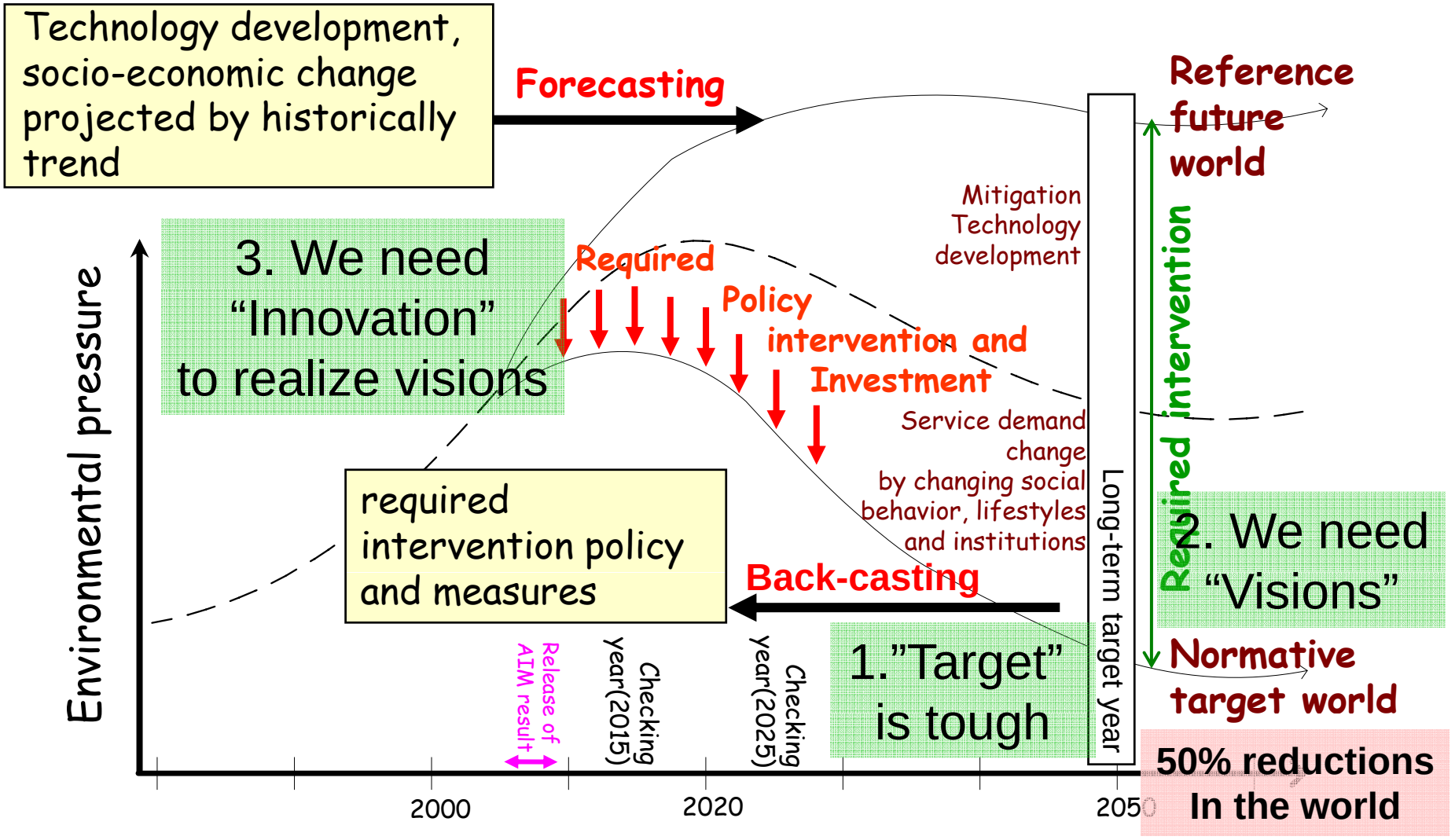
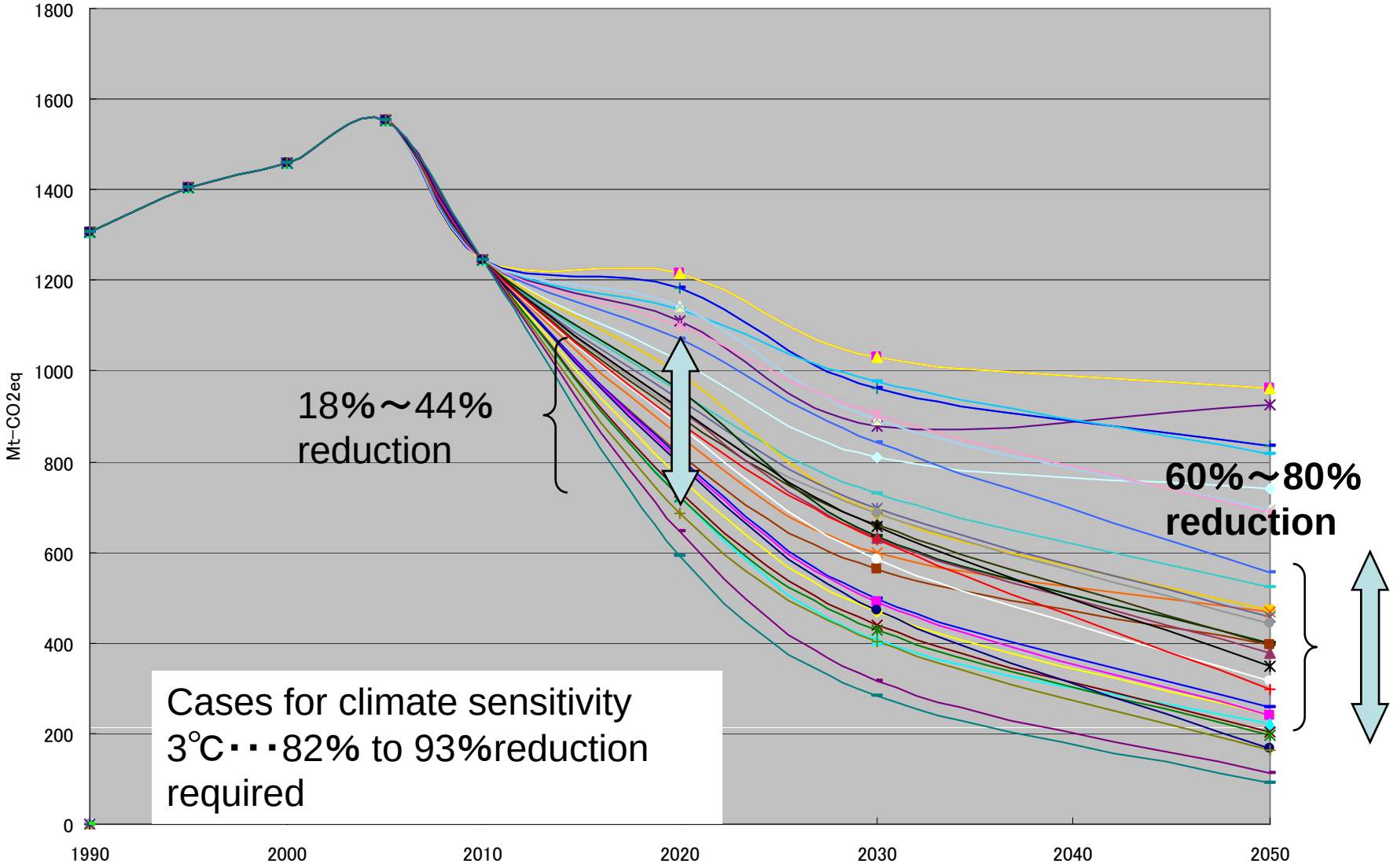
All slides are available on Japan LCS study homepage: http://2050.nies.go.jp

# Japan Low Carbon Society Scenarios toward 2050

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

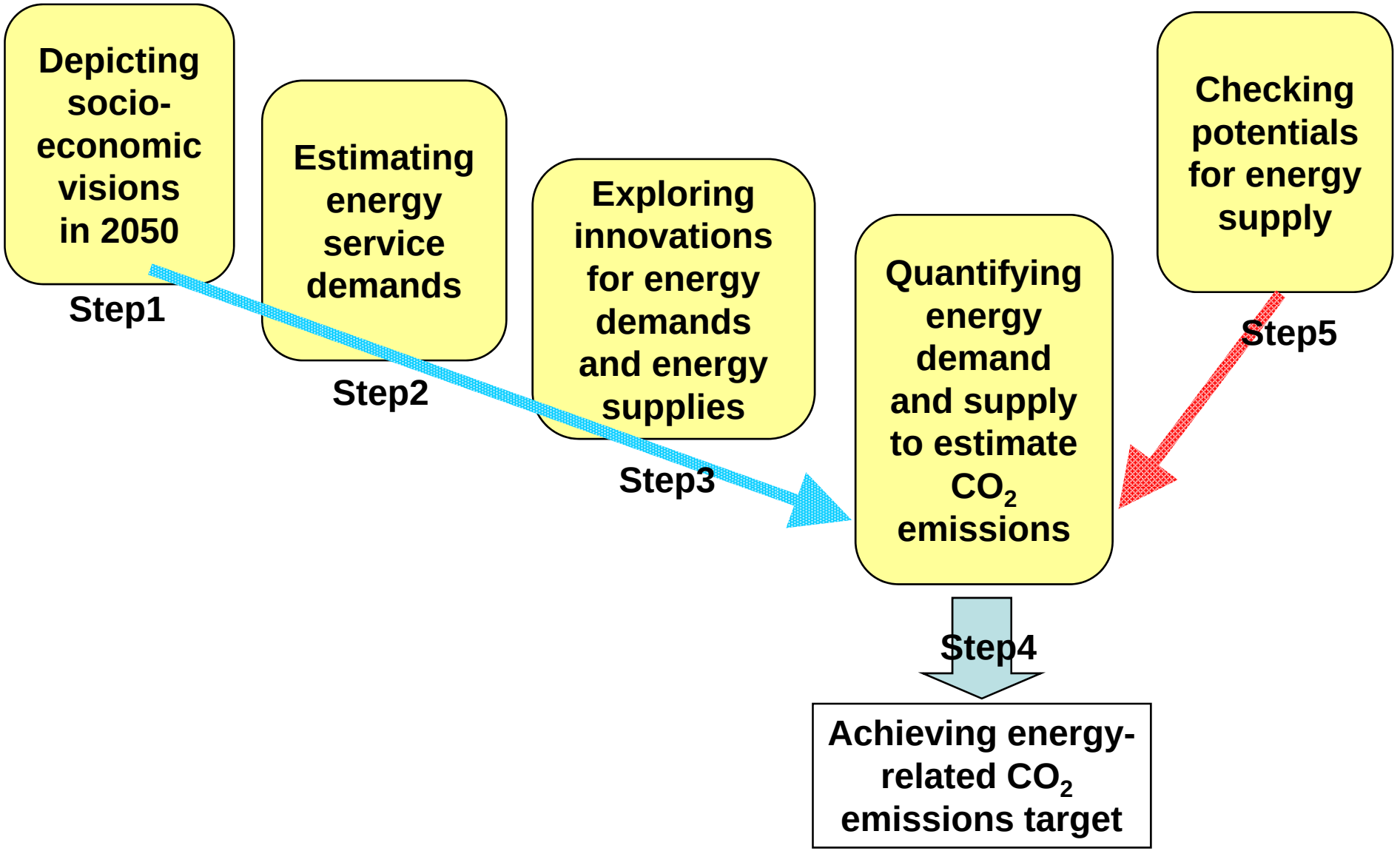


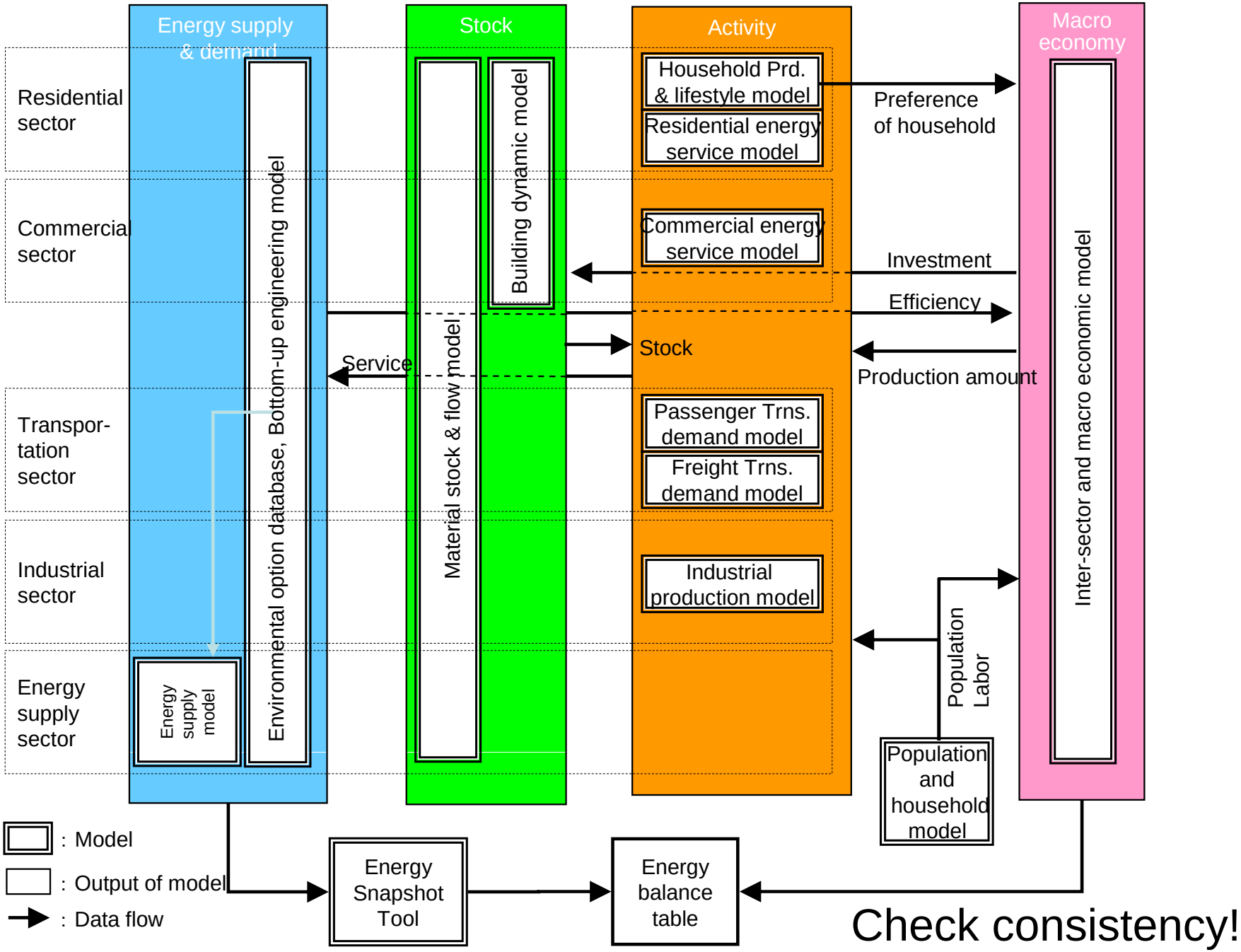
# Emission reduction of Japan 2050: range of required reduction for 2℃ target




Norichika Kanie, “Emission Reduction Required for the Globe and Japan in 2050”,
Japan Low-Carbon Society Scenarios toward 2050 Project Symposium, 12 February 2009

# Scenario Approach to Develop Japan Low-Carbon Society (LCS)






**AIM (Asia-Pacific Integrated Modeling) for Japan LCS scenarios**

# Visions

## we prepared two different but likely future societies for Japan

| Vision A | Vision B |
|---|---|
| Vivid, Technology-driven | Slow, Natural-oriented |
| Urban/Personal | Decentralized/Community |
| Technology breakthrough<br>Centralized production /recycle | Self-sufficient<br>Produce locally, consume locally |
| Comfortable and Convenient | Social and Cultural Values |
| 2%/yr GDP per capita growth | 1%/yr GDP per capita growth |
|  |  |

# Visions and Innovations

**LCS house in 2050**
**Comfortable and energy-saving house**

Utilizing solar power

Photovoltaic

34-69MW
(25-47% house has PV on roof (now 1%))
and develop high efficiency (<30%) PV

Eco-life education

10-20% energy demand reduction

rooftop gardening

High efficiency lighting
【eg LED lighting】

Reduce 1/2 energy demand
Share 100%

Solar heating

Diffusion rate: 20-60%
（currently 8%）

Monitoring system
equipped with appliances

High-insulation

Reduce 60% warming energy demand, share 100%

Super high efficiency air conditioner

COP (coefficients of performance=8), share 100%

Fuel cell

share 0-20%

Heat-pump heating

COP＝5
share 30-70%

Stand-by energy reduction

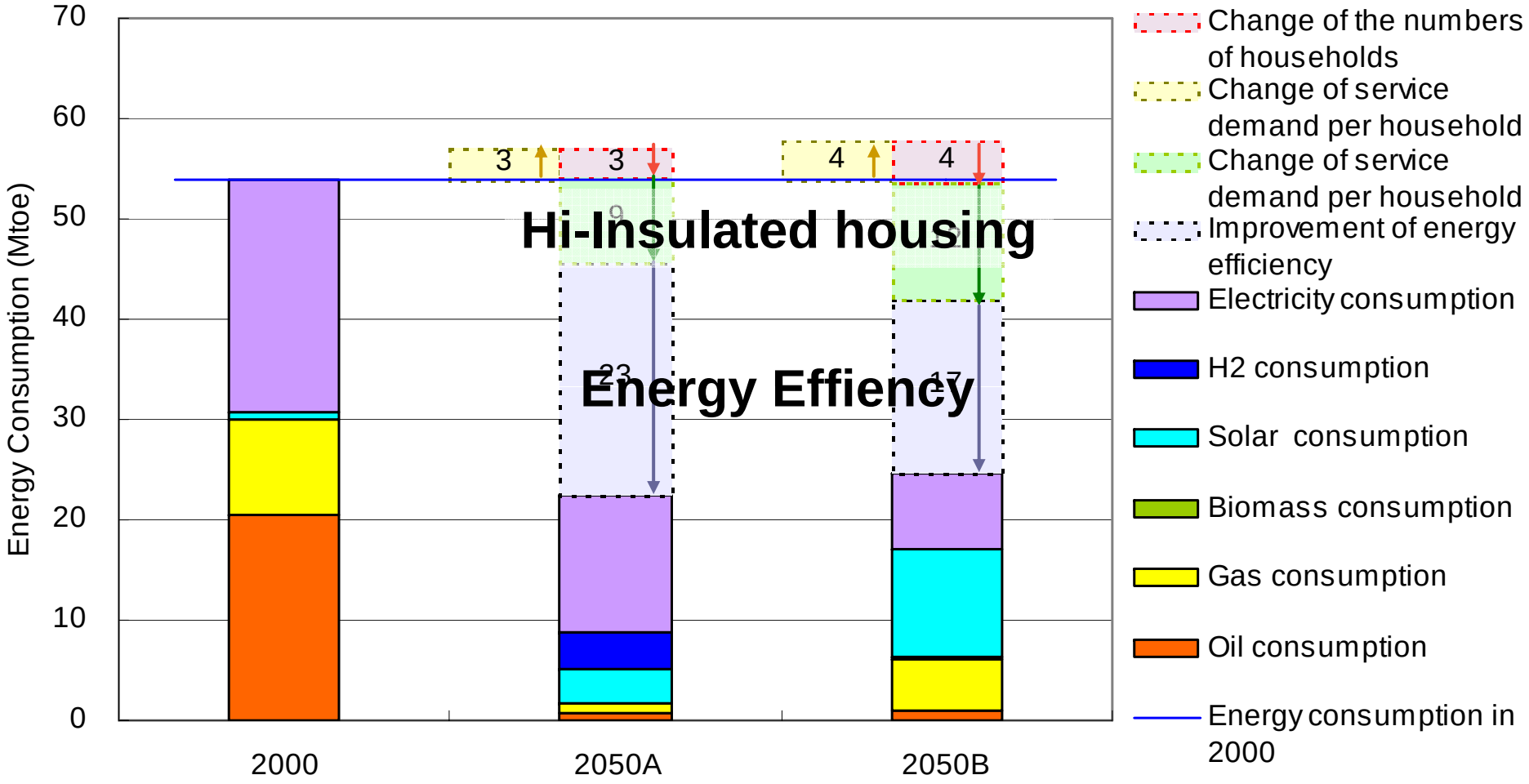
Reduce 1/3 energy demand,
share 100%

Good information for economy and environment makes people's behavior low-carbon

High efficiency appliances reduce energy demand and support comfortable and safe lifestyle

# Residential sector
# Energy reduction potential: 40-50%

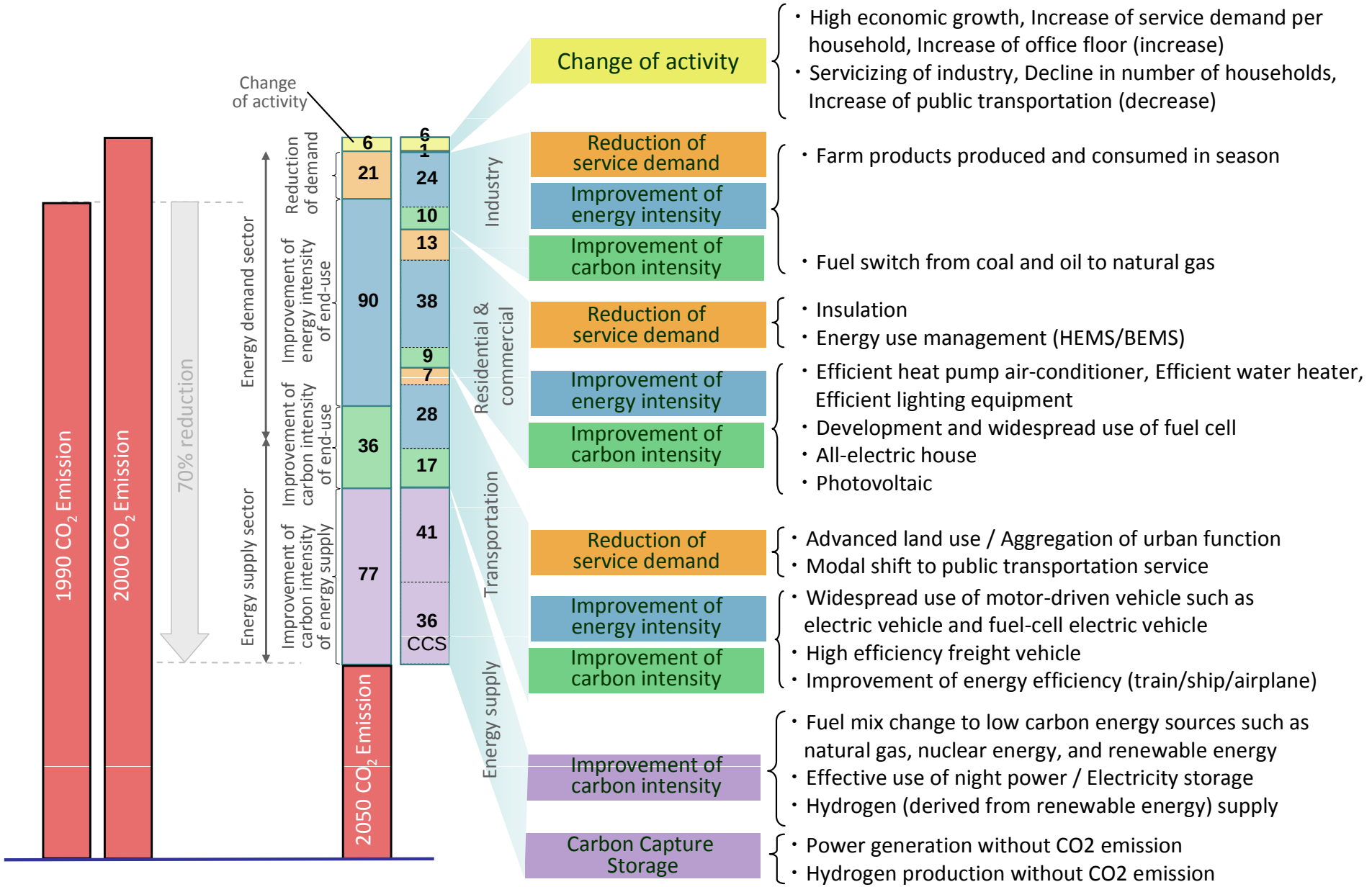
**Innovations**




Change of the number of households: the number of households decrease both in scenario A and B
Change of service demand per household: convenient lifestyle increases service demand per household
Change of energy demand per household: high insulated dwellings, Home Energy Management System (HEMS)
Improvement of energy efficiency: air conditioner, water heater, cooking stove, lighting and standby power

# GHG 70% reduction in 2050 Scenario A: Vivid Techno-driven Society

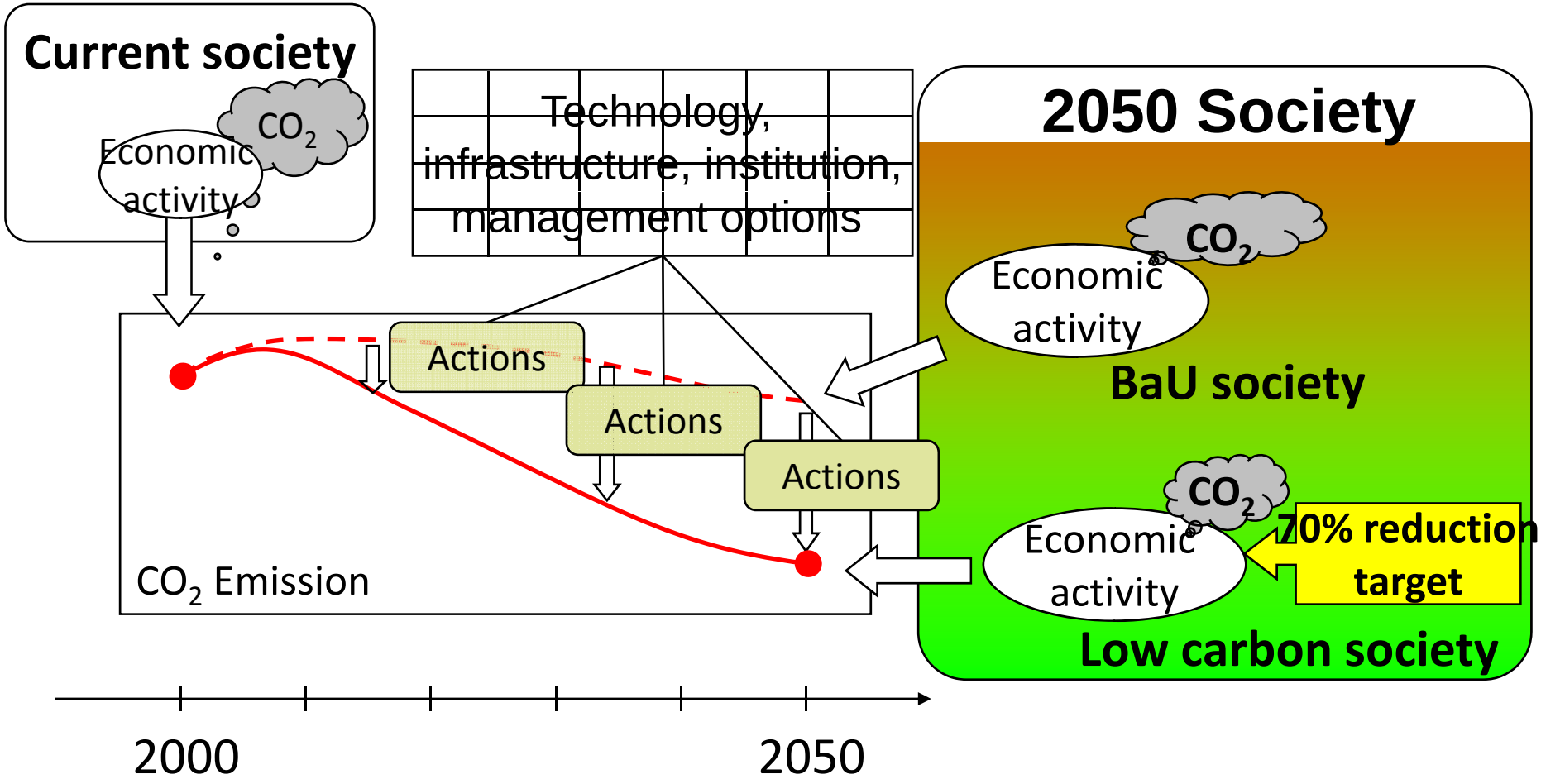
Demand side energy -40% ＋ Low carbonization of primary energy＋CCS
with moderate cost of technological options as 0.3% of GDP in the year of 2050



**To achieve the 70% reduction goal by 2050, we investigated**

- **which options should be selected,**
- **when options should be introduced,**
- **how much of each option should be introduced at each stage,**

**with reference of candidate options as prepared.**



# A Dozen Actions towards Low-Carbon Societies

**Press release on May 22, 2008**

## Residential/commercial sector actions

1. Comfortable and Green Built Environment
Efficiently use of sunlight and energy efficient built environment design. Intelligent buildings.

2. Anytime, Anywhere Appropriate Appliances
Use of Top-runner and Appropriate appliances. Initial cost reduction by rent and release system resulting in improved availability.

## Industrial sector actions

3. Promoting Seasonal Local Food
Supply of seasonal and safe low-carbon local foods for local cuisine

4. Sustainable Building Materials Using local and renewable buildings materials and products.

5. Environmentally Enlightened Business and Industry Businesses aiming at creating and operating in low carbon market. Supplying low carbon and high value-added goods and services through energy efficient production systems.

## Transportation sector actions

6. Swift and Smooth Logistics
Networking seamless logistics systems with supply chain management, using both transportation and ICT infrastructure

7. Pedestrian Friendly City Design
City design requiring short trips and pedestrian (and bicycle) friendly transport, augmented by efficient public transport

## Energy supply sector actions

8. Low-Carbon Electricity Supplying low carbon electricity by large-scale renewables, nuclear power and CCS-equipped fossil (and biomass) fired plants

9. Local Renewable Resources for Local Demand
Enhancing local renewables use, such as solar, wind, biomass and others.

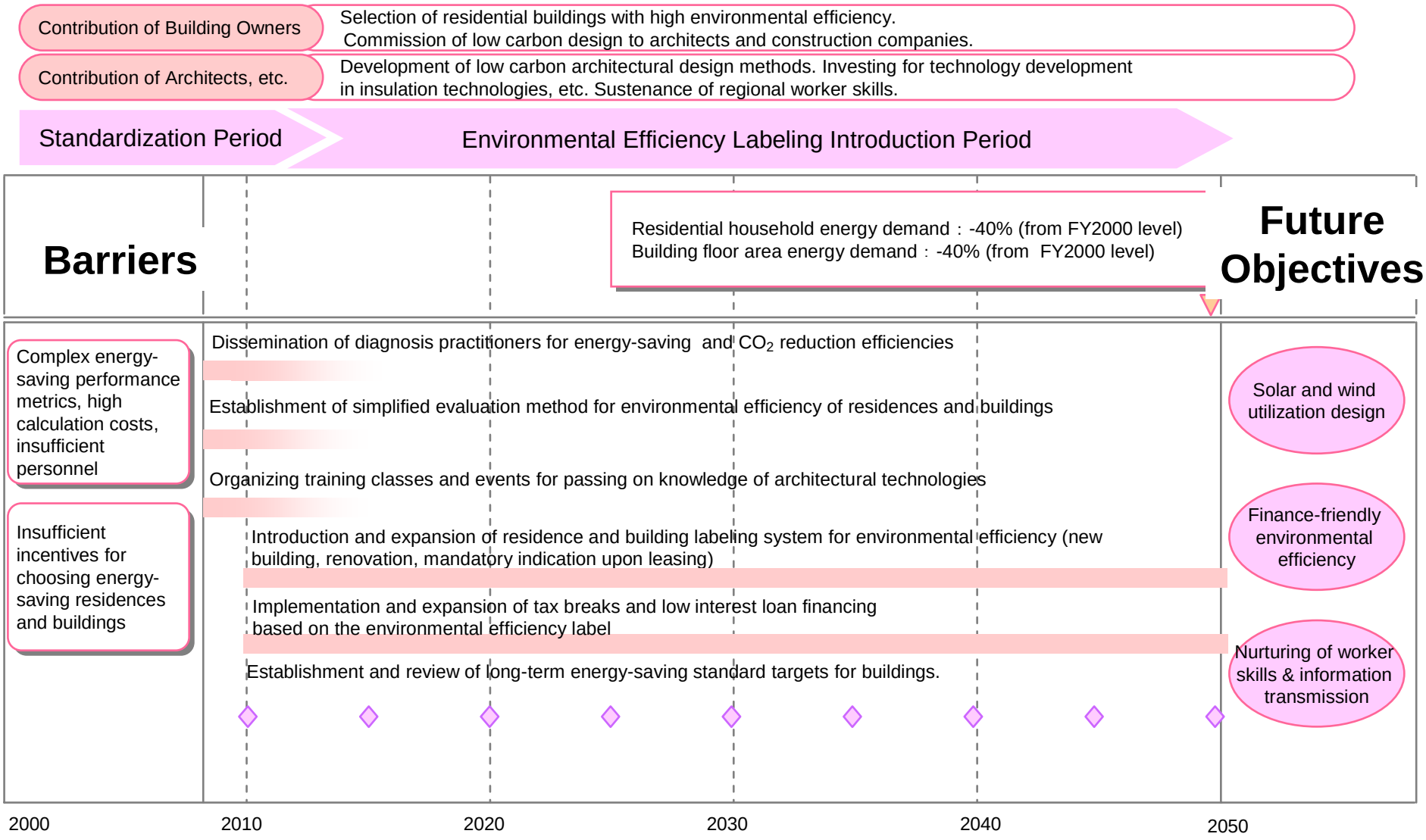
10. Next Generation Fuels Development of carbon free hydrogen- and/or biomass-based energy supply system with required infrastructure

## Cross-sector actions

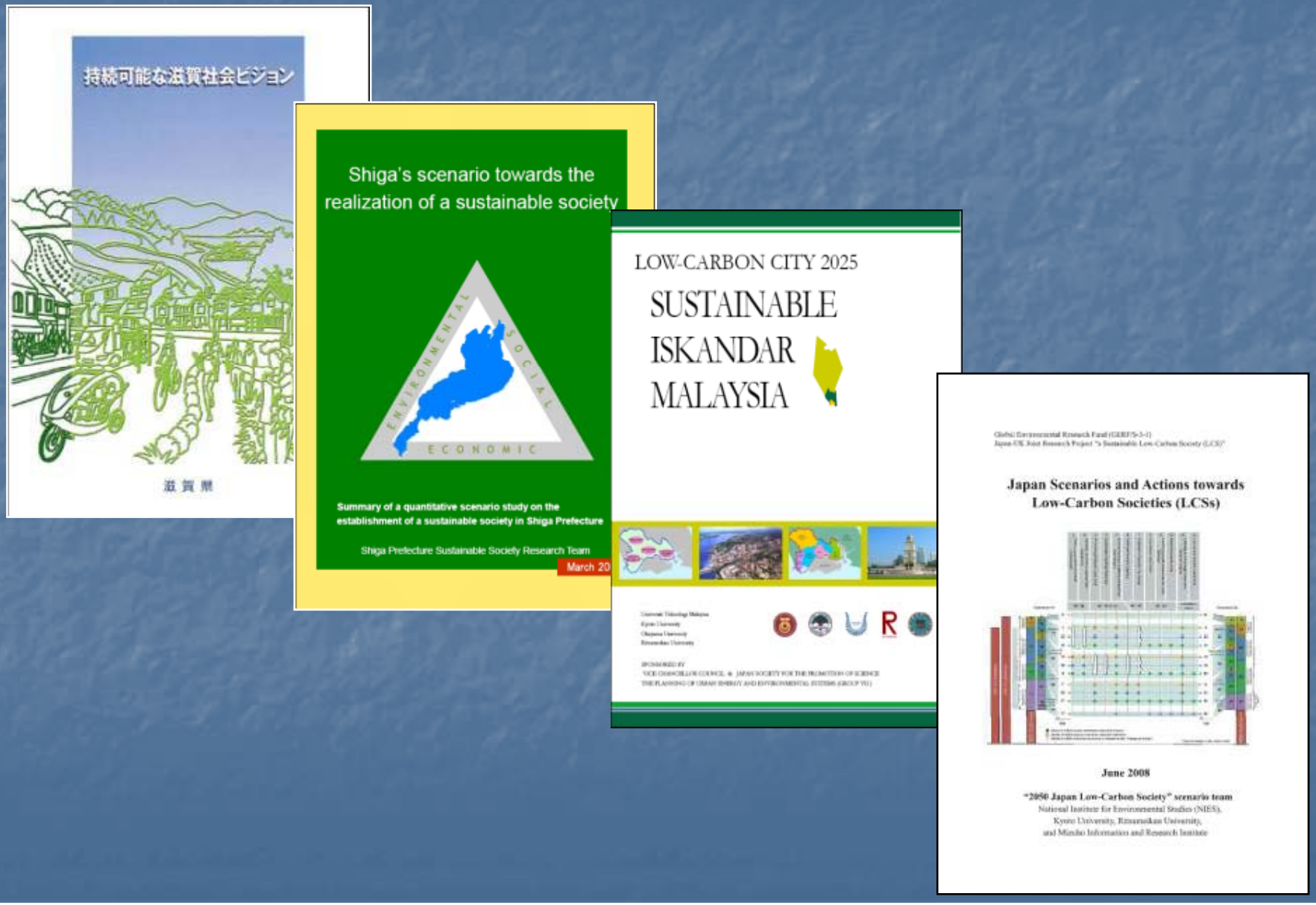
11. Labeling to Encourage Smart and Rational Choices
Visualizing of energy use and CO2 costs information for smart choices of low carbon goods and service by consumers, and public acknowledgement of such consumers

12. Low-Carbon Society Leadership Human resource development for building “Low-Carbon Society” and recognizing extraordinary contributions.

# 1. Comfortable and Green Built Environment



# Demonstration and publicity material of our LCS study on national-level and sub-national-level analysis



# 2. Asian LCS scenarios study

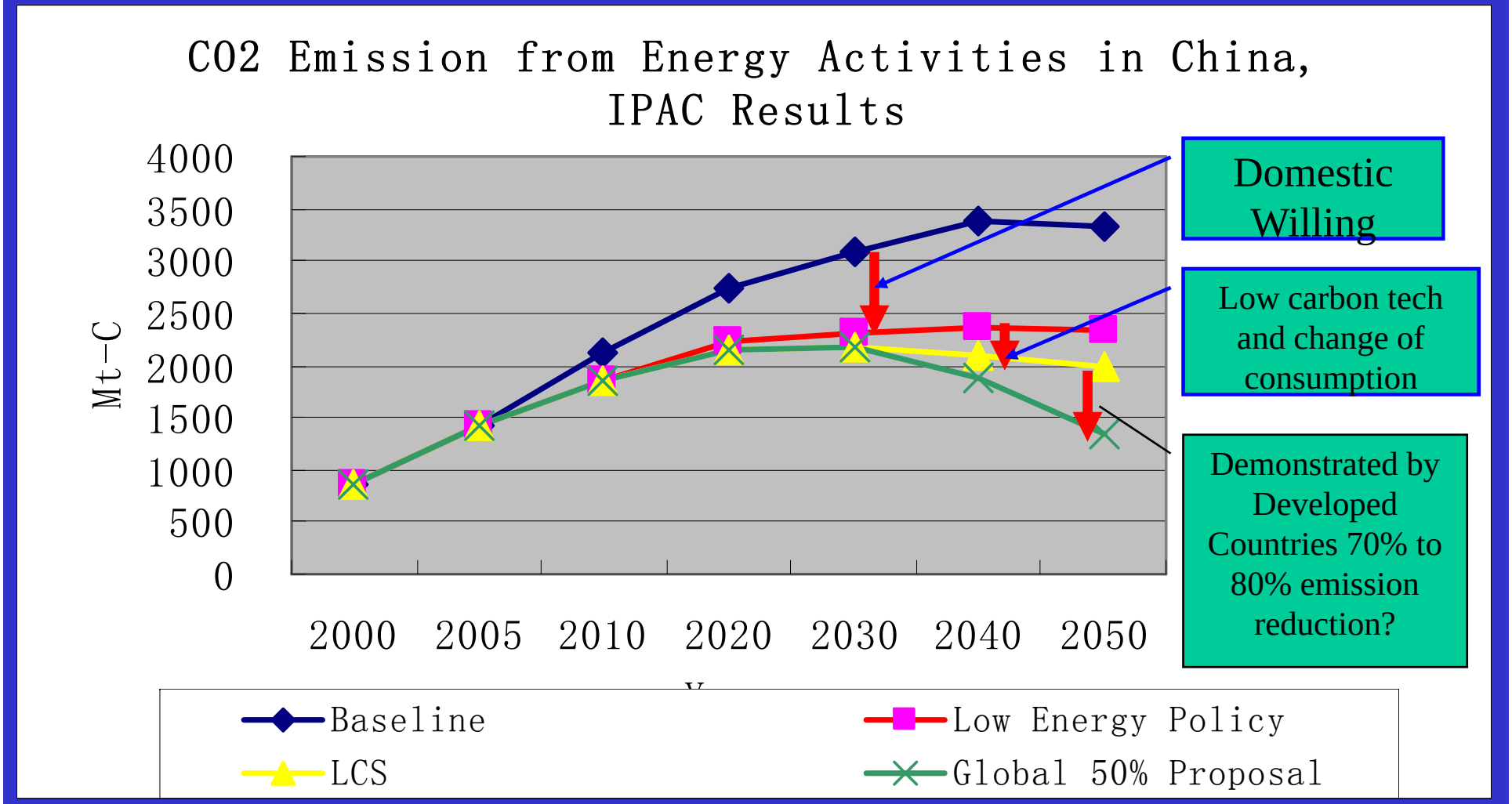
# Path toward Low-Carbon Society: Japan and Asia -Results from Japan Low-Carbon Society (LCS) Scenarios Study- on February 12, 2009 in Tokyo Organized by MOEJ and NIES

**2nd Session "Advancement of Low-Carbon Society Scenario Studies in Asian countries"**

1. China Low Carbon Society Scenarios (Dr. Jiang Kejun, Energy Research Institute, National Development & Reform Commission, China)
2. India Low Carbon Society Scenarios (Prof. P.R. Shukla, Indian Institute of Management, India)
3. Thailand Low Carbon Society Scenarios (Prof. Ram Manohar Shrestha, Asian Institute of Technology, Thailand)
4. Implication of terrestrial carbon emissions in a LCS (Dr. Jae Edmonds, Pacific Northwest National Laboratory, USA)
5. Wrap-up "Direction of Low Carbon Asia Study (Dr. Mikiko Kainuma, NIES, Japan)

**Workshop "Toward Low-Carbon Society: Japan Scenarios and Asian Challenge" on February 13, 2009 in Tsukuba**

All slides are available on Japan LCS study homepage: http://2050.nies.go.jp




Jiang Kejun (Energy Research Institute) , ***Low Carbon Sociaty Scenario up to 2050 for China***

Japan Low-Carbon Society Scenarios toward, 2050 Project symposium

Ram M. Shrestha and Shreekar Pradhan (AIT)

# Measures to achieve low carbon society during 2005-2050

## Cleaner Fuel Use and Environment Friendly Public Transport System

**Use of non-motorized transport systems**
- shift to non-motorized transport

**Master plan for compact cities**
- Lowers travel demand

**Public transport friendly design of cities and transport system**
- modal shift, higher use of Mass Rapid Transits

**Use of clean fuel and efficient vehicles**
- improving efficiency and lowering carbon intensity of energy use in transport; promoting biofuels.

## Energy Efficiency Improvements (End Use and Industrial Production)

**Labeling on electrical appliances**

**Energy auditing – promoting use of efficient technology in industries**

**Carbon emission labeling of industrial products**
- Promoting use of low carbon products.

## Low Carbon Electricity Generation

**Efficient and cleaner power generation**
- Promoting natural gas based advanced combined cycle power plants

**Renewable Portfolio Standard (RPS)**
- Biomass based power
- Solar based power

**Nuclear power generation**

**Natural gas use in electricity generation**

## Building Insulation in Residential and Commercial Sector

**Building codes**
- Regulatory measures to lower energy use

**Financial incentives through Energy Conservation Fund**

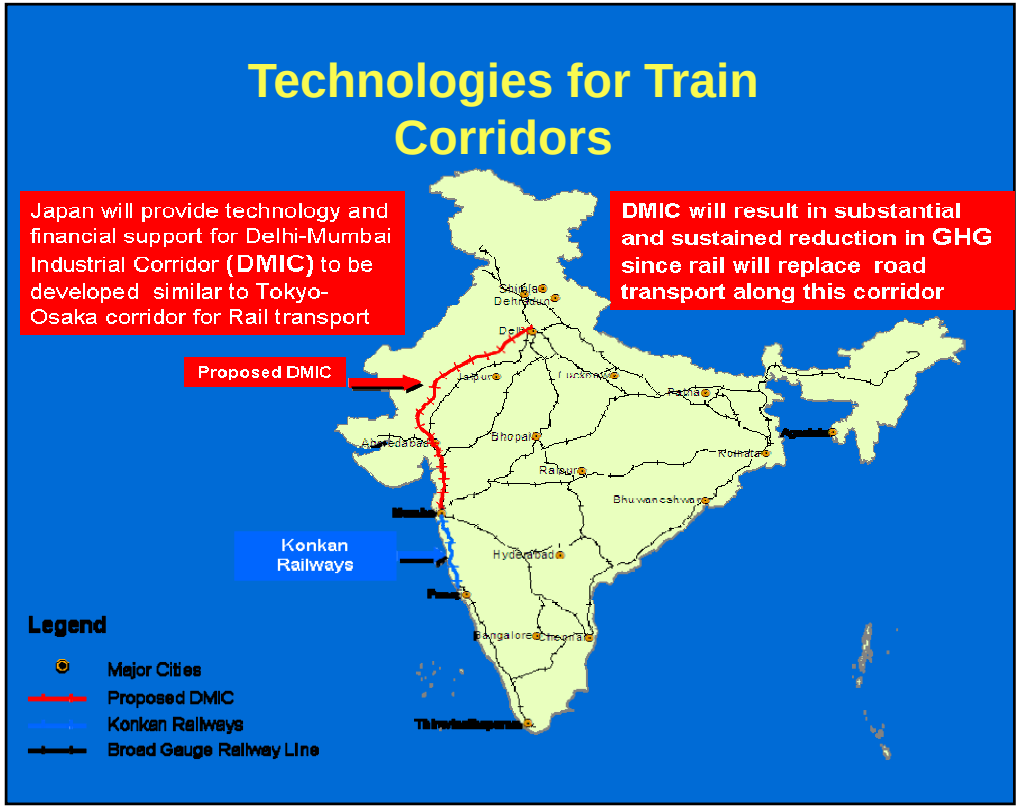
**Public awareness campaign**
- to promote voluntary measures

# Sustainable Cities: Planning and Infrastructures

- Land-use Planning
- Building Choices
- Infrastructures
- Service Networks

## Bus Rapid Transport System


## Technologies for Train Corridors



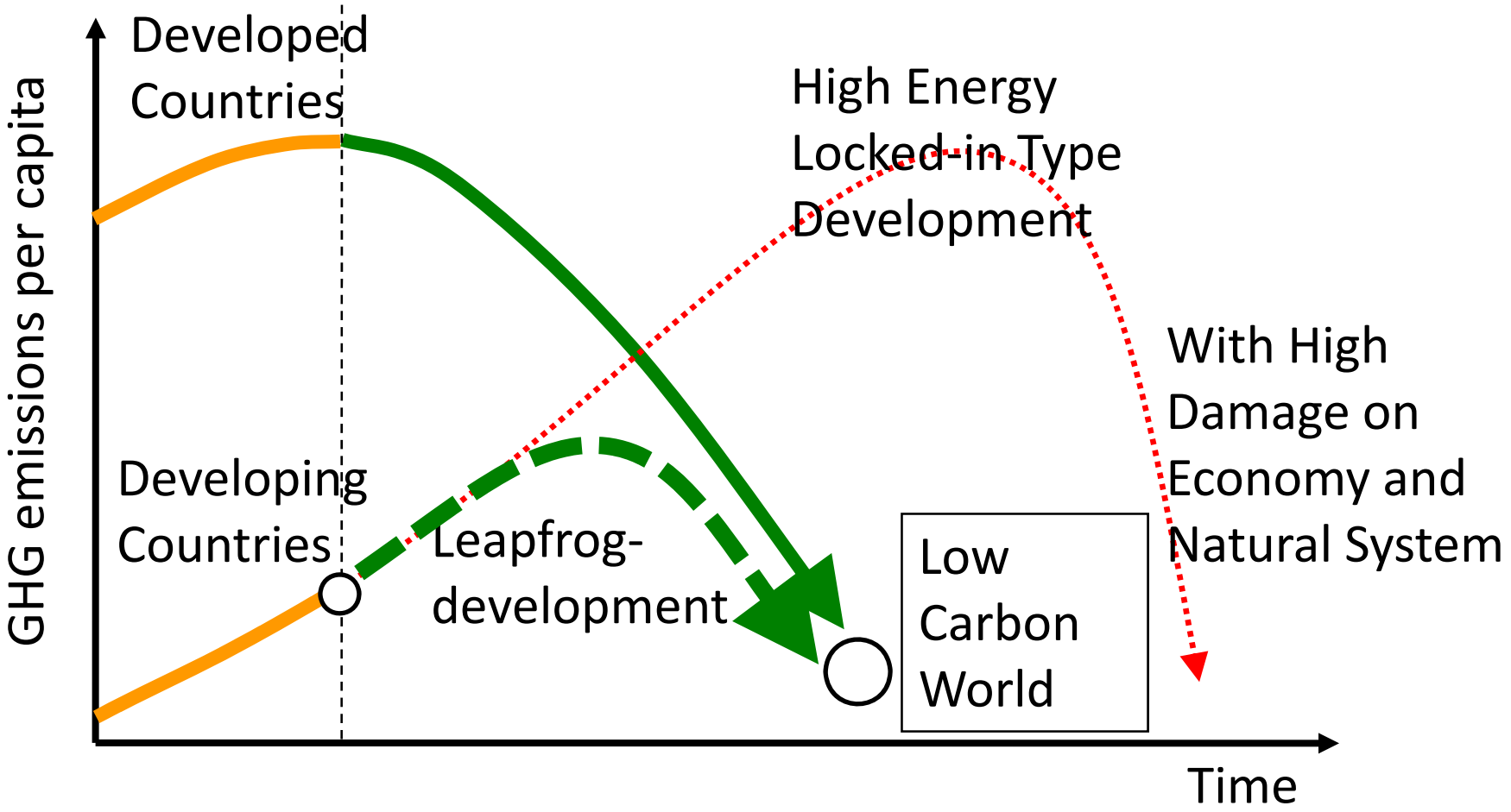

**Low-Carbon Society Scenarios for India:**

*Aligning Sustainable Development and Climate Actions*

P.R. Shukla, Indian Institute of Management"

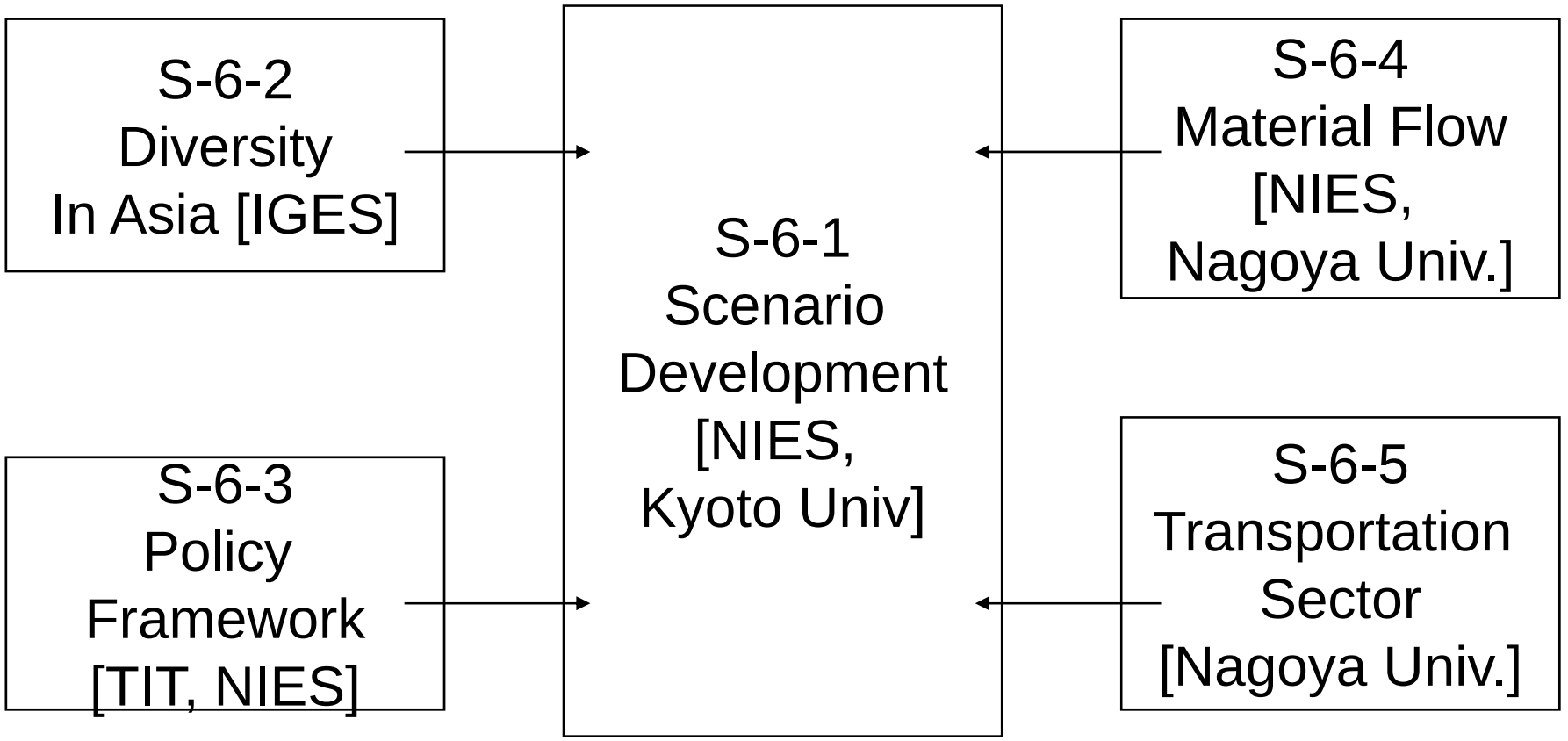
**Japan Low Carbon Society Scenarios toward 2050 Project Symposium"**
Tokyo, Japan, February 12, 2009

**We have just started new research project "Asian Low-Carbon Society Scenario Development Study" (project leader: Mikiko Kainuma) during FY2009-2013, funded by Global Environmental Research Program, MOEJ**




# Modeling Sustainable Low-Carbon Asia

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




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

# What are the Asian low carbon societies we will design in this study?

By the middle of this century (2050), the target societies will satisfy the followings;

1. Harmonized with drastically changing future Asian society and economy,
2. complying with each country's national reduction target that consists with the global low carbon target, under the global, national and regional constraints on fossil and renewal energy resources, and land resource,
3. developing/devising/promoting LCS policies based on each region’s characteristics,
4. and also utilizing effectively co-benefits of LCS policies and neighboring policies.

# 3. Research Collaboration, Outreach…

# Japan LCS research project and Japanese CC policy

- Feb 13th 2007 Interim Report “Japan Scenarios torwards Low-Carbon Society (LCS) -Feasibility study for 70% CO2 emission reduction by 2050 below 1990 level-”
- May 24th 2007 Former Prime Minister Abe launched “Cool Earth 50” to reduce 50% GHG emissions by 2050
- March 2008 Japan-UK joint LCS research project released “Call for Action” to G20 in Chiba and G8 EMM in Kobe
- May 22nd 2008 Interim Report “Dozen Actions towards LCSs”
- June 9th 2008 Former Prime Minister Fukuda set the target of Japanese CO2 emissions reduction by 60-80% in 2050
- July 29th 2008 Japanese government set “Action Plan for Achieving a Low-carbon Society”


# Japan-UK Joint Research Project Sustainable Low-Carbon Societies (LCSs)

(Co-chairs : Shuzo Nishioka(NIES) and Jim Skea(UKERC))

*In 2006, the Governments of Japan and UK established an innovative joint research project with participation from a diverse group of some 20 countries including most G8+5 countries, Asian countries (Australia, Korea, Thailand, Nepal, Malaysia, Indonesia), African countries, and others.*

## ■ Launch of the Project : 16th Feb 2006 (Anniversary of Kyoto Protocol)


Former Japanese Environment Minister Yuriko Koike and UK Ambassador to Japan Sir. Graham Fry announced the launch of the joint research of the Low-Carbon Society.

## ■ 1st Workshop: June 2006

## Developing Visions for a LCS through Sustainable Development


Tokyo

WS: 19 countries, 54 experts
Symposium: around 500 people

- A long-term perspective focusing on the need for urgent action to reduce $CO_2$ towards 2050.
- Achievement of LCS will involve the development and deployment of low carbon technologies, changes in lifestyles and institutions, and need to align with sustainable development.

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

## 2nd Workshop: June 2007 **Achieving a Sustainable LCS**

London 30 countries,100 participants

- A wide range of stakeholders- from government, business, and civil society need to be engaged in finding solutions.
- A significant share of GHG is due to cities. Effective Action can be and is being undertaken.

## 3rd Workshop : Feb 2008 **Roadmap to Low Carbon World**

Tokyo


WS: 18 countries, 79 experts
Symposium: 273 participants

- Creation of appropriate incentives for business using long-term policy signals to strengthen carbon pricing.
- Expanding financial flows, international cooperation in low-carbon approaches.
- Building trust between countries and stakeholders though enhancement of communication is important.

**"Call for Action" and WS3 "Executive Summary" were delivered to G20 in Chiba, March 14-16 2008.**

**G8 Gleneagles 2005**

**G8 Environmental Ministerial Meeting, May 2008**
**G8 Japan, July 2008**


Japanese Former PM outlines green 'Fukuda vision‘ on 9th June 2008 pledged to cut of 60-80 per cent of greenhouse gas emissions based on current levels by 2050 in Japan.

Japanese government set “Action Plan for Achieving a Low-carbon Society” on 29th July 2008 (http://www.kantei.go.jp/foreign/policy/ondanka/080729.pdf).

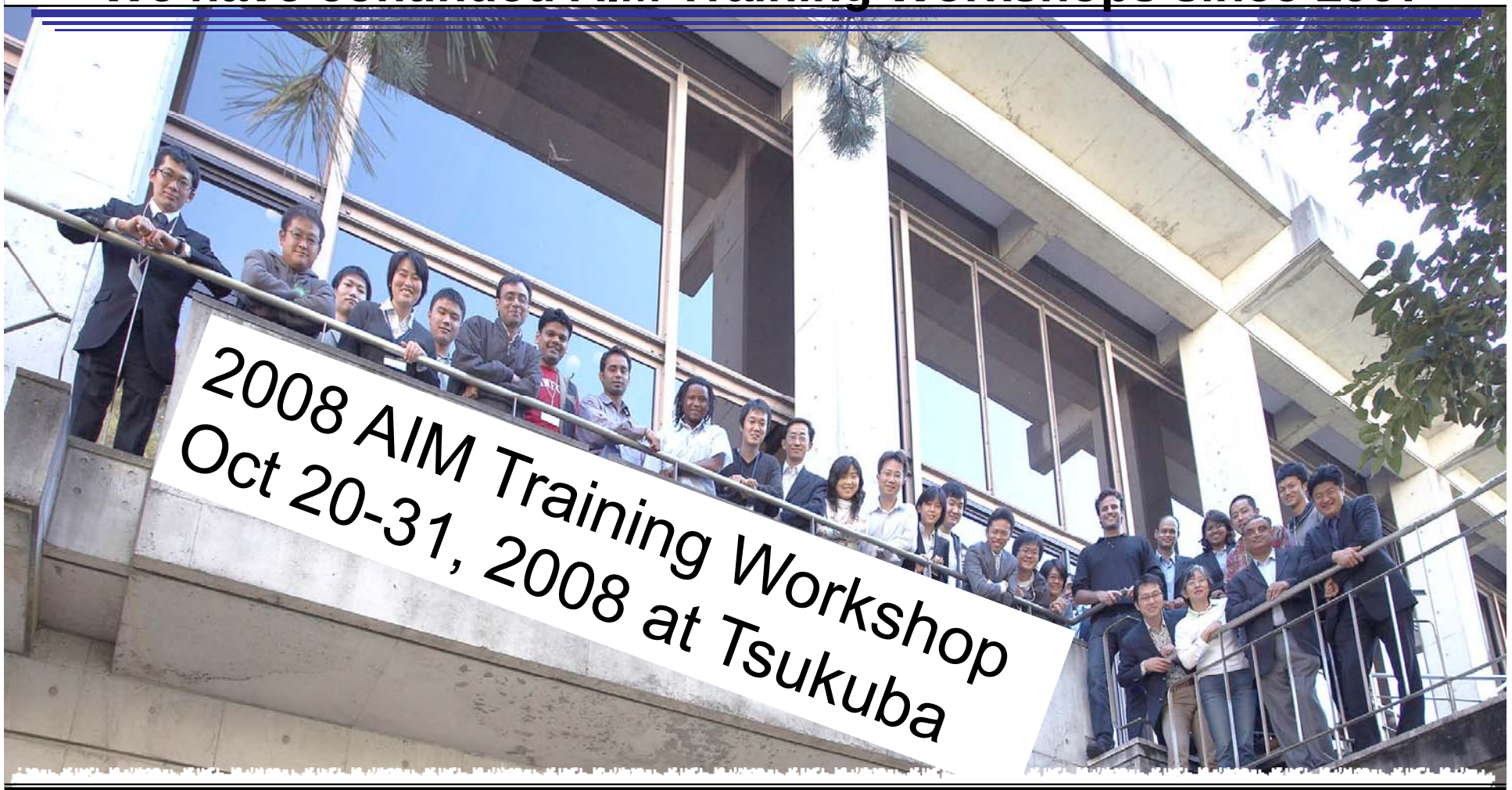
# Side Event at UNFCCC/COP

- COP11 (2005), “Global Challenges Toward Low-Carbon Economy -Focus on Country-Specific Scenario Analysis-”
- COP12 (2006), “Global Challenges toward Low-Carbon Society (LCS) through Sustainable Development (SD)”
- COP13 (2007), “Low-Carbon Asia: To be or not to be”
- COP14 (2008), “Sustainable Low-carbon Asia: How can it change the post-2012 climate negotiations?”
- COP15 (2009), …

COP11 (2005), Montreal

# We support country-wise LCS modeling through SD for Asia-Pacific and the world

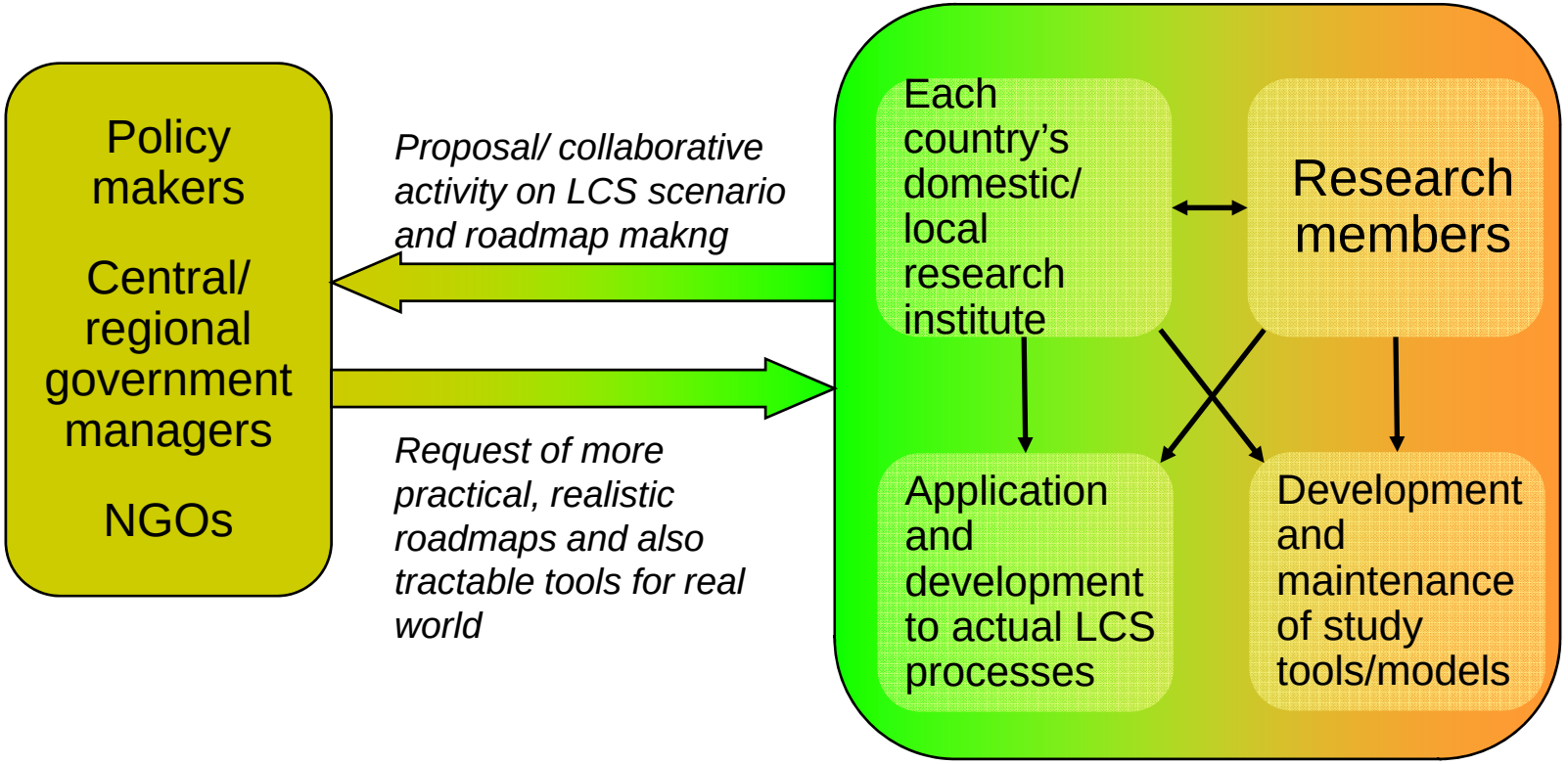
## - We have continued AIM Training Workshops since 1997 -




India China Thailand Korea Malaysia Indonesia Brazil Russia South Africa Taiwan, China USA Japan

http://2050.nies.go.jp

# Expectations on LCS-RNet: "How to deploy our study to real world?"




Designed by Hajime Sakai (airbox-pin@nyc.odn.ne.jp)

# Focused points in this modeling study

In this study, with models, quantification and consolidation of the following points are focused, and they are reflected in LCS roadmaps using the back-casting model.

| | Issues | Challenges |
|---|---|---|
| 1 | Accumulation and deepening processes of the next five capitals. 1) Energy infrastructure and technology, 2) Urban infrastructure, 3) Human capital, 4) Institution, 5) Social capital | How to integrated in LCS roadmaps wth engineering/ economic/ financial/ institutional rationality ? |
| 2 | Resolution of urban and rural disparity, energy-poverty nexus. | Realization of renewable energy society, and leapfrogging to new rungs on the energy ladder |
| 3 | Development and specialization of industrial structure, external dependency and vulnerability of the region. | Trend-breaking to new material/energy efficient, economicaly robust, and endogenously developing industrial system |
| 4 | Deployment of urban and inter-urban traffic systems. | How to realize comfortable Asian compact cities ? |
| 5 | Regional climate characteristics, building characteristics and lifestyle.. | Harmonization and merging of appropriate life and building style, e.g. Asian vernacular habitation, modern highly insulated material intensive building, … |
| 6 | Potentials of renewable energy resources, and developments of their utilizing facilities. | Integration of natural conservation, regional tradition, renewable energy deployment, and energy security |

# Two stages of LCS scenario development and where to apply three model groups

***Stage 1: Design of a Low Carbon Society***

1. Creation of narrative storylines of future Low Carbon Societies
2. Description of sector-wise details of the future LCSs.
3. Quantification of the Macro-economic and social aspects of the LCSs.
4. Identification of effective policy measures and packaging them

***Stage 2: Putting them together and design roadmaps towards LCS***

1. Design of policy roadmaps toward the Low Carbon Society
2. Feasibility analysis of the roadmaps considering uncertainties involved in each policy option
3. Analysis of robustness of the roadmap caused by social, economical and institutional acceptability and uncertainties

***Group 1: Element models;***

1) Snapshot models;
   - *cge[country]:* Quasi steady computable general equilibrium (CGE) model
   - *enduse[country]:* Energy technology bottom-up models
   - *ESM:* Energy supply model
   - *HPLM*: Household production/lifestyle model
   - *TDM:* Transportation demand model

2) Transition models;
   - *PHM:* Population and household model
   - *BDM:* Building dynamics model
   - *MSFM:* Material stocks and flow model
   - *EME:* Econometric type macro-economy model

***Group 2: Extended Snapshot Tool (ExSS)***

***Group 3: Backcasting Model for roadmap design and transient control (BCM)***

## Estimated results on potential $CO_2$ emission reduction in the urban area by HP, CGS and DHC with wheeling (aggregated by prefecture)

| Prefecture | Potential CO2 reduction rate | Prefecture | Potential CO2 reduction rate | Prefecture | Potential CO2 reduction rate |
|---|---|---|---|---|---|
| Hokkaido | 16.6% | Ishikawa | 18.1% | Okayama | 18.1% |
| Aomori | 17.5% | Fukui | 17.5% | Hiroshima | 18.6% |
| Iwate | 16.0% | Yamanasi | 17.9% | Yamaguti | 18.0% |
| Miyagi | 18.7% | Nagano | 17.9% | Toskushima | 18.0% |
| Akita | 15.9% | Gifu | 16.5% | Kagawa | 21.7% |
| Yamagata | 17.1% | Shizuoka | 21.0% | Ehime | 18.8% |
| Hukusima | 18.2% | Aichi | 23.7% | Kochi | 16.7% |
| Ibaragi | 20.9% | Mie | 19.3% | Fukuoka | 24.3% |
| Tochigi | 18.1% | Shiga | 19.7% | Saga | 19.6% |
| Gunma | 20.7% | Kyoto | 19.0% | Nagasaki | 19.1% |
| Saitama | 25.3% | Oosaka | 30.0% | Kumamoto | 18.5% |
| Chiba | 21.6% | Hyogo | 19.8% | Oita | 17.0% |
| Tokyo | 30.4% | Nara | 22.2% | Miyazaki | 17.5% |
| Kanagawa | 29.5% | Wakayama | 18.6% | Kagoshima | 17.9% |
| Niigata | 17.5% | Tottori | 18.7% | Okinawa | 21.9% |
| Toyama | 18.4% | Shimane | 16.3% | **Japan** | **18.6%** |

Transportation system

# 2050Vision: Passenger transport

| | | Metro Urban | Metro Suburb | Provincial Urban | Provincial Rural | Total |
|---|---|---|---|---|---|---|
| $\frac{TransServ}{capita}$ | Compact neighborhood | △ Rehabilitation | ○ Rehabilitation | △ Rehabilitation | ○Compact Settlement | 112−>33Mt To 1990 − 70% Including (Inter−city Passenger: 30km−) Index: ◎: − 30% ○: − 20% △: − 10% ×: no room |
| $\frac{Pkm(Tkm)}{TransServ}$ | Compact city | △City center renewal | △Withdrawal | △City center renewal | × | |
| $\sum_{Mode}$ | Enhance public transit | △Pricing | △Park & Ride etc. | ○LRT | △van pool, shared taxi | |
| $\frac{Vkm}{Pkm(Tkm)}$ | Improve load efficiency | △Utilize small vehicles | | △Enhance sharing | × | |
| $\frac{Fuel}{Vkm}$ | Improve fuel consumption | ◎Urban mode | ○local mode | | | |
| $\frac{CO_2EF}{Fuel}$ | Low carbon energy | △less room for improve | ○biofuel, Low Carbon Electricity for EV and PHEV etc. | | | |
| $\frac{CO_2}{capita}$ | pop(million) | 46→40 | 15→12 | 27→20 | 35→23 | 124→94 |
| | t−$CO_2$/capita | 0.66→0.27 | 0.94→0.35 | 1.03→0.38 | 1.11→0.51 | 0.90→0.35 |

2050年の70%削減に向けたビジョンの例

Yuichi Moriguchi, “Transportation in Low Carbon Society”, Japan Low-Carbon Society Scenarios toward 2050 Project Symposium, 12 February 2009

IT-society

# Positive Against Negative Impact of ICT

| | Industry | Freight transport | Passenger transport | Office | Home | Recycling | Impact on CO2 emmisions | |
|---|---|---|---|---|---|---|---|---|
| Diffusion of ICT equipment | Resource | | | Electric | Electric | Waste | Negative II | +1to2% |
| Supply chain ma (B2B) | | | | | | | Positive I | -3% |
| Internet shopping (B2C) | Resource consumption | Resource consumption | | Number of shops | | | Negative/Psotive | |
| Teleworking | | | Transport | Number of offices | Electric power | | Positive III | -1% |
| Advanced traffic utilization system (modal shift in commuting, ETC, etc.) | | Transport | Energy consumption | | | | Postive II | |
| Dematerialization system (newspaper, magazine, and CD) | Resource consumption | Transport | | Number of shops | | Waste | Positive III | -1% |
| Energy-manageme (HEMS, BEMS) | | | | | | | Positive II | -1to-2% |
| Eco-life guidance s | | | consumption | power | power | aste | Positive I | |
| A product and manufacture management | Resource consumption | | | | | | Positive I | |
| Recycling information system | Resouce consumption | | | | | Waste | Negative/Psotive | |
| E-government | | | Transport | | | Wastes | Positive III | |

CO2 reduction of 2 to3% in 2010

CO2 reduction of 10%in 2050

| | |
|---|---|
| | Reduction |
| | Unknown |
| | Increase |

| | Rate to the total 2020' emissions |
|---|---|
| I | 3-5% |
| II | 1-3% |
| III | 0-1% |

Jun Fujimoto, “LOW-CARBON SOCIETY SCENARIO: ICT AND ECODESIGN”, Japan Low-Carbon Society Scenarios toward 2050 Project Symposium, 12 February 2009