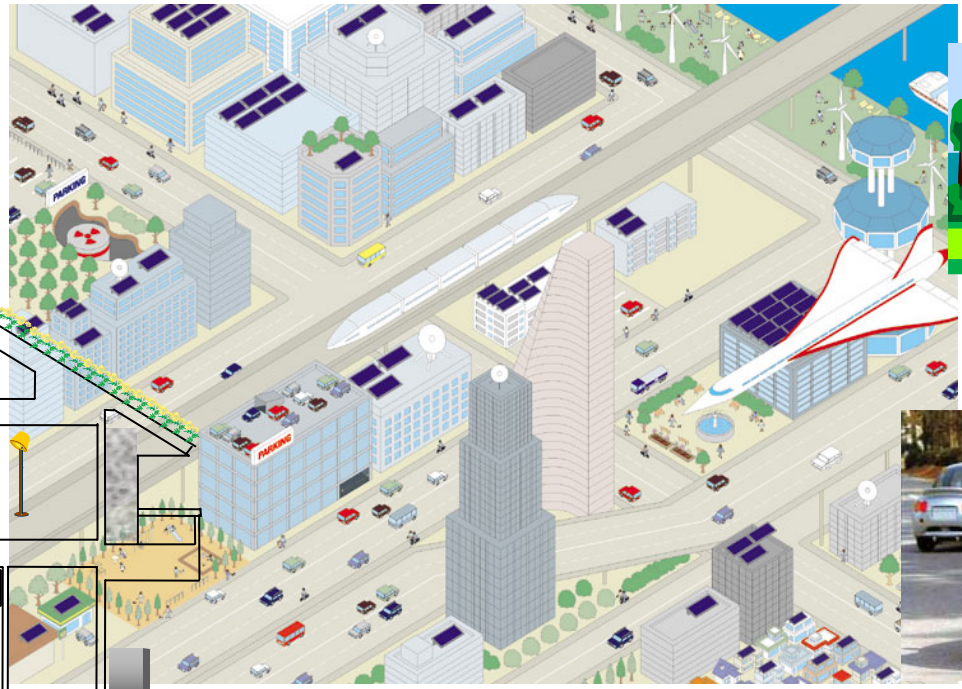
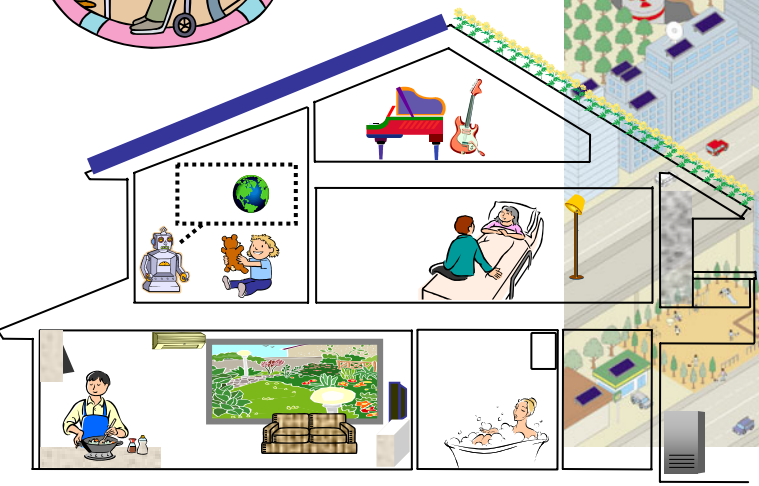
# Japan LCS study

Japan Low Carbon Society 2050

http://2050.nies.go.jp







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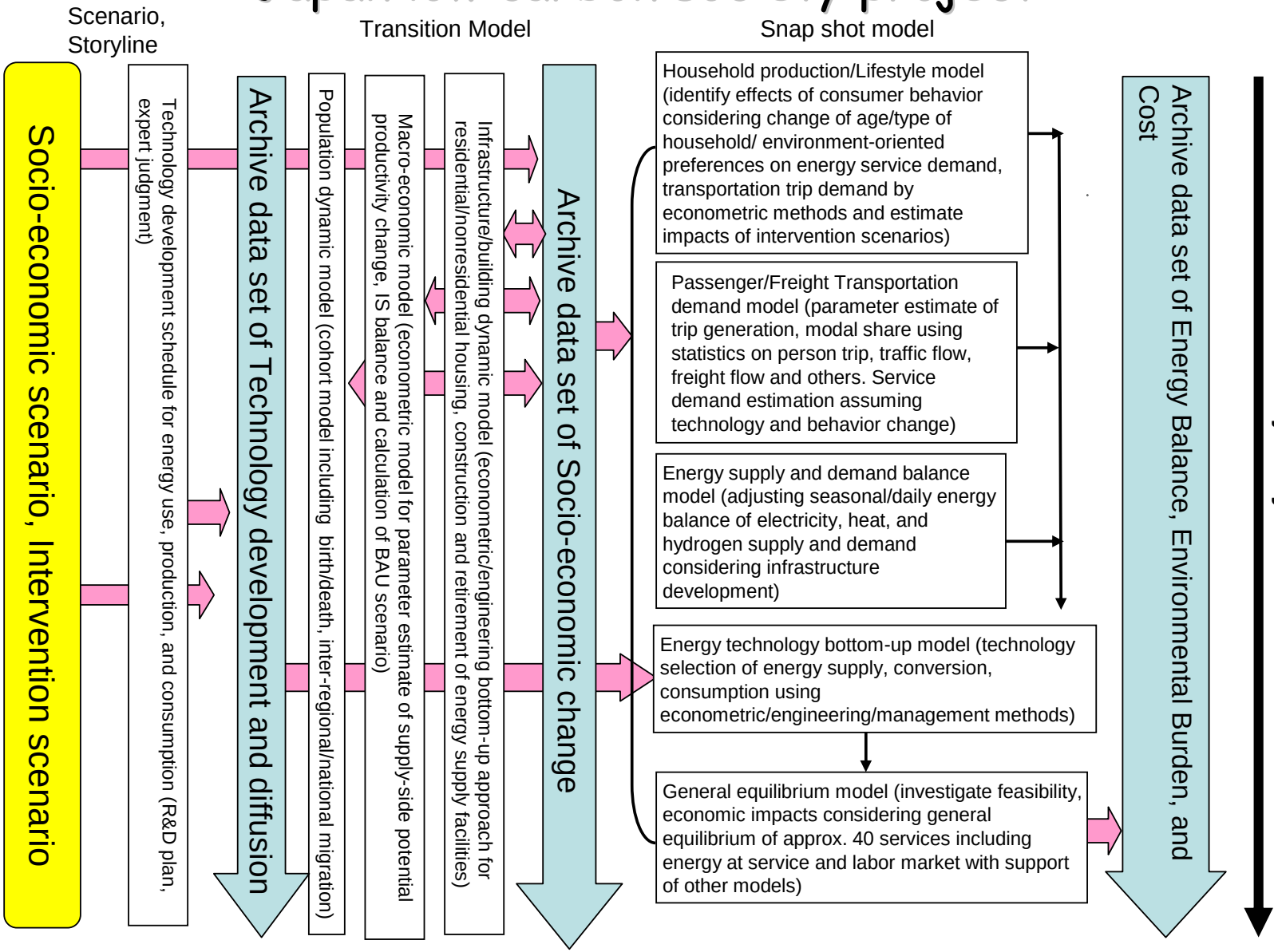
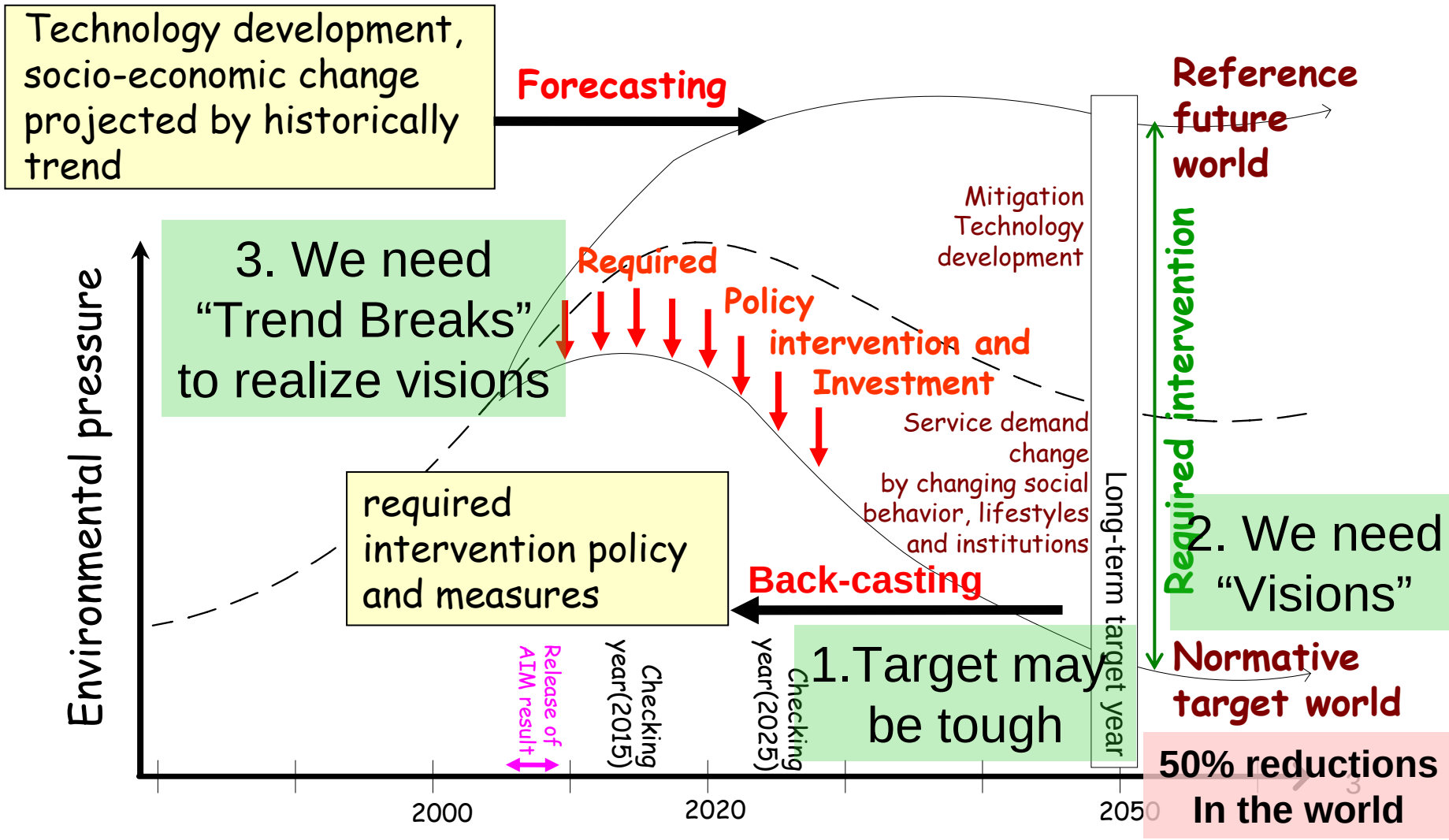
19-21, February 2007, NIES/Tsukuba/Japan

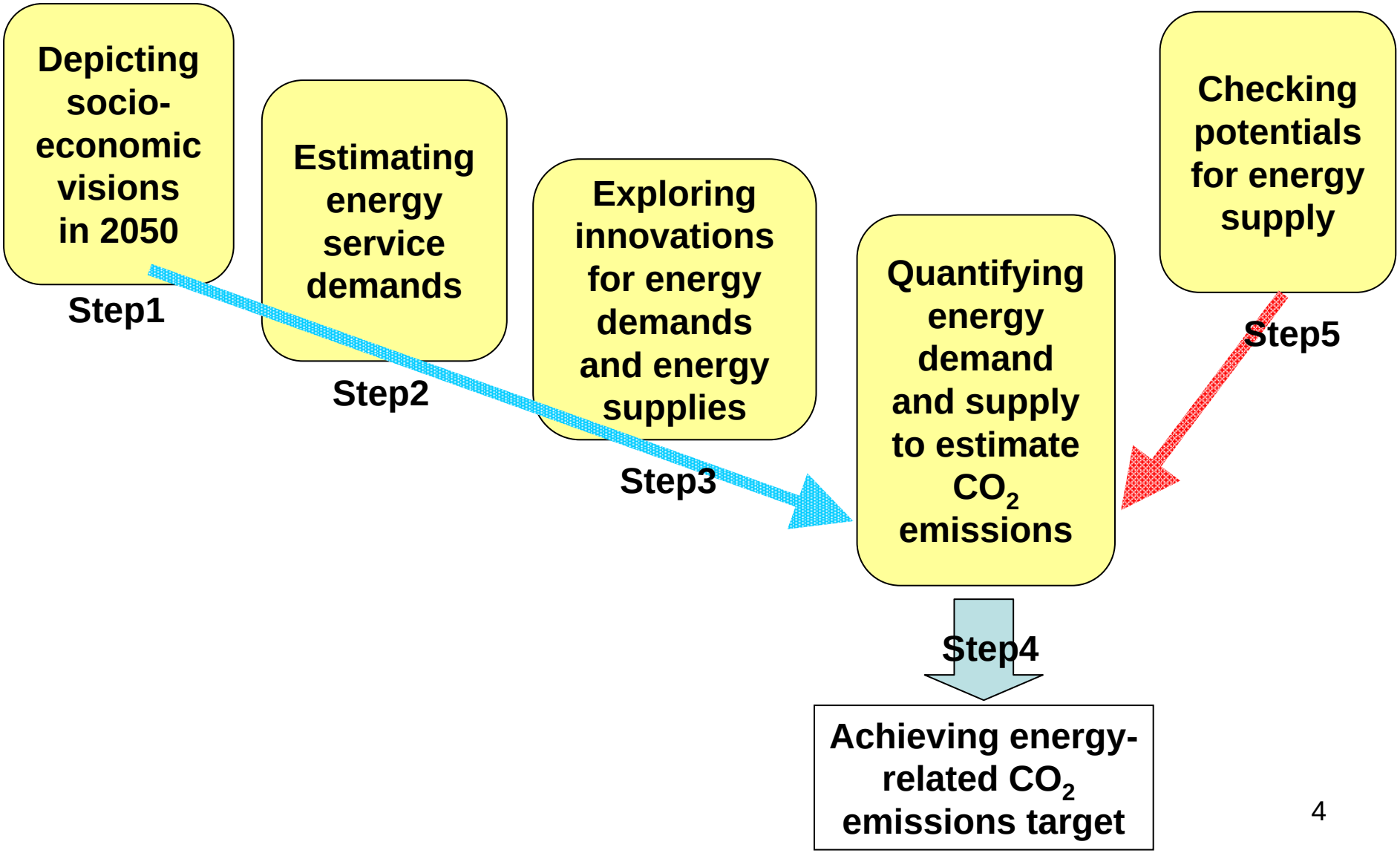
# Element models for Japan low carbon society project



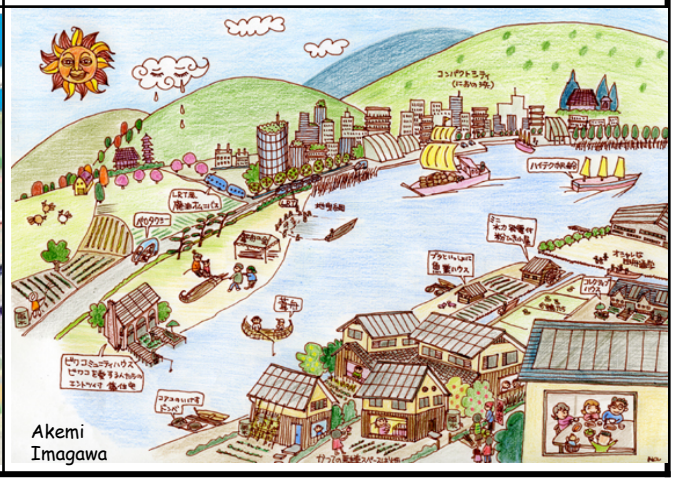
# Forecasting from now and Backcasting from future prescribed/normative world



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



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

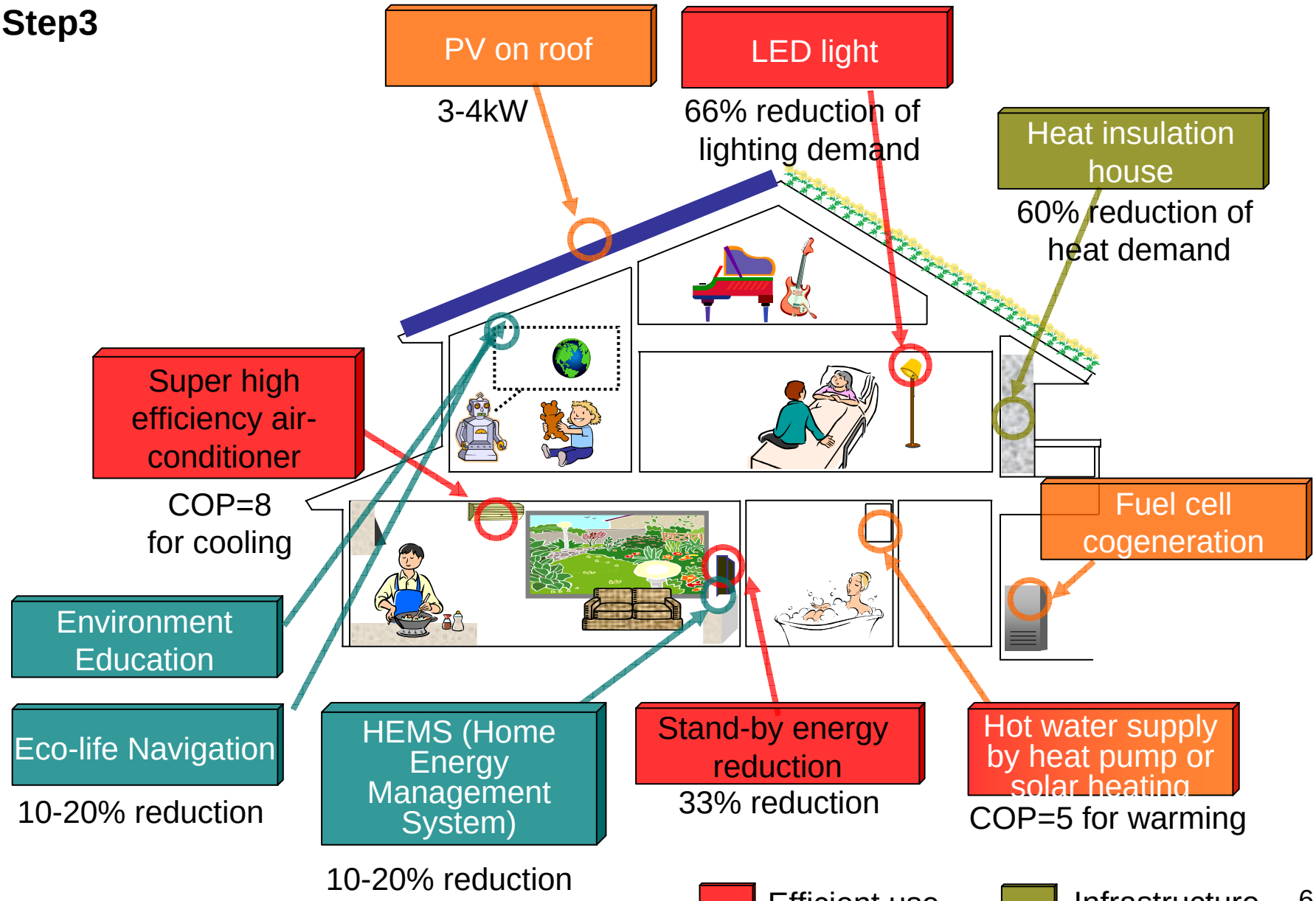
| Vision A "Doraemon" | Vision B "Satsuki and Mei" |
|---|---|
| Vivid, Technology-driven | Slow, Natural-oriented |
| Urban/Personal | Decentralized/Community |
| Technology breakthrough<br>Centralized production /recycle | Self-sufficient<br>Produce locally, consume locally |
| Comfortable and Convenient | Social and Cultural Values |
|  |  |

Doraemon is a Japanese comic series created by Fujiko F. Fujio. The series is about a robotic cat named Doraemon, who travels back in time from the 22nd century. He has a pocket, which connects to the fourth dimension and acts like a wormhole.

Satsuki and Mei's House reproduced in the 2005 World Expo. Satsuki and Mei are daughters in the film "My Neighbor Totoro". They lived an old house in rural Japan, near which many curious and magical creatures inhabited.

Step1 and Step3

# Depict Future Image: Residential sector in 2050



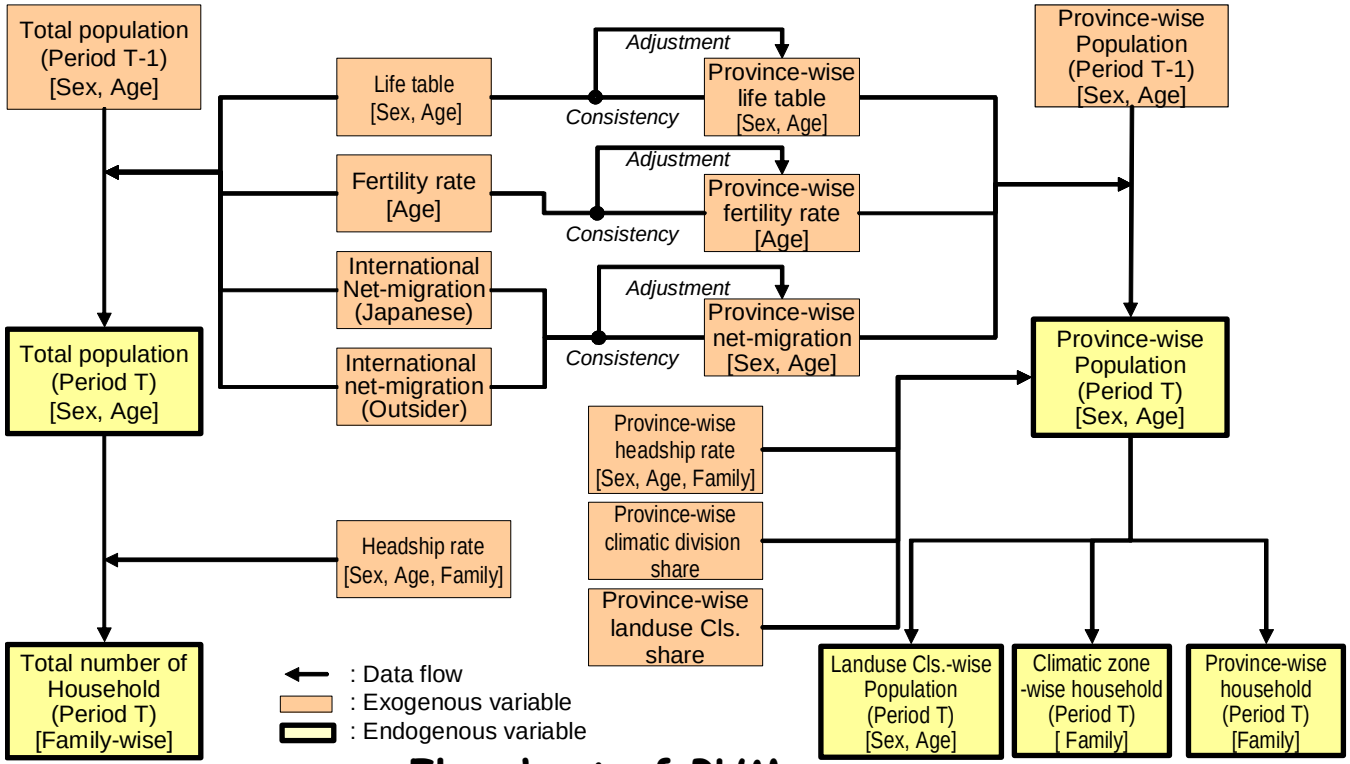



Maho Miyashita

Step2

# Population and Household Model

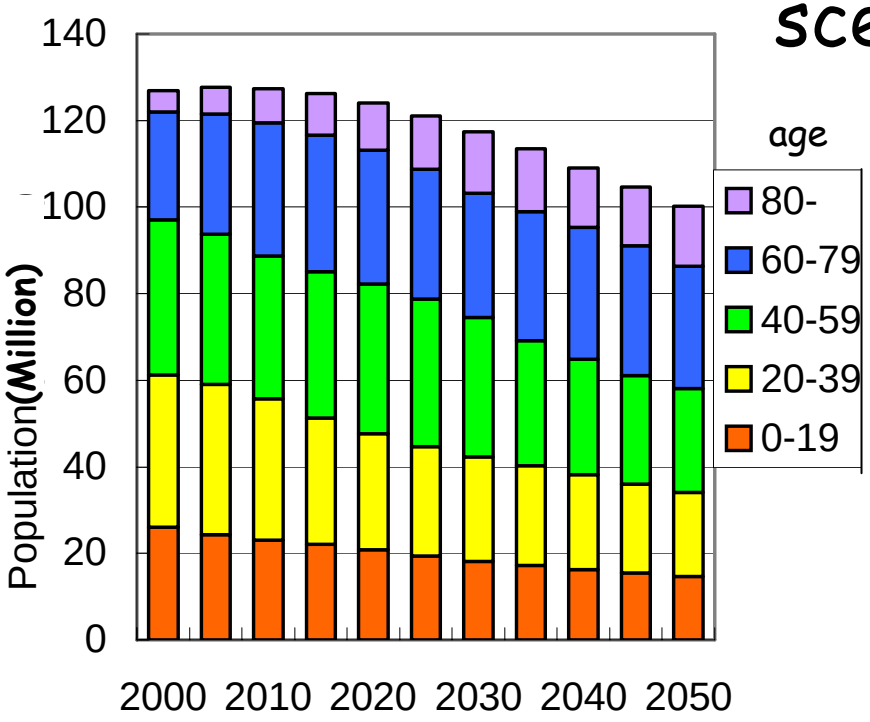
- Drastic change is projected in Japan's population structure by 2050. Downturn in birthrate, depopulation and aging will continue until 2050, and they affect greatly the future vision.
- A cohort component model for population, a household headship rate model for household types, with spatial resolution of provinces, land-use types and climate zones and five family types was developed, and is used to analyze effects of depopulation and changes in family composition on the realization of LCS.

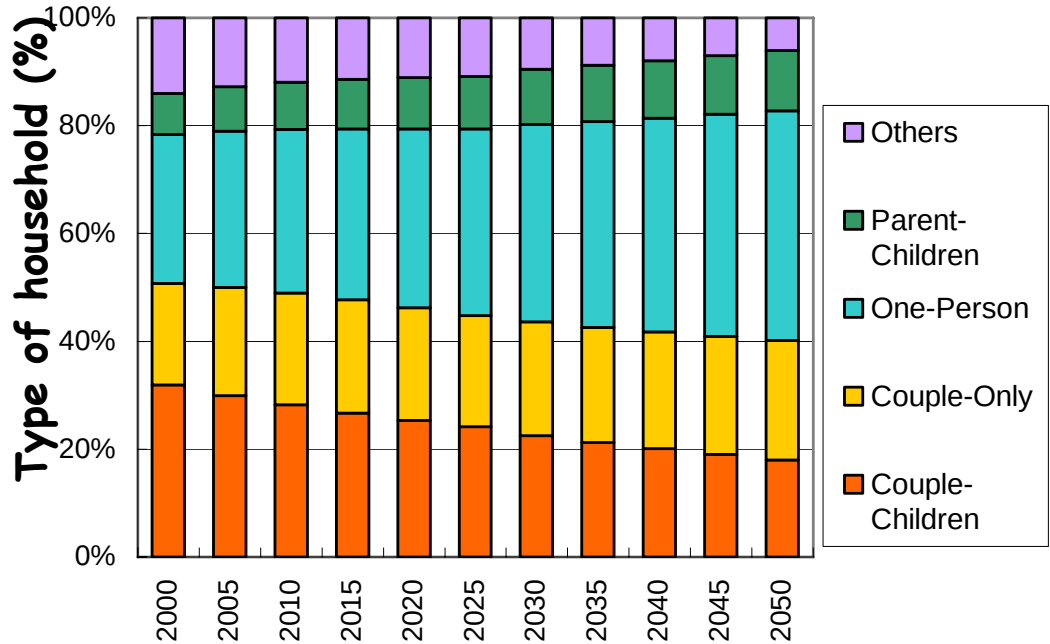



Flowchart of PHM

Step2

# Projection Japan population and households in scenario A

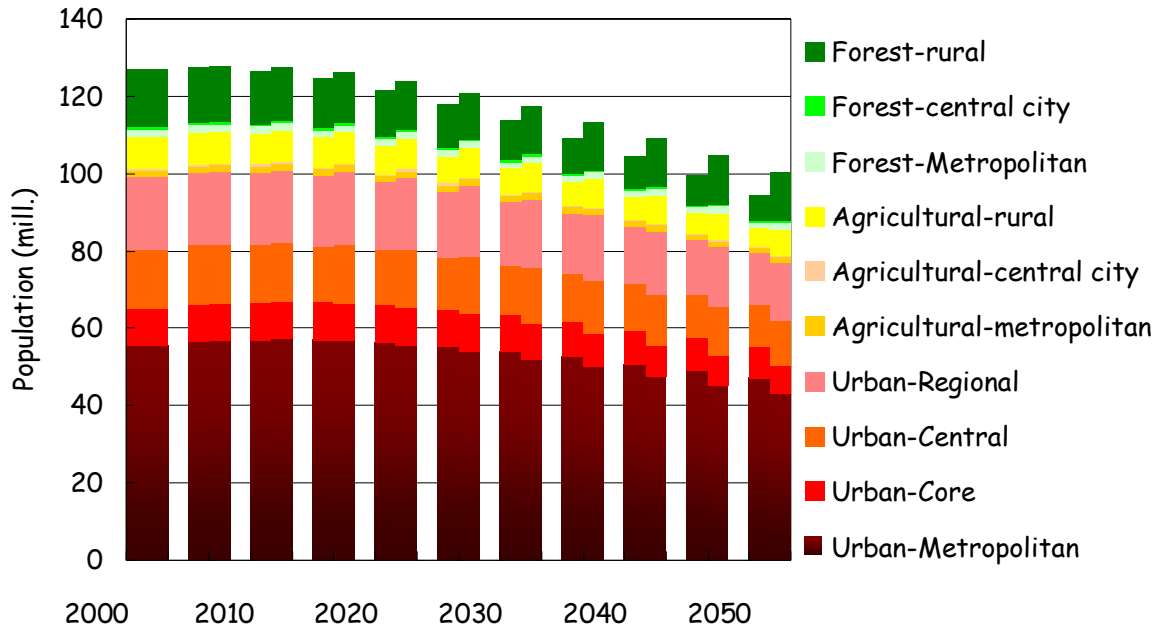



| year | 2000 | 2050 | |
|---|---|---|---|
| | | A | B |
| Population (million) | 126.9 | 94.5 | 100.3 |
| Aged population ratio (%) | 17.4 | 53.7 | 35.8 |
| Average number of household | 2.71 | 2.19 | 2.38 |
| Single-person households (%) | 27.6 | 42.6 | 35.1 |

Step2

# Projection of urbanization



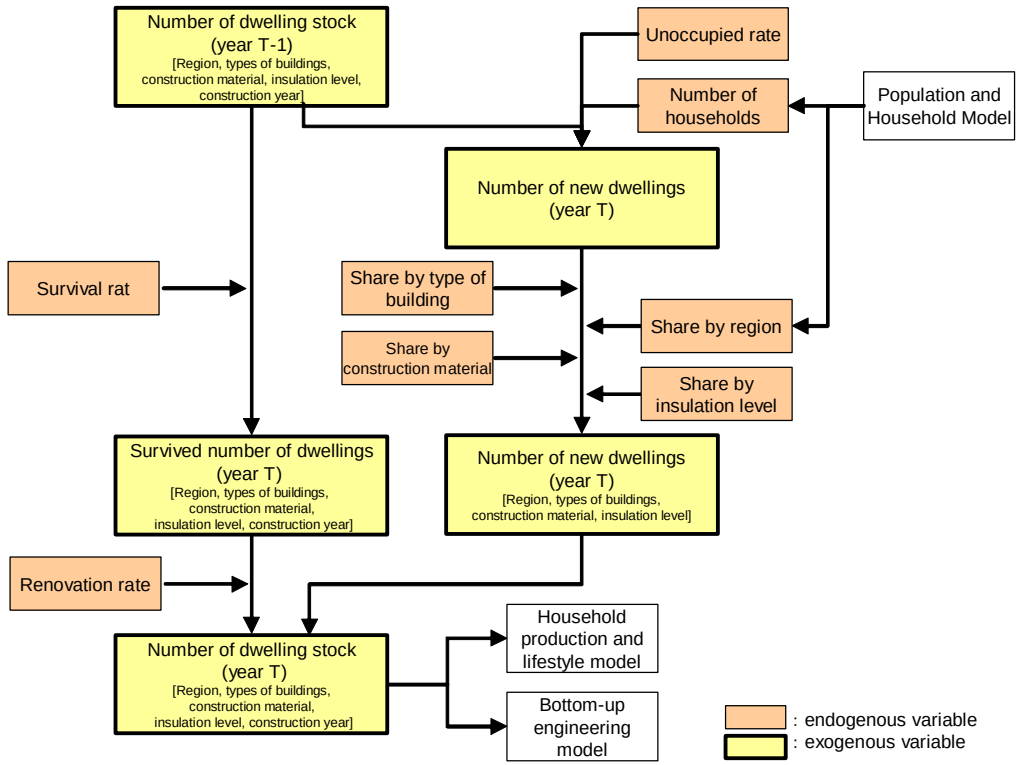

| year | 2000 | 2050 | |
|---|---|---|---|
| | | A | B |
| Population (million) | 126.9 | 94.5 | 100.3 |
| Urban population(%) | 78.1 | 84.2 | 76.7 |
| Agricultural area population(%) | 8.2 | 7.1 | 8.5 |
| Forest area population(%) | 13.7 | 8.7 | 14.8 |

# Building Dynamics Model

- Enhancement of building insulation is very effective countermeasures. 60% of the heating demand from the residential sector can be cut down, if appropriate insulation systems are installed. Besides, configuration of buildings in urban and rural area affects social energy efficiency greatly.

- In order to take account these factors, a model of building dynamics (BDM) was developed.

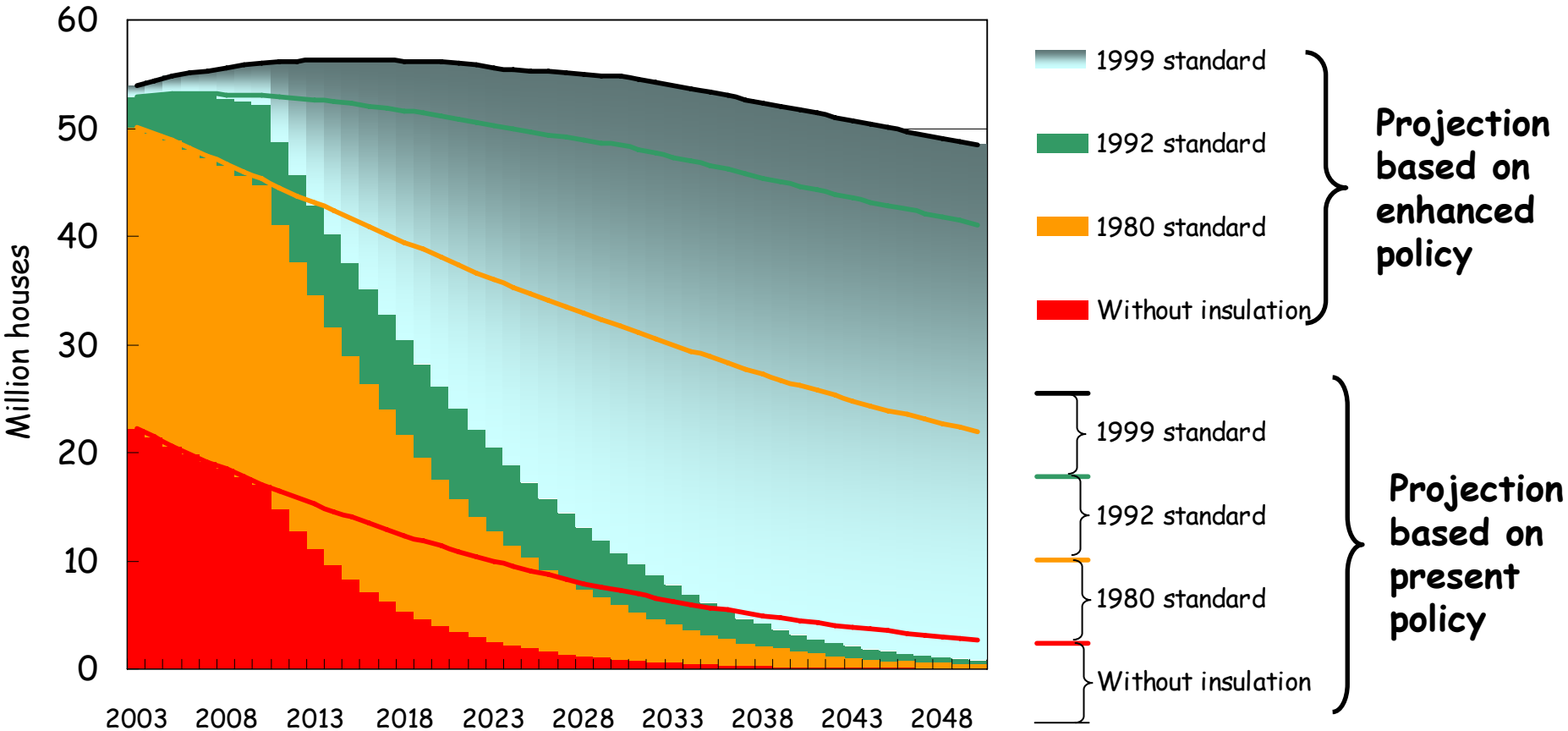
- It is a cohort model with a spatial resolution of climate zones, four heat insulation levels, four residential building types, and six commercial building types.




Flowchart of BDM (residential)

Step2

# Projection of residential building stock by insulation level



# Quantification of Scenario A and B in 2050

| year | unit | 2000 | 2050 A | 2050 B | model |
|---|---|---|---|---|---|
| Population | Mil. | 127 | 94 (74%) | 100 (79%) | |
| Household | Mil. | 47 | 43 (92%) | 42 (90%) | Population and Household model |
| Average number of person per household | | 2.7 | 2.2 | 2.4 | |
| GDP | Tril.JPY | 538 | 1059 (197%) | 693 (129%) | |
| Share of production | | | | | Inter-sector and Macro Economic Model |
| primary | % | 1.8% | 1.0% | 1.4% | |
| secondary | % | 39.9% | 32.3% | 35.4% | |
| tertiary | % | 58.4% | 66.7% | 63.3% | |
| Office floor space | Mil.$m^2$ | 1654 | 2078 (126%) | 1739 (105%) | Building dynamics Model & Inter-sector and Macro Economic Model |
| Travel Passenger volume | bill. p·km | 1297 | 1016 (78%) | 794 (61%) | |
| Private car | % | 53% | 27% | 53% | Transportation demand model & Inter-sector and Macro Economic Model |
| Public transport | % | 40% | 62% | 34% | |
| Walk/bycycle | % | 8% | 8% | 13% | |
| Freight transport volume | bill. t·km | 578 | 525 (91%) | 458 (79%) | |
| Industrial production index | | 100 | 142 (142%) | 113 (113%) | |
| Steel production | Mil.t | 107 | 40 (37%) | 40 (37%) | Inter-sector and Macro Economic Model |
| Etylen production | Mil.t | 8 | 4 (50%) | 4 (50%) | |
| Cement production | Mil.t | 82 | 40 (49%) | 40 (49%) | |
| Paper production | Mil.t | 32 | 16 (50%) | 27 (85%) | |

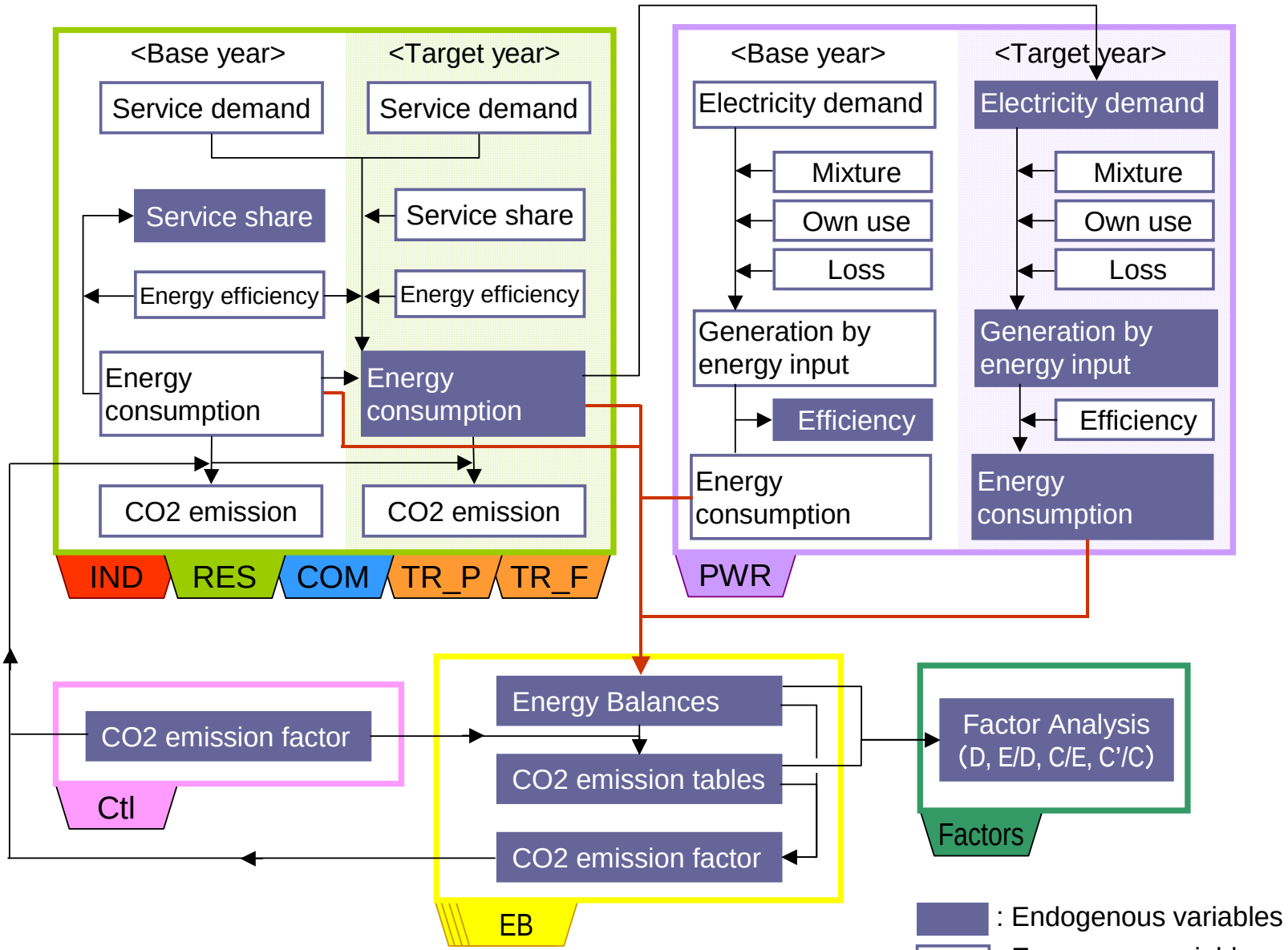
( %) is a percentage compared with year 2000

# Key technological countermeasures in the Environmental Option Database (EDB) for Residential and Commercial Sector

| Sector | Technology |
|---|---|
| Residential & Commercial | Efficient air conditioner, Efficient electric water heater, Efficient gas/oil water heater, Solar water heater, Efficient gas cooking appliances, Efficient electric cooling appliances, Efficient lights, Efficient visual terminal, Efficient refrigerator, Efficient cool/hot carrier system, Fuel cell cogeneration, Photovoltaic, Building energy management system, Efficient insulation, Eco-life navigation, Electric newspaper/magazine etc. |

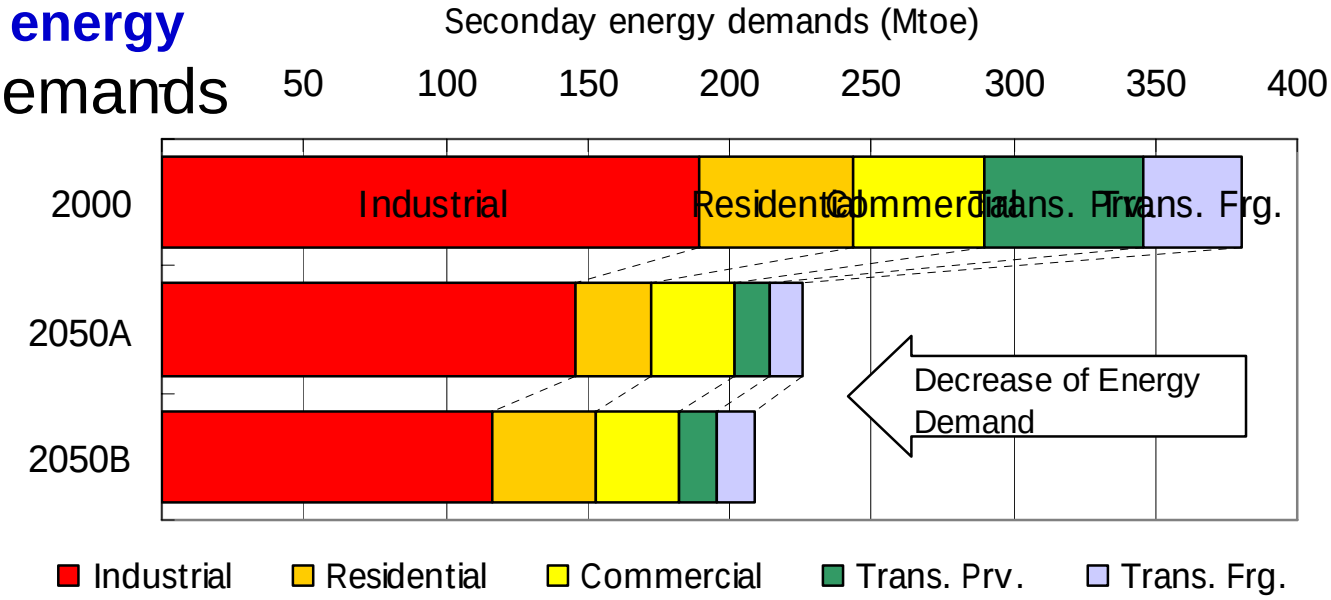
Step4

# Snapshot Integration Tool (SSI)
## - energy part -

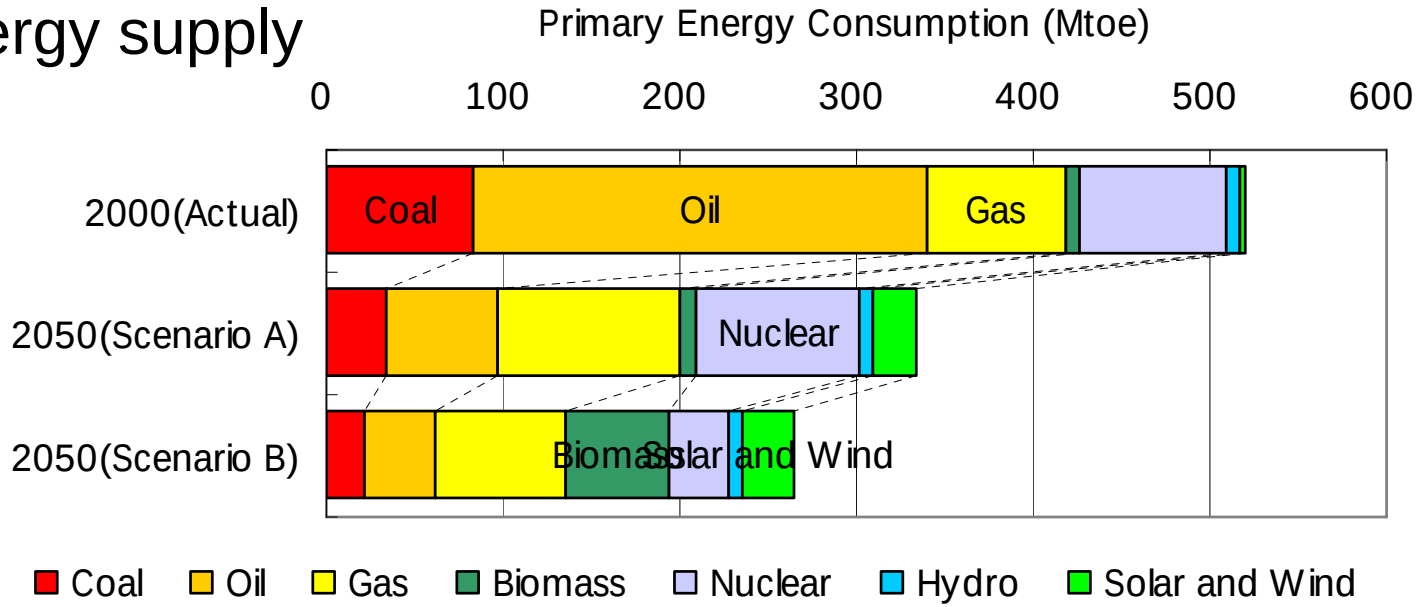


# 70% reduction: Combination of demand side energy reduction ＋low carbon energy

## Final energy demands




## Primary energy supply

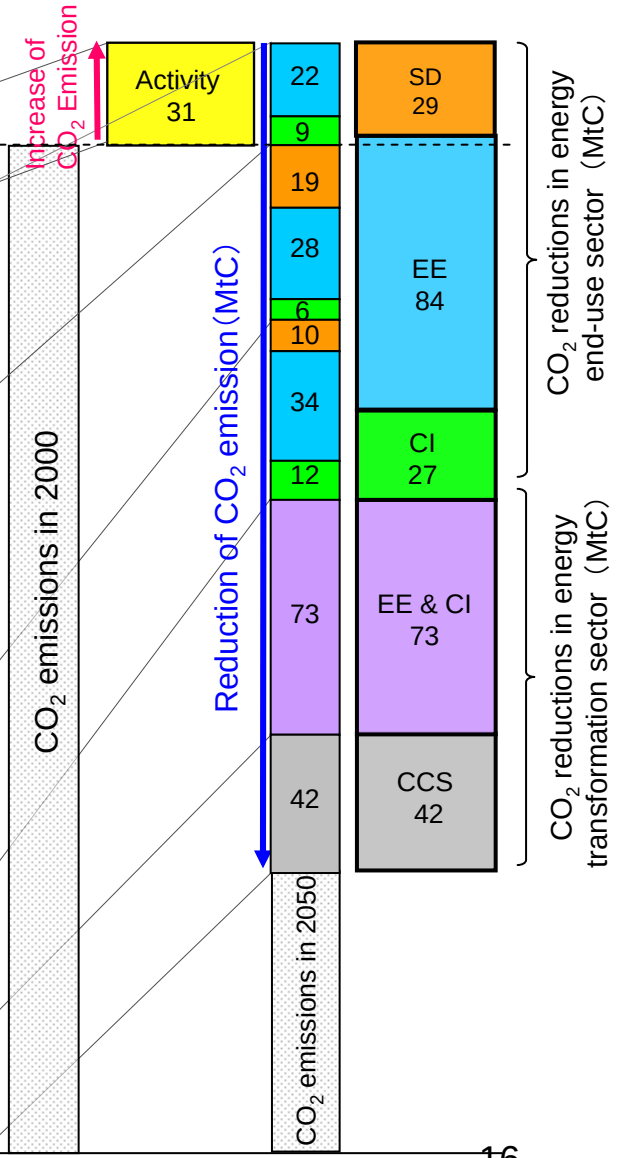



**Step4 and Step5**

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

Demand side energy -40% ＋ Low carbonization of primary energy＋CCS

| | Main factors to reduce $CO_2$ emissions | Factors Class. |
|---|---|---|
| Society | • High economic growth<br>• Decrease of population and number of households | Demand growth by activity level change |
| Industrial | • Energy efficient improvement of furnace and motor etc. | Energy Efficiency Imp. (EE) |
| | • Fuel switching from coal and oil to natural gas | Carbon Intensity Imp. (CI) |
| Residential and commercial | • High insulation dwelling and building<br>• Home/Building energy management system | Reduction of service demands (SD) |
| | • Efficient air-conditioner, Efficient water heater, Efficient lighting system<br>• Fuel cell system<br>• Photovoltaic on the roof | Energy Efficiency Imp. (EE)<br>Carbon Intensity Imp. (CI) |
| Trans-portation | • Intensive land-use, Concentrated urban function<br>• Public transportation system | Reduction of service demands (SD) |
| | • Motor-driven mobiles: Electric battery vehicles, Fuel cell battery vehicles | EE & CI |
| Energy Transformation | • Nuclear energy<br>• Use of electricity in night time, Electric storage<br>• Hydrogen supply system | Carbon Intensity Imp. (CI) |
| | • Advanced fossil fueled plants + CCS<br>• Hydrogen supply using fossil fuel + CCS | Carbon Capture and Storage (CCS) |



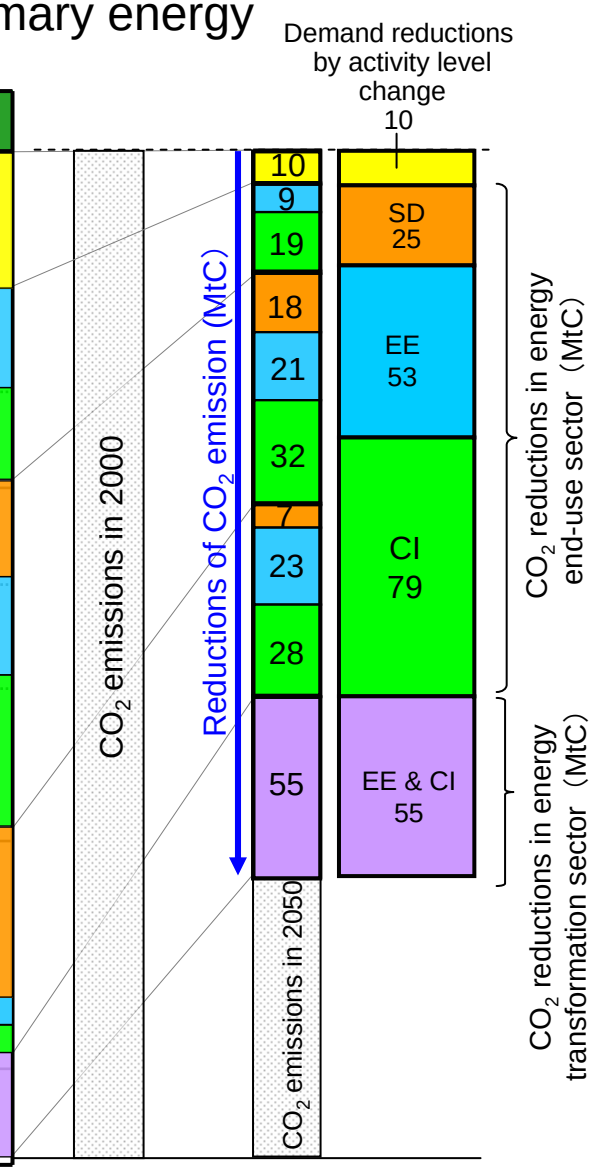



**Step4**

# GHG 70% reduction in 2050 Scenario B: Slow-nature oriented Society

Demand side energy -45% ＋ Low carbonization of primary energy

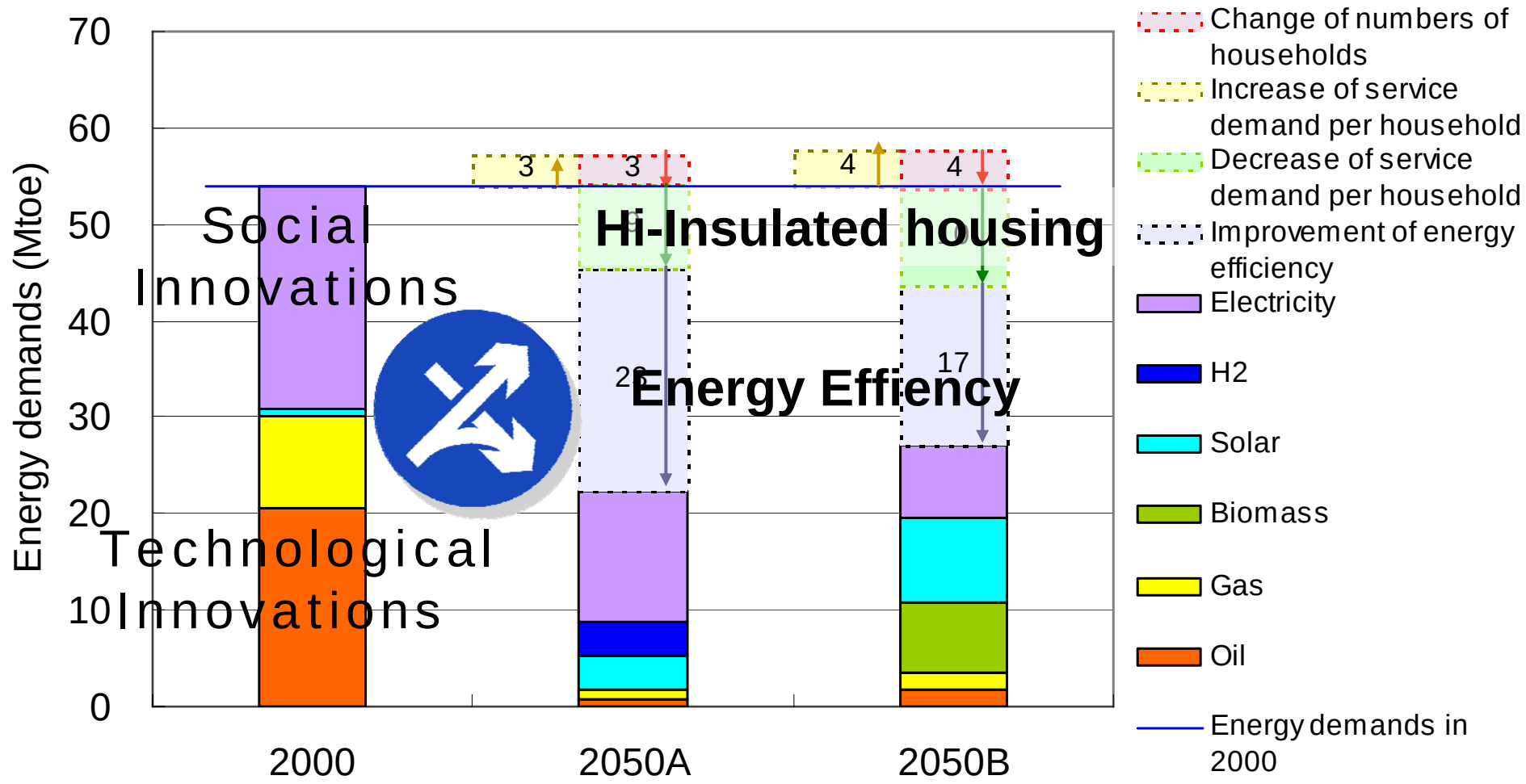
| | Main factors to reduce $CO_2$ emissions | Factors Class. |
|---|---|---|
| Society | • Reduction of final demand by material saturation<br>• Reduction of raw material production<br>• Decrease of population and number of households | Demand growth by activity level change |
| Industrial | • Energy efficient improvement of furnace and motor etc. | Energy Efficiency Imp. (EE) |
| | • Increase of Fuel switching from coal and oil to natural gas and biomass | Carbon Intensity Imp. (CI) |
| Residential and commercial | • High insulation dwelling and building<br>• Eco-life navigation system | Reduction of service demands (SD) |
| | • Efficient air-conditioner, Efficient water heater, Efficient lighting system | Energy Efficiency Imp. (EE) |
| | • Photovoltaic on the roof<br>• Expanding biomass energy use in home<br>• Diffusion of solar water heating | Carbon Intensity Imp. (CI) |
| | • Shortening trip distances for commuting through intensive land use<br>• Infrastructure for pedestrians and bicycle riders (sidewalk, bikeway, cycle parking) | Reduction of service demands (SD) |
| Trans-portation | • Biomass-hybrid engine vehicle | EE and CI |
| | • Expanding share of both advanced gas combined cycle and biomass generation | Carbon Intensity Imp. (CI) |






**Step4**

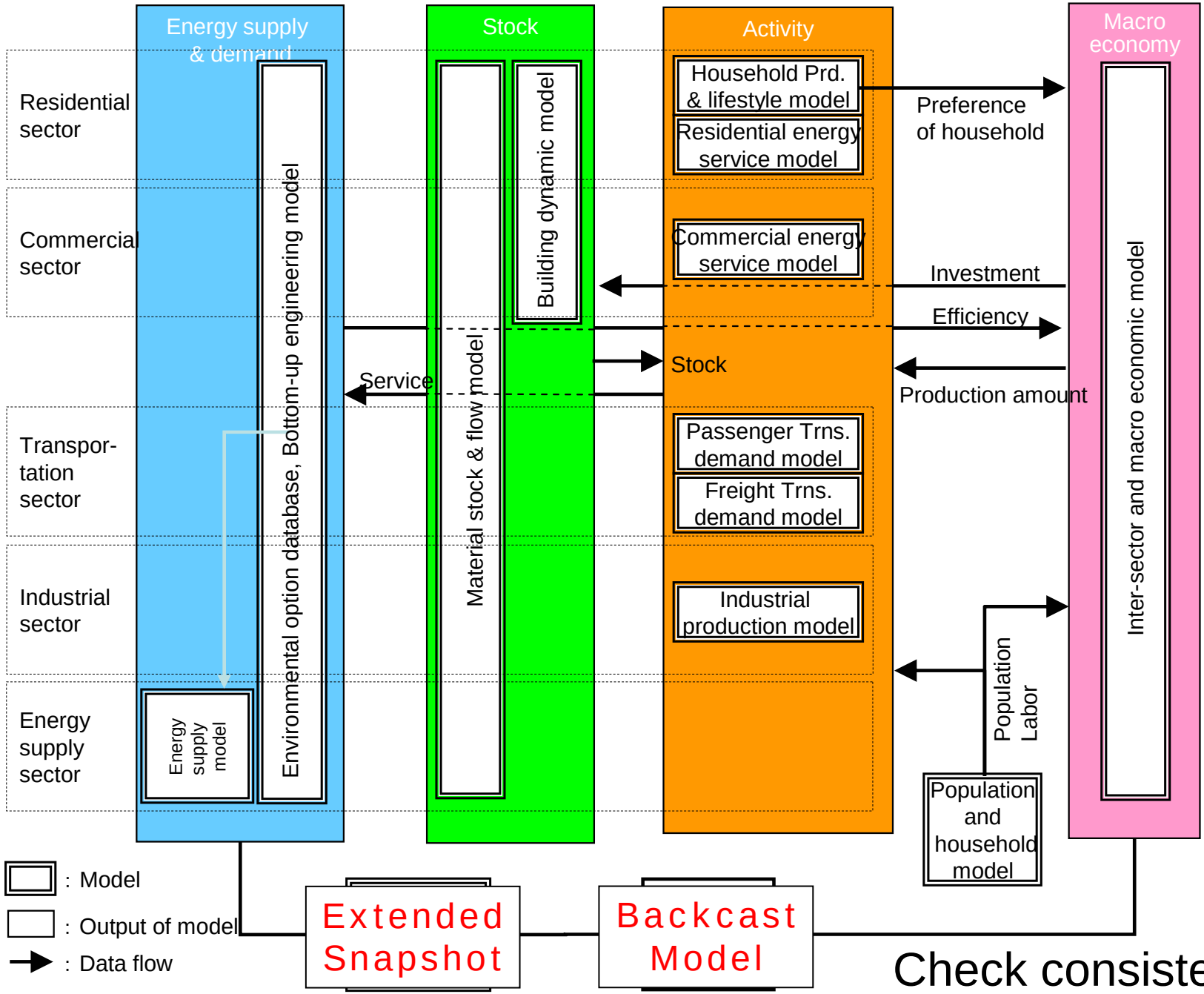
# Residential sector
# CO2 reduction potential: 50%




**Step4**


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

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



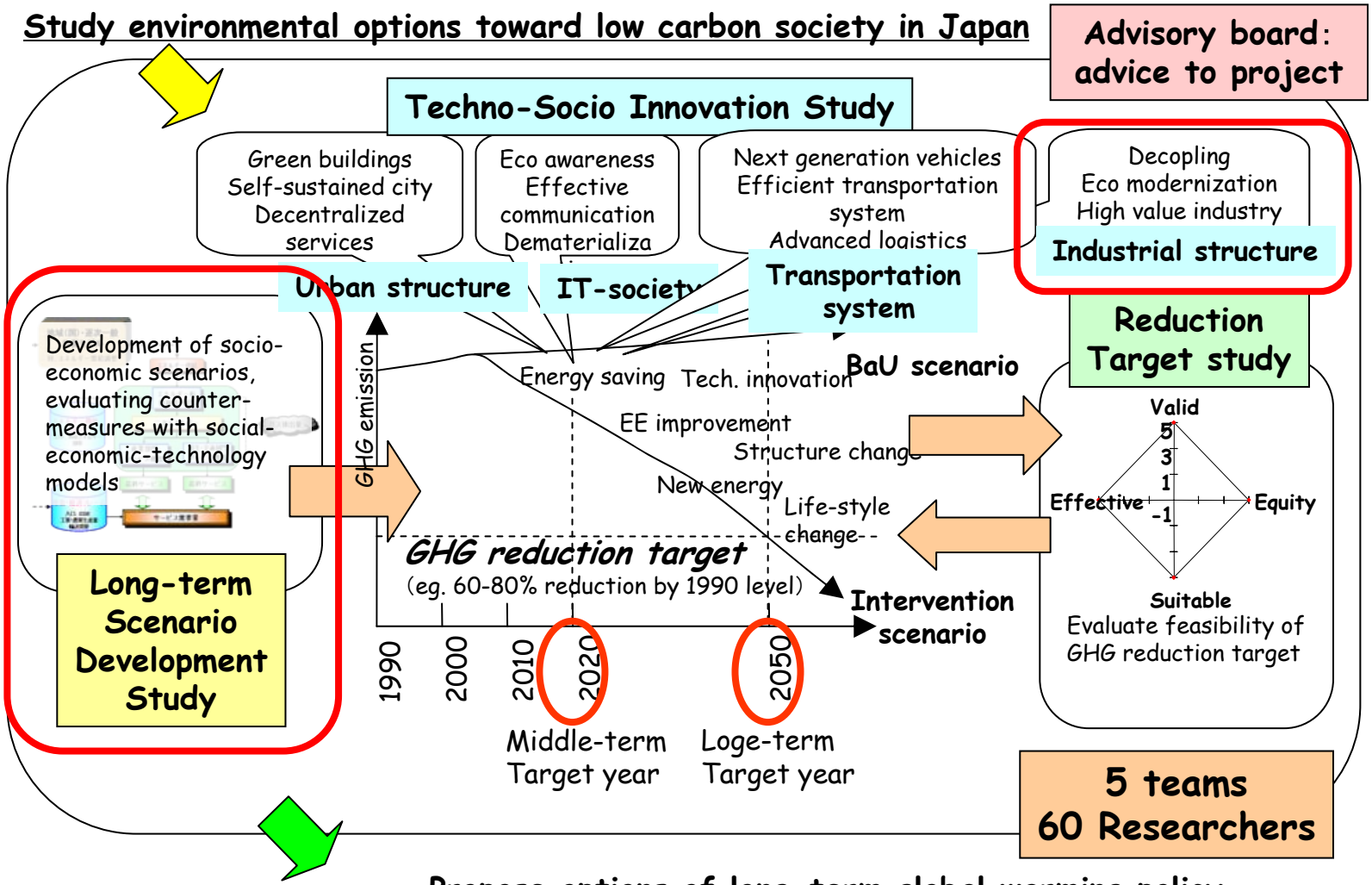



**AIM (Asia-Pacific Integrated Modeling) for Japan LCS scenarios**

# Back-up slides

# Japan Low Carbon Society Scenarios toward 2050

## FY2004-2006 (PhaseI),2007-2008 (Phase II)
## Global Environmental Research Program, MOEJ



# Focusing points of LCS modeling study

1. Support to develop LCS scenarios which satisfy the prescribed emission targets as well as the related environmental, economical and social targets.

2. The scenarios are concrete, plausible, quantitative and consistent with technology, economy and sociality.

3. However, the LCS may be far from the current trend, and in order to reach them, the models can be useful to search "Trend Breaking Interventions" and to estimate their effects from the viewpoint of technological, environmental, and economical aspects.

# Narrative description of Scenario A

Technical progresses in the industrial sectors are considerably high because of vigorous R&D investments by the government and business sectors. The economic activities as a whole are so dynamic that average annual per capita GDP growth rate is kept at the level of 2%. The other reasons for such high economic growth are high rates of consumption in both business and household sectors.

The employment system has been drastically changed from that in 2000 and equal opportunities for the employment have been achieved. Since workers are employed based on their abilities or talents regardless of their sex, nationality and age, the motivation of the worker is quite high in general.

As many women work outside, the average time spent for housekeeping has decreased. Most of the household works are replaced by housekeeping robots or services provided by private companies. Instead, the time used for personal career development has increased.

The new technologies, products, services are positively accepted in the society. Therefore, purchasing power of the consumer is strong and upgrade cycles of the commodities are short.

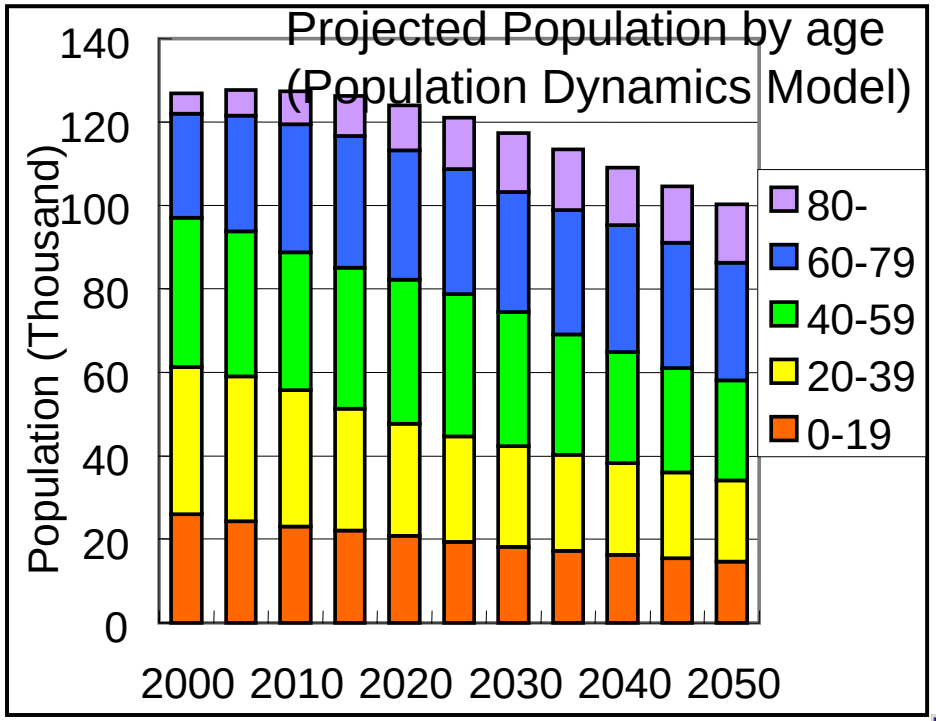
Household size becomes smaller and the number of single-member households has increased. Multi-dwellings are preferred over detached houses, and the urban lifestyle is more popular than the lifestyle of countryside.

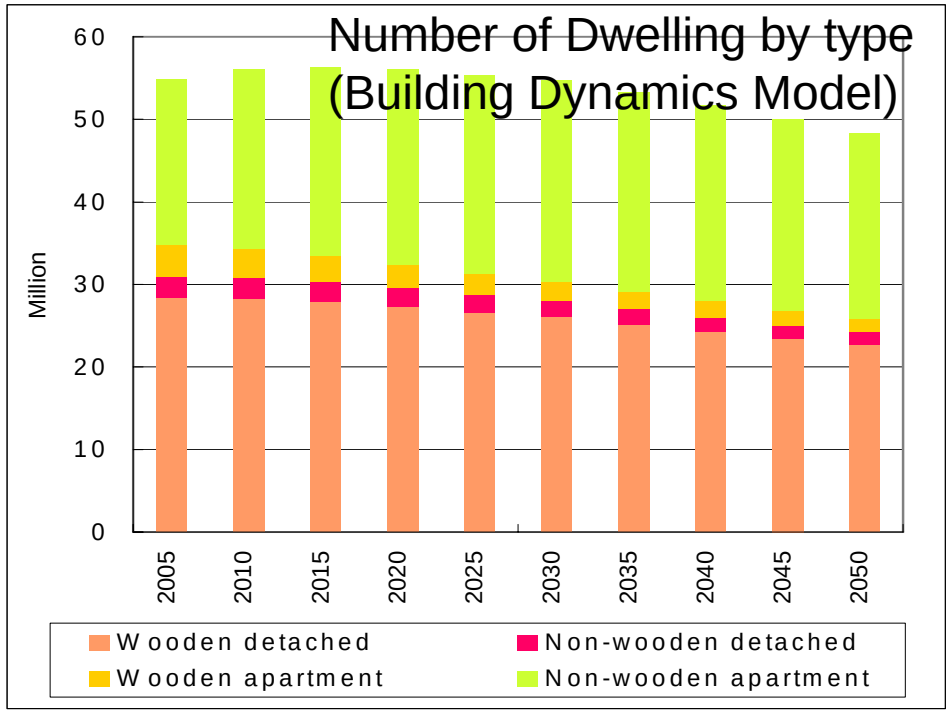
# Narrative description of Scenario B

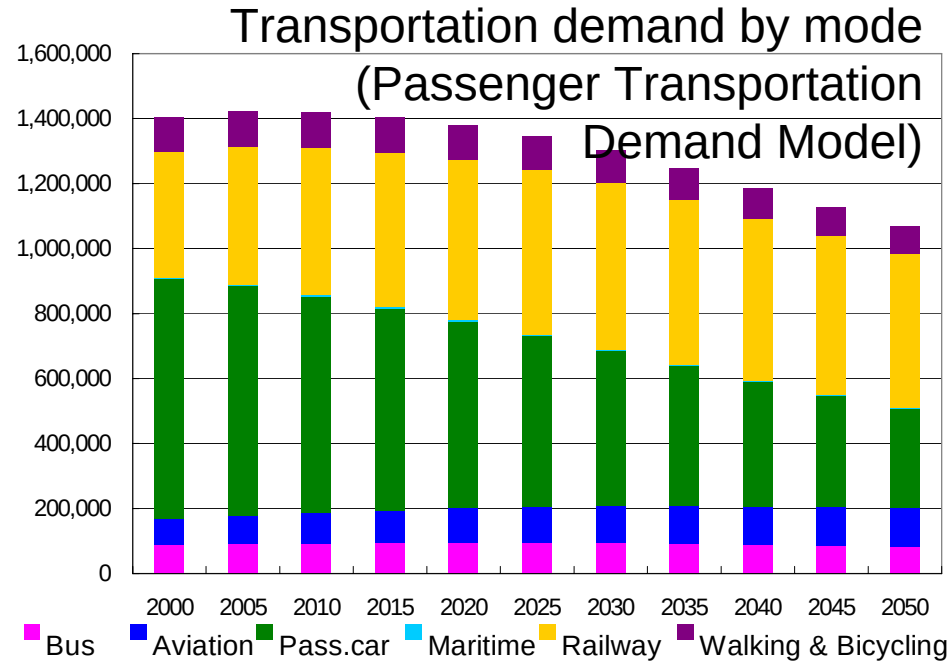
Although average annual growth rate of per capita GDP is approximately 1%, people can receive adequate social services no matter where they live. Volunteer works or community based mutual aid activities are the main provider of the services. Since the levels of medical and educational service in the countryside have drastically improved, continuous migration of population from city to countryside has been observed.

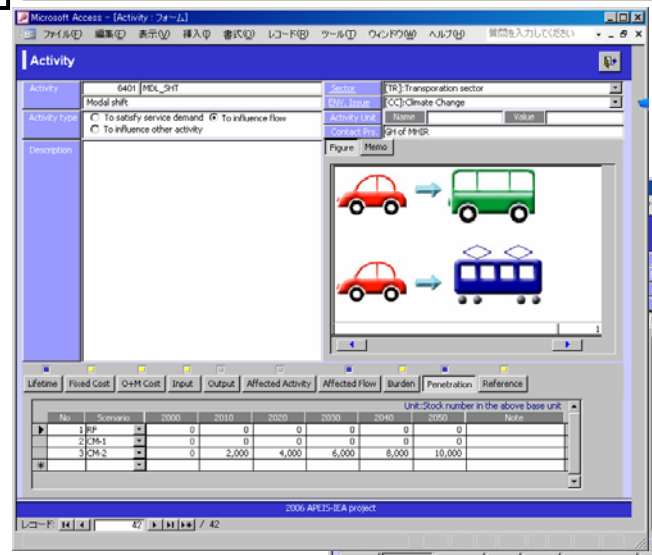
The number of family who own detached dwellings has increased. The trend is especially prominent in the countryside. The size of the houses and the floor area per houses has also increased with the increasing share of detached houses.

The ways people work have also changed. The practice that husbands work outside and wives work at home is not common anymore. In order to avoid the excessive work of the partner, the couples help each other and secure the income according to their life plan. Housework is shared mainly among family members, but free housekeeping services provided by local community or social activity organizations are also available. As a result of the changes in lifestyle, the time spent within family has increased. The time spent on hobby, sports, cultural activities, volunteer activities, agricultural works, and social activities has also increased.






EDB
Environmental option DataBase

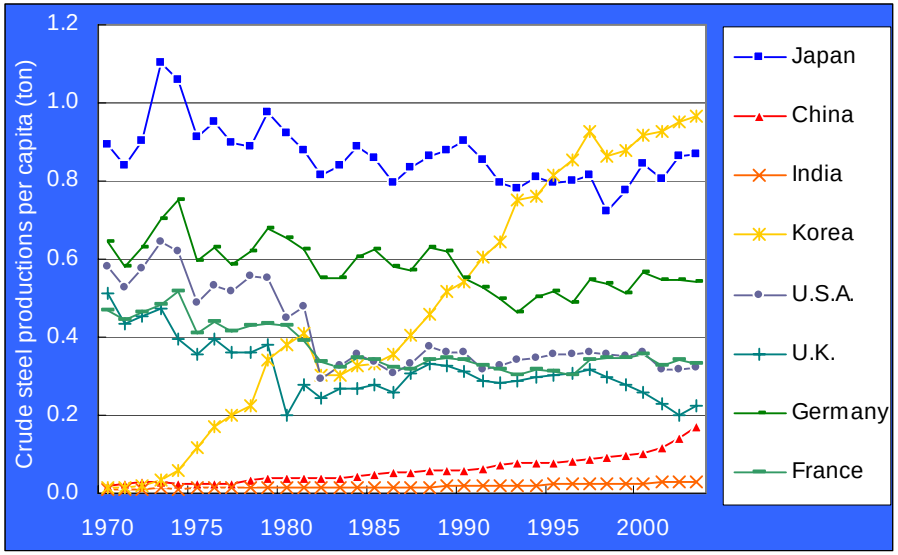
# LCS Japan Scenarios for Economy and Industry

| | | |
|---|---|---|
| **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<br>・Dependent on import products | ・Recovery of GDP share<br>・Revival of public interest in agriculture and forestry |
| **Secondary Industry** | ・Increasing add value<br>・Shifting production sites to overseas | ・Declining GDP share<br>・high-mix low-volume production with local brand |
| **Tertiary industry** | ・Increase in GDP share<br>・Improvement of productivity | ・Gradual increase in GDP share<br>・Penetration of social activity |

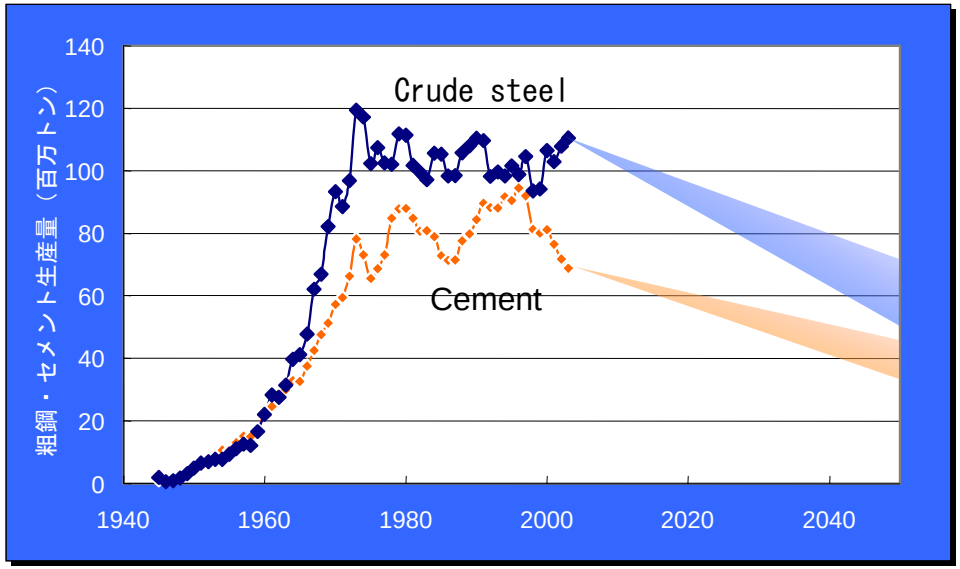
# Family life style

# Figure 2

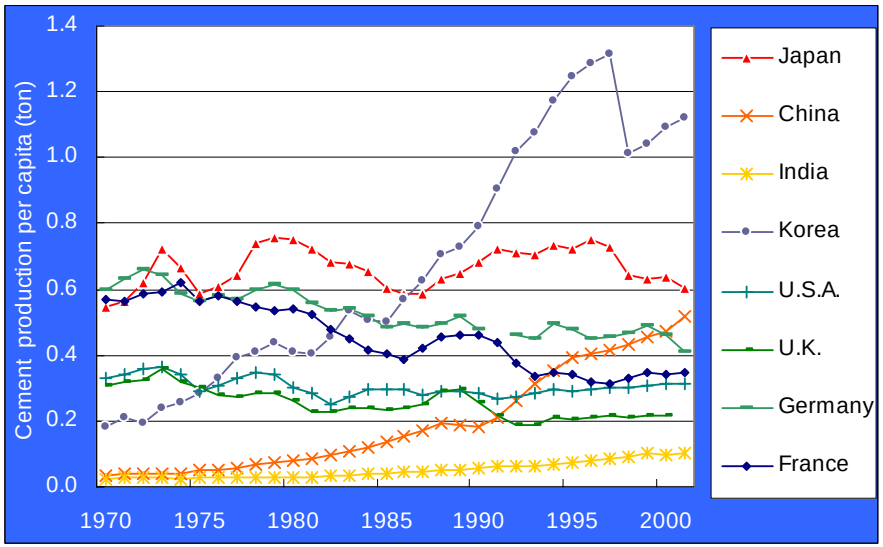
Crude steel production per capita by country




Future trends for crude steel and cement production in Japan



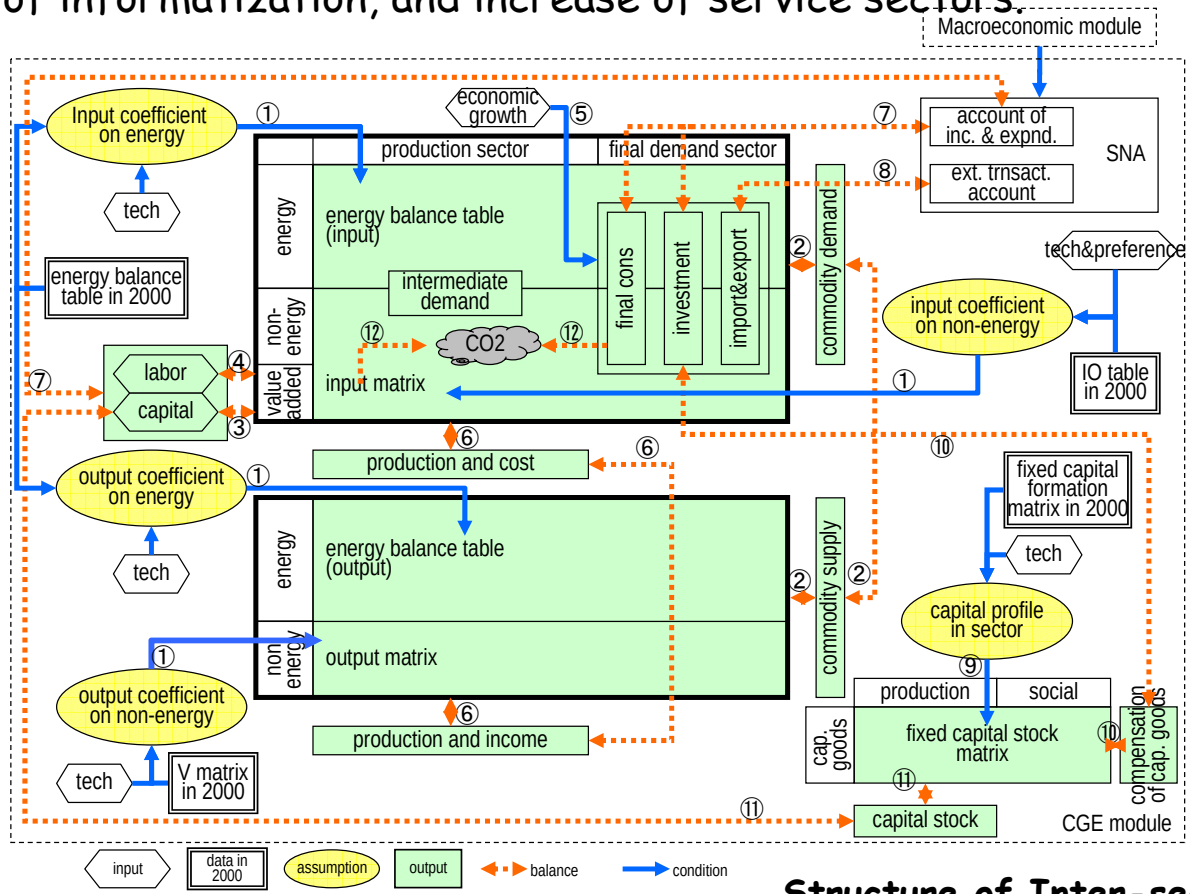

Cement production per capita by country




Source：
(Crude steel production, Cement production)
Industrial Commodity Production Statistics (United Nations)、World Development Indicators (World Bank)
(Crude steel production, Cement production in Japan)
Reports by Advisory Committee on Energy and Natural Resources (1998, 2004, 2005) and predictions by the Institute of Energy Economics, Japan.

# Inter-sector and Macro Economic Model

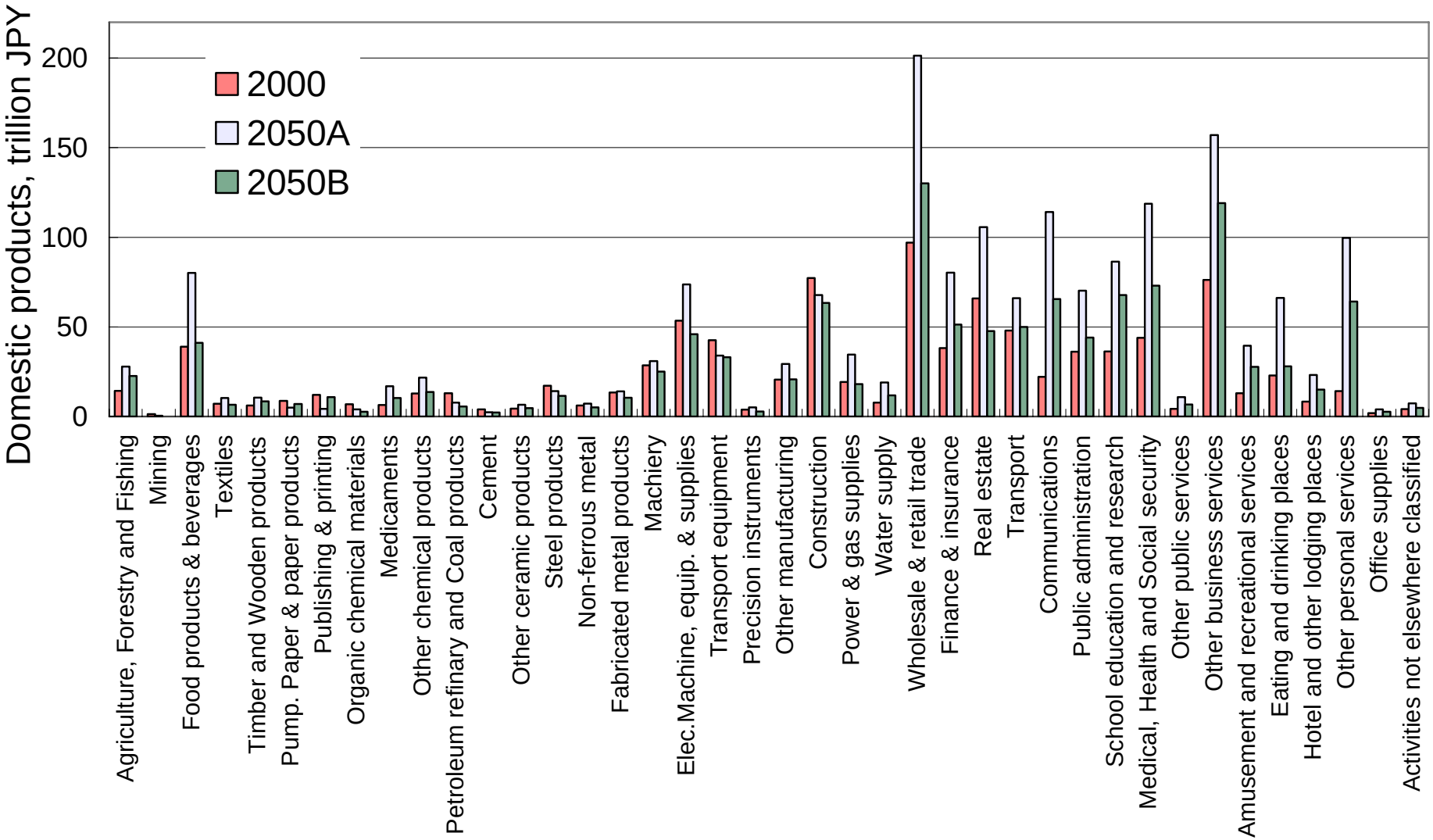
- Projecting macro economic activity, sectoral production, and also taking account the countermeasures proposed in the individual models, we developed "Inter-sector and Macro Economic Model (IMEM)", which consists of a sequential dynamic general equilibrium module and a macroeconomic module.
- The model can be used to estimate national and sectoral economic activities, the impacts of energy efficient and dematerialization technologies in industrial sectors, development of informatization, and increase of service sectors.



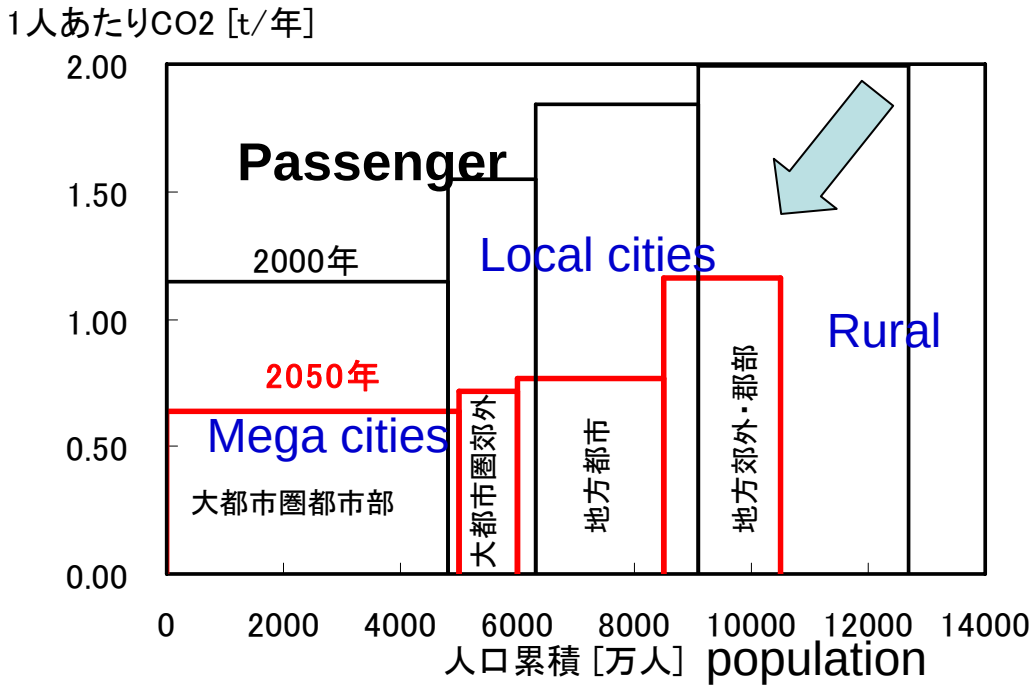

① production function
② commodity market
③ capital market
④ labor market
⑤ calculation of GDE
⑥ expenditure and income in production sector
⑦ expenditure and income in household and government
⑧ assumption of import and export
⑨ fixed capital stock matrix
⑩ investment goods market
⑪ capital stock
⑫ $CO_2$ emissions

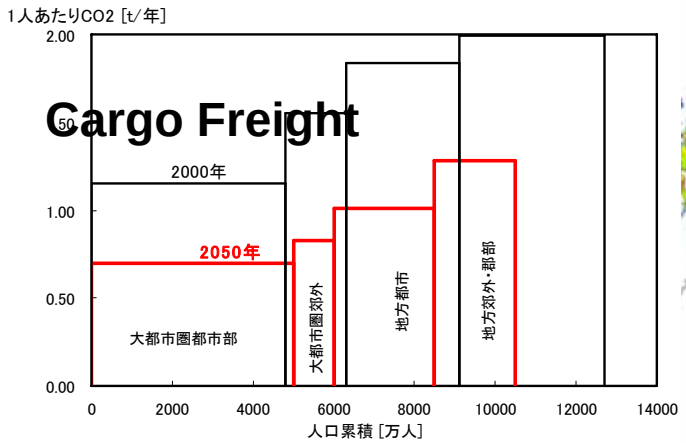
**Structure of Inter-sector Module**

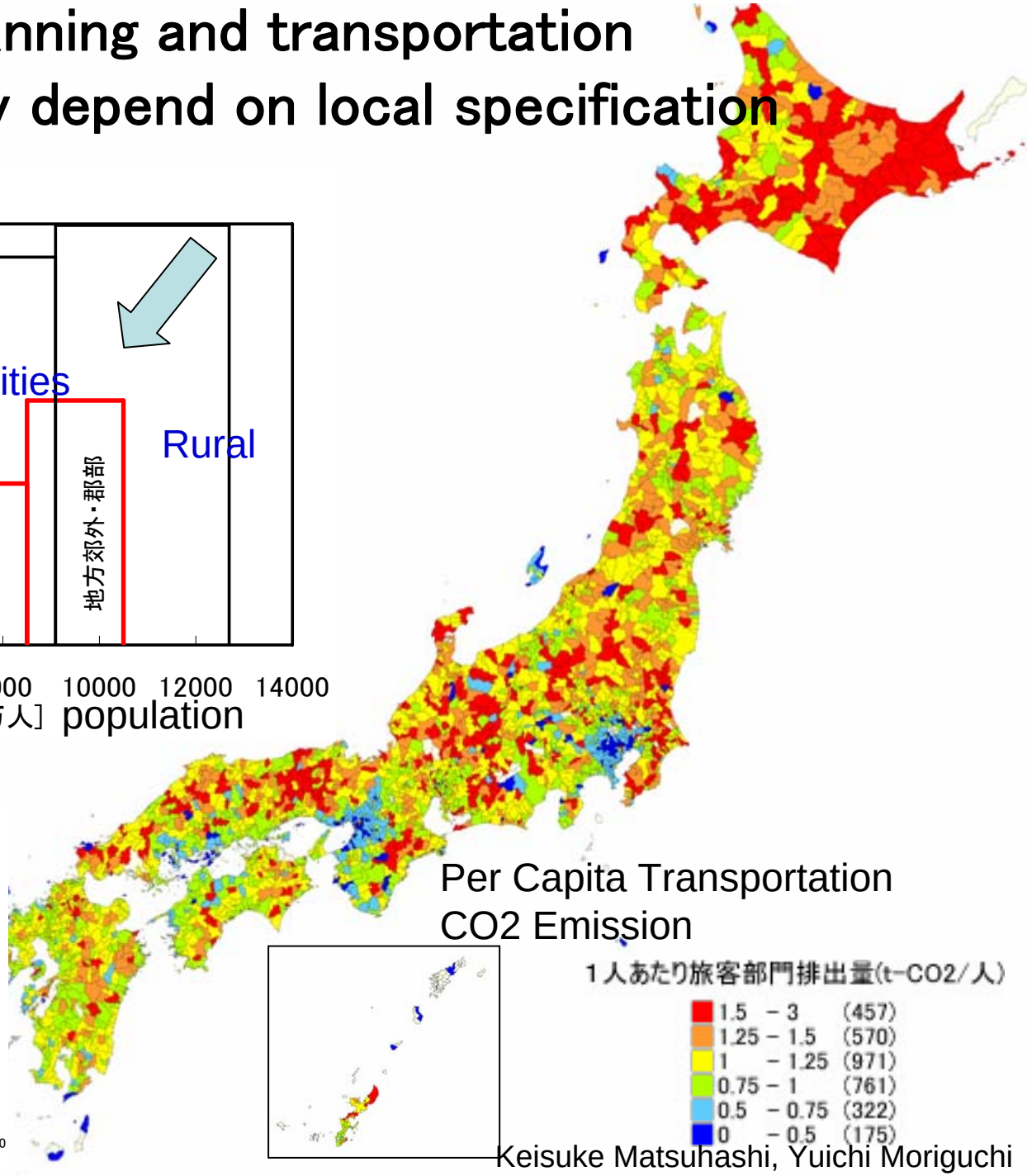
# Figure 3


Domestic products, trillion JPY
0
50
100
150
200
2000
2050A
2050B
Agriculture, Forestry and Fishing
Mining
Food products & beverages
Textiles
Timber and Wooden products
Pump. Paper & paper products
Publishing & printing
Organic chemical materials
Medicaments
Other chemical products
Petroleum refinary and Coal products
Cement
Other ceramic products
Steel products
Non-ferrous metal
Fabricated metal products
Machiery
Elec.Machine, equip. & supplies
Transport equipment
Precision instruments
Other manufacturing
Construction
Power & gas supplies
Water supply
Wholesale & retail trade
Finance & insurance
Real estate
Transport
Communications
Public administration
School education and research
Medical, Health and Social security
Other public services
Other business services
Amusement and recreational services
Eating and drinking places
Hotel and other lodging places
Other personal services
Office supplies
Activities not elsewhere classified

# Land-use planning and transportation
# Reduction strategy depend on local specification




Per Capita Transportation
CO2 Emission

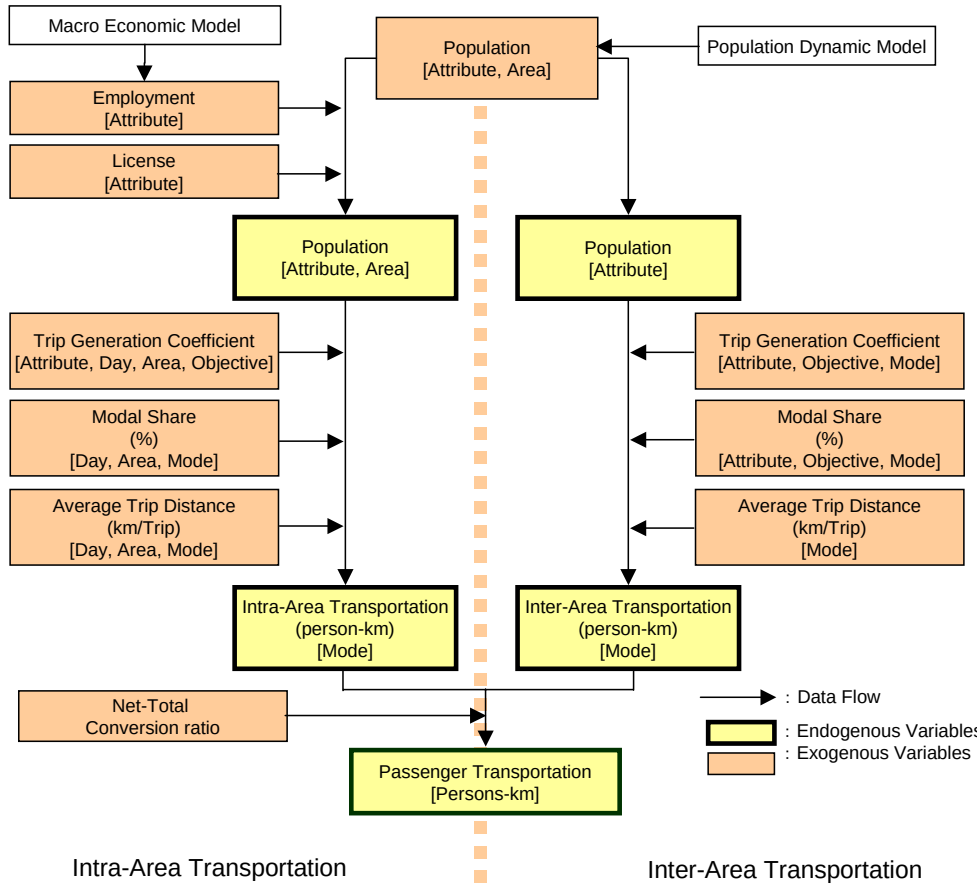
Keisuke Matsuhashi, Yuichi Moriguchi

# Passenger Transportation Demand Model

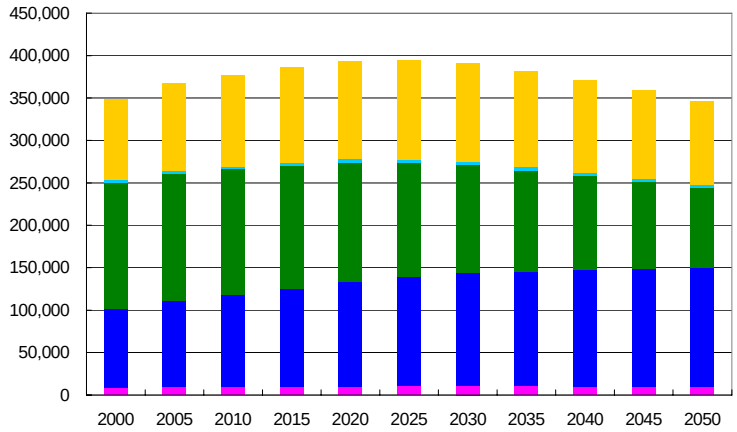
- Many effective countermeasures exist related with transportation. Modal shift from private motor vehicles to mass transit systems, urban planning towards compact cities, transportation substitution with diffusions of teleworking and virtual communication systems and so on.
- Passenger Transportation Demand Model (PTDM) can simulate transportation demand associated with changes in population distribution, people's activity patterns, modal shares and average trip distances.
- The demands in this model are divided into two types,

  1)Intra-regional transportation within the daily living area,
  2)Inter-region transportation between the daily living areas,

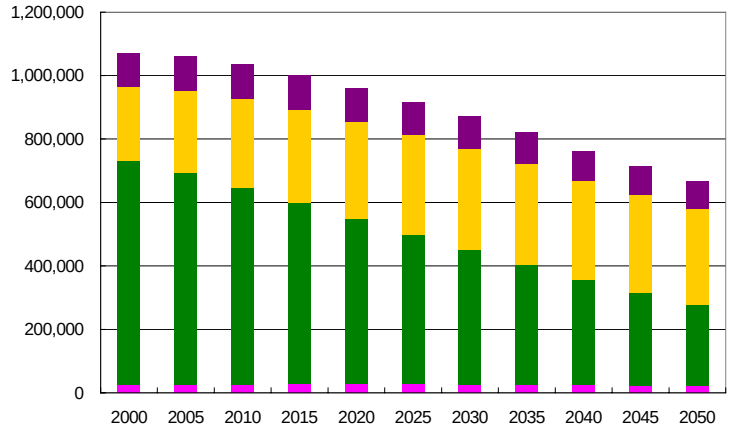
  and they are calculated separately.



# Passenger Transportation Demand Model (2)
# Scenario A




Inter-region transportation demand by mode of transportation (mil. person-km)



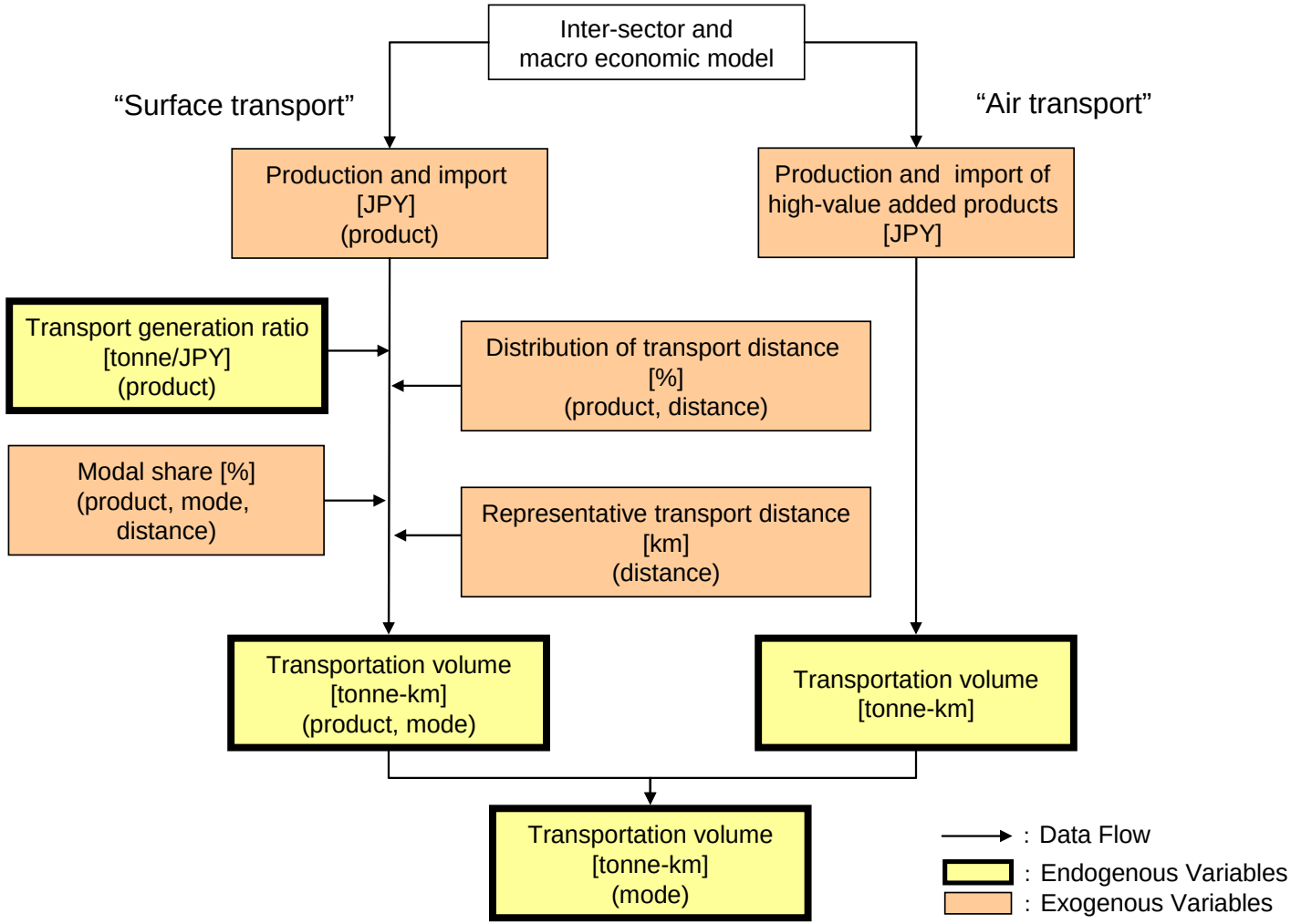

Intra-region transportation demand by mode of transportation (mil. person-km)

Buses Aviation Pass.cars Maritime Railways Walk&Bike

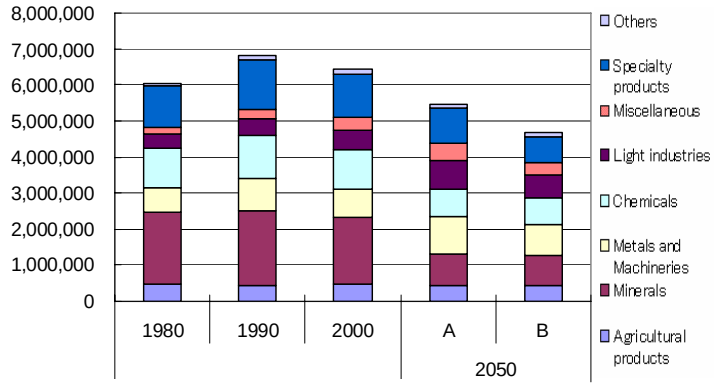
- Coupled with population decrease, and intensive decreasing policy of average trip distance, such as the compaction of neighborhood communities causes significant decrease of intra-regional transportation demand.
- In addition, the share of railways transportation will increase rapidly due to the promotion of modal shift from car to train.

# Freight Transportation Demand Model

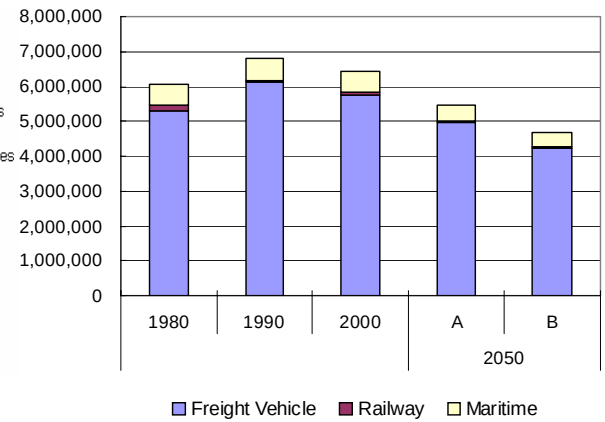
**This model simulates freight transportation volume associated with changes in industrial structure, material density of commodities, transportation distance, and modal share.**



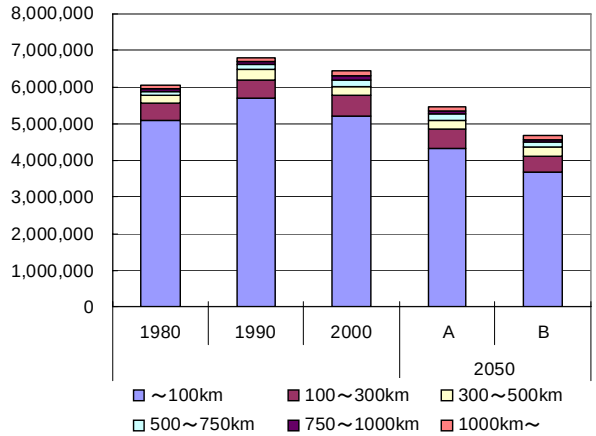
# Freight Transportation Demand Model (2)



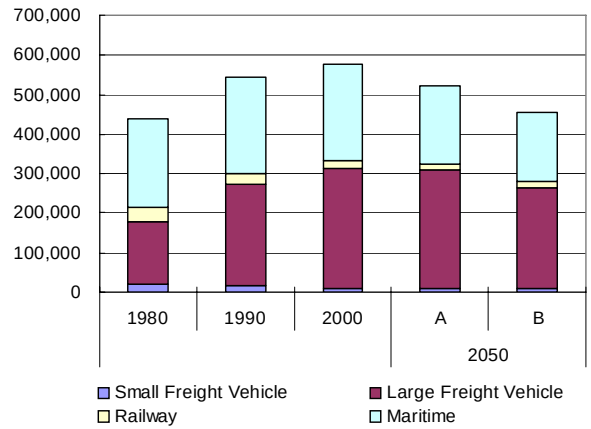

Transportation volume in tonnes by product (1000 tonne)




Transportation volume in tonnes by mode (1000 tonne)



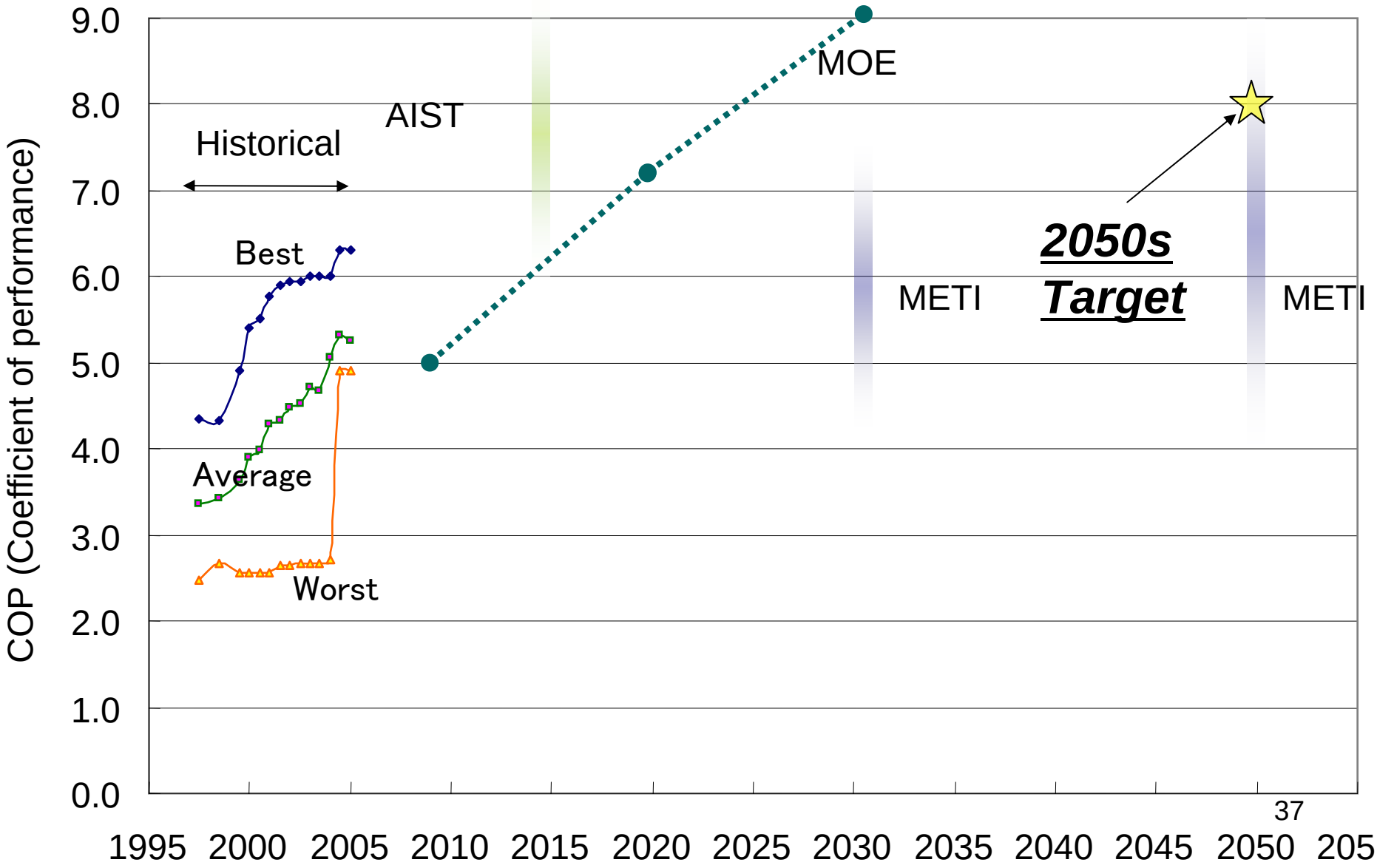

Transportion volume in tonnes by transport distance (1000 tonne)



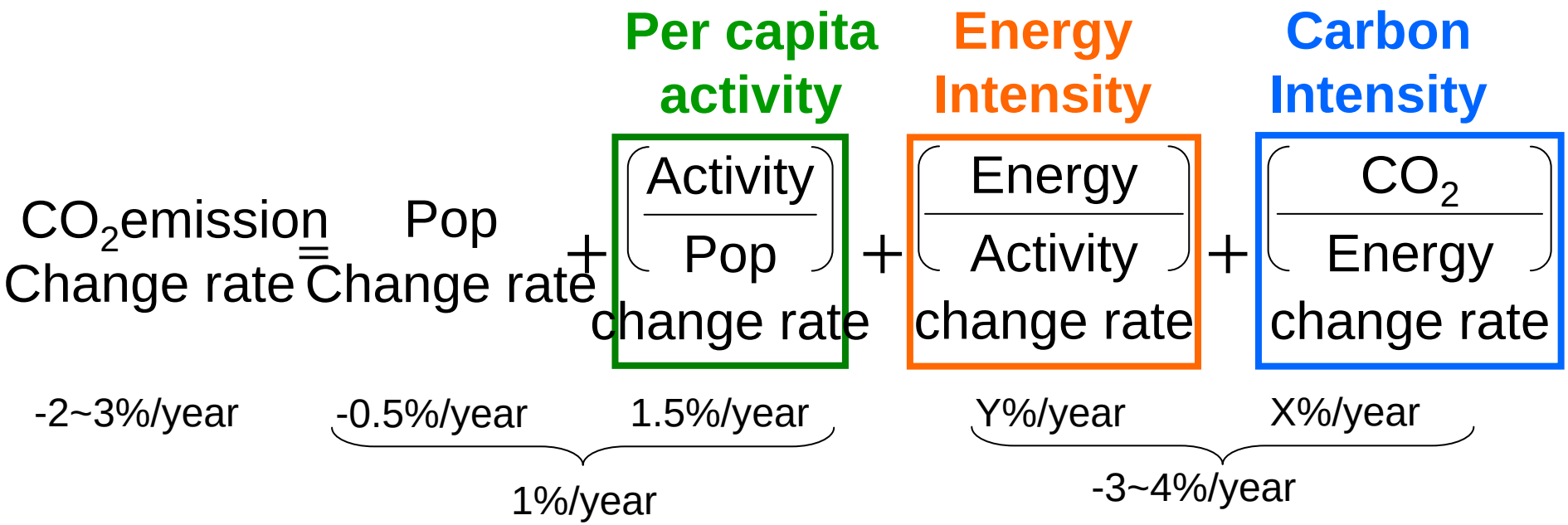

Transportion volume in tonne-km by mode (mil. tonne-km)

- By year 2050, in tonne-km, the volumes of freight transport are 0.91 and 0.79 times, because of the decrease of long-distance transport of basic materials.
- On the contrary. short distance transport does not decrease so much.

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



# How can we reduce GHG emissions?




**Change of growth pattern**

Green GDP
SD index
Lifestyle change

**Enhance/Keep service level, use less energy**

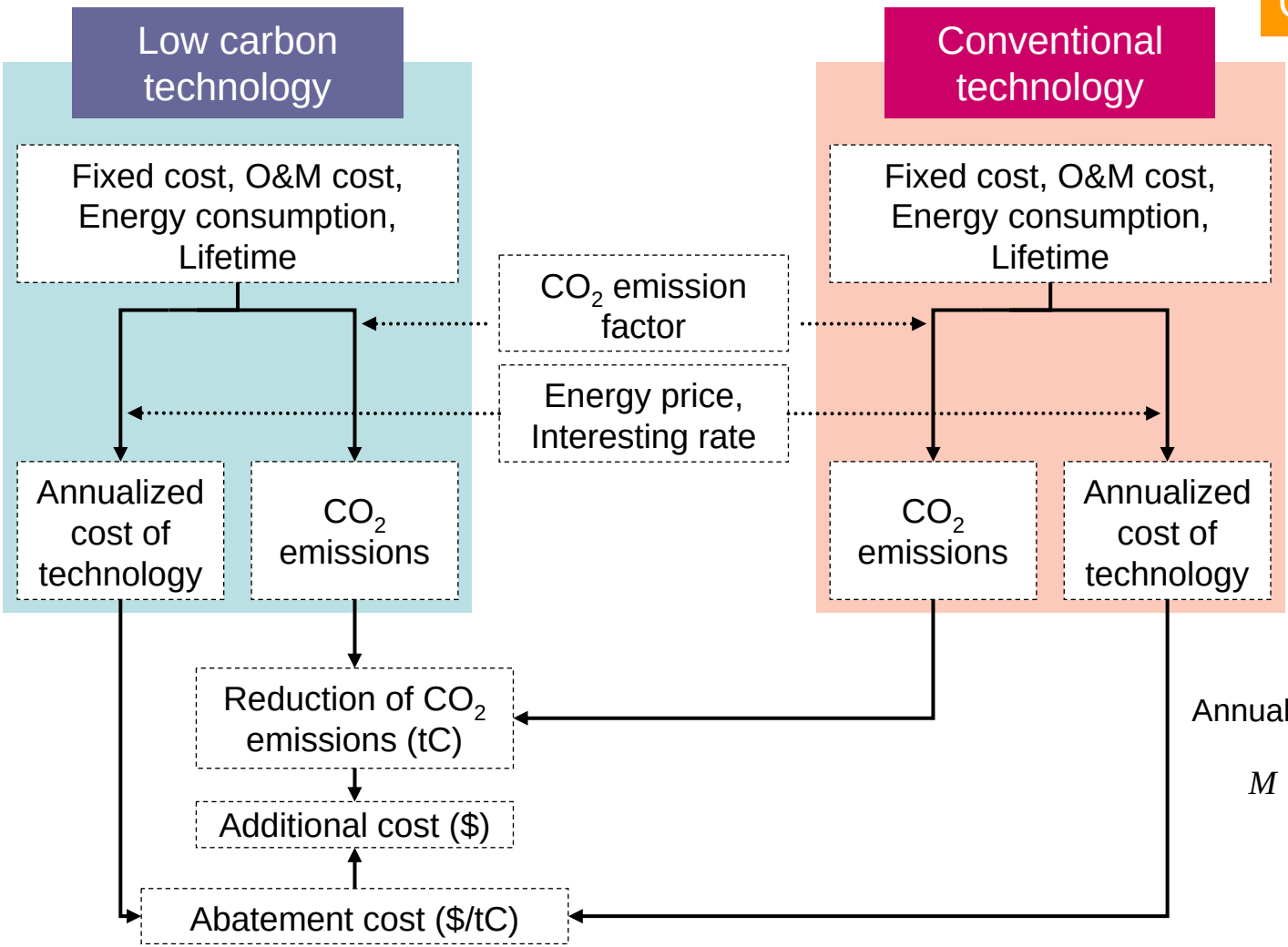
Energy Efficiency
Energy Saving
Eco-industry
Env. sound transportation
Compact city

**Use less GHG intensive fuel**

Fuel switching
Renewables
Nuclear
CCS
Hydrogen/Fuel cell

# Figure 6 Additional costs

GH of MHIR 070213

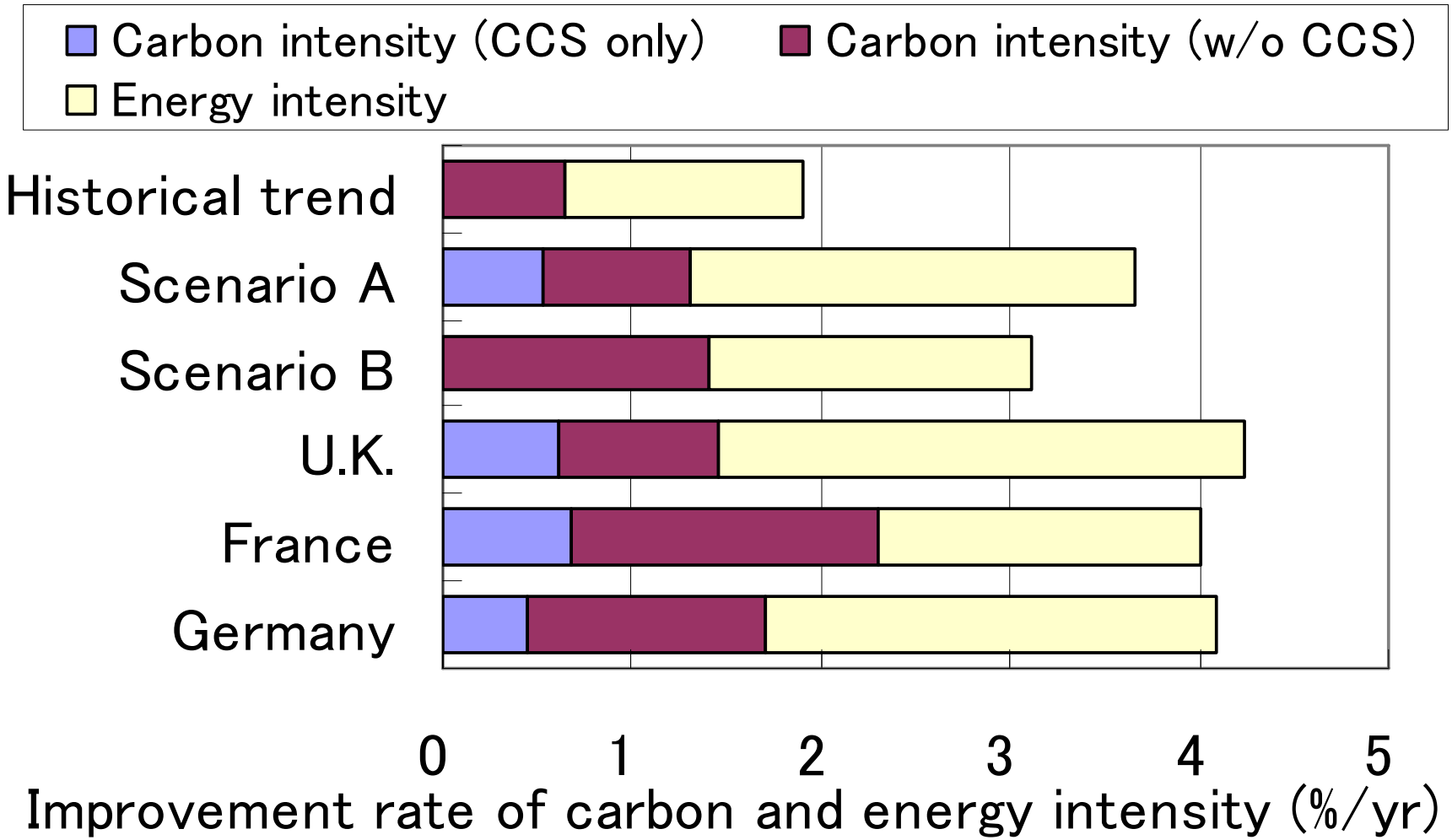



Annualized cost of technology: M

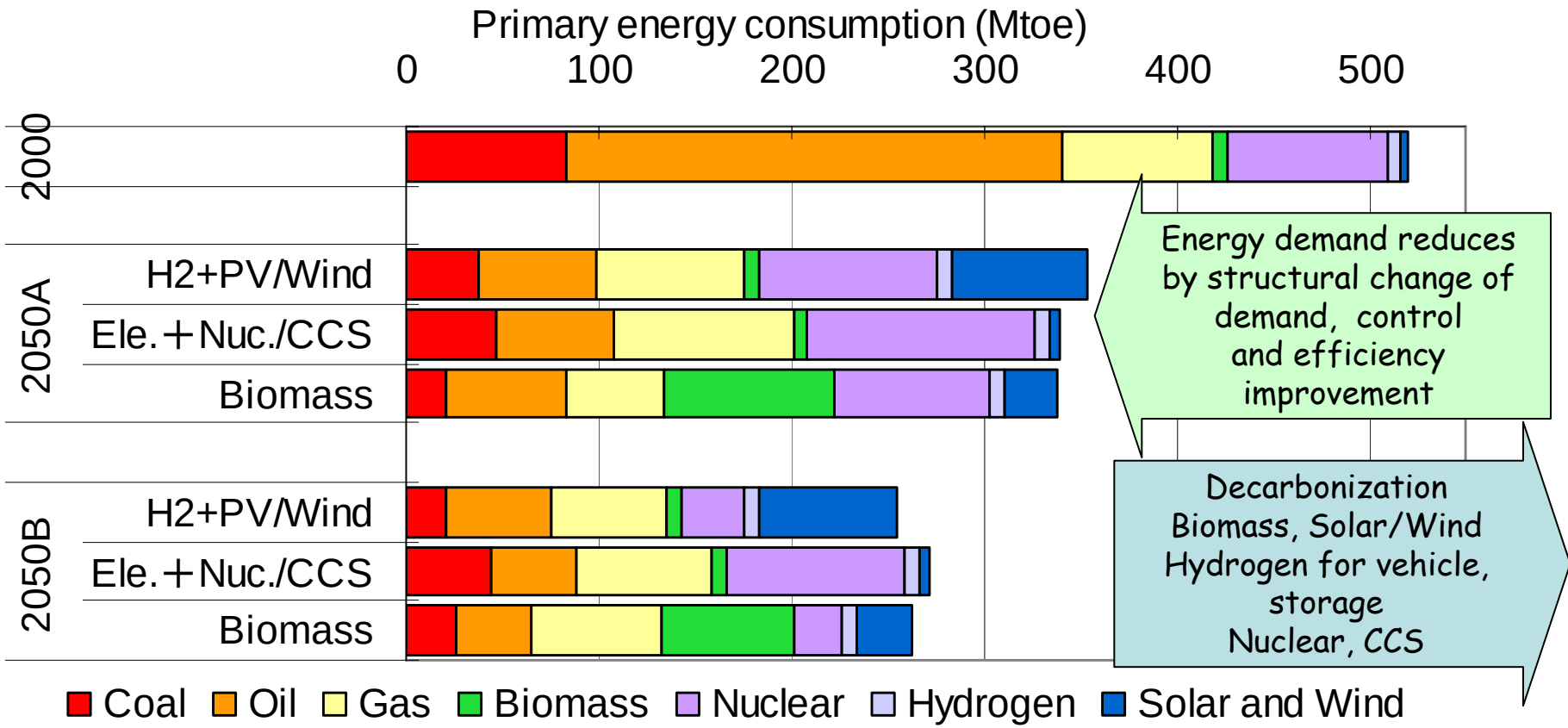
$$M = \frac{\alpha(1+\alpha)^L}{(1+\alpha)^L - 1} \bullet P + OM + EN$$

P: Fixed costs ($)
OM: O&M costs ($/yr)
EN: Energy costs ($/yr)
A : Interesting rate (%)
L: Service life (yr)

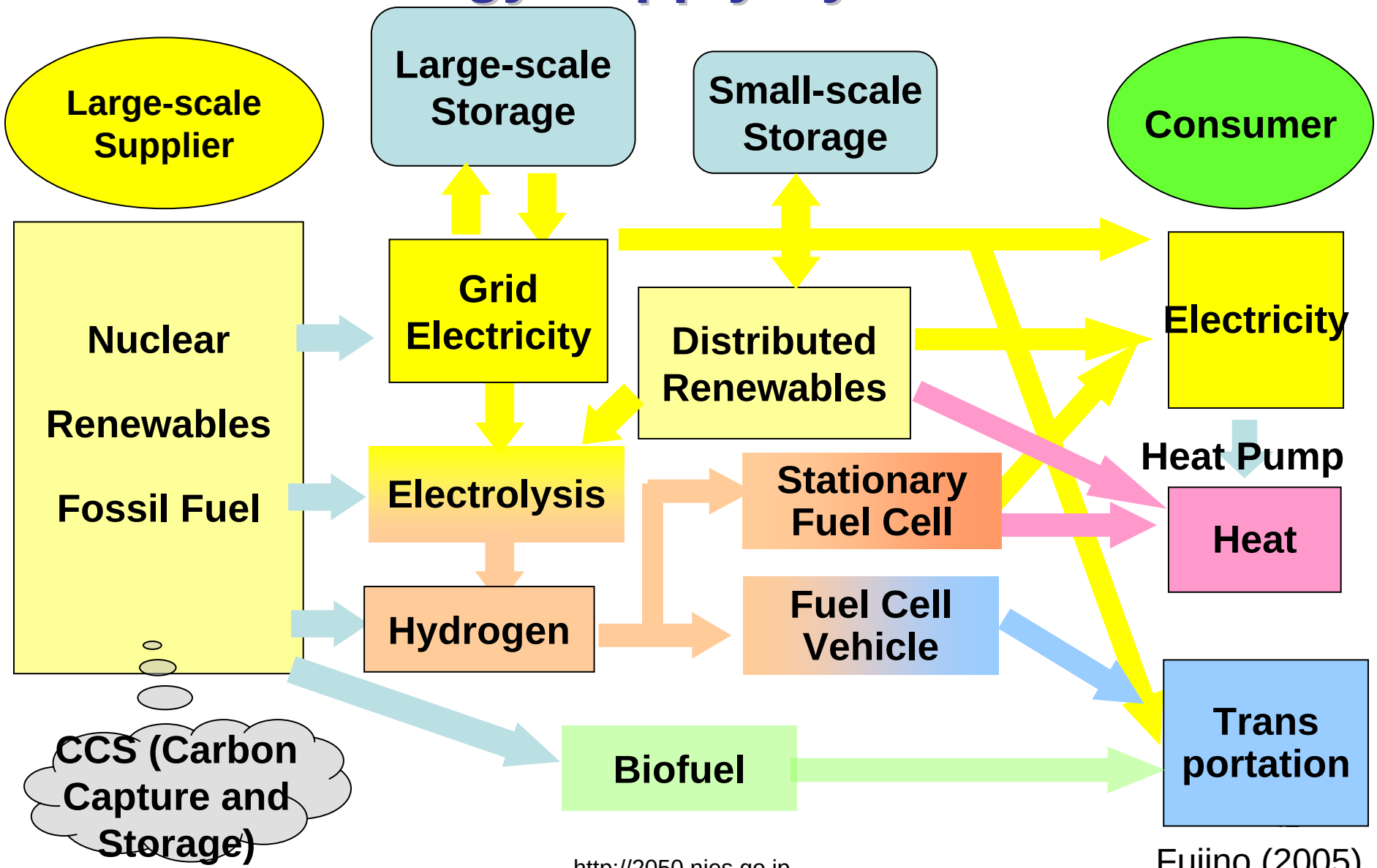
# Figure 7 Required improvement rate of carbon and energy intensity



# Figure 8 Three energy supply scenarios



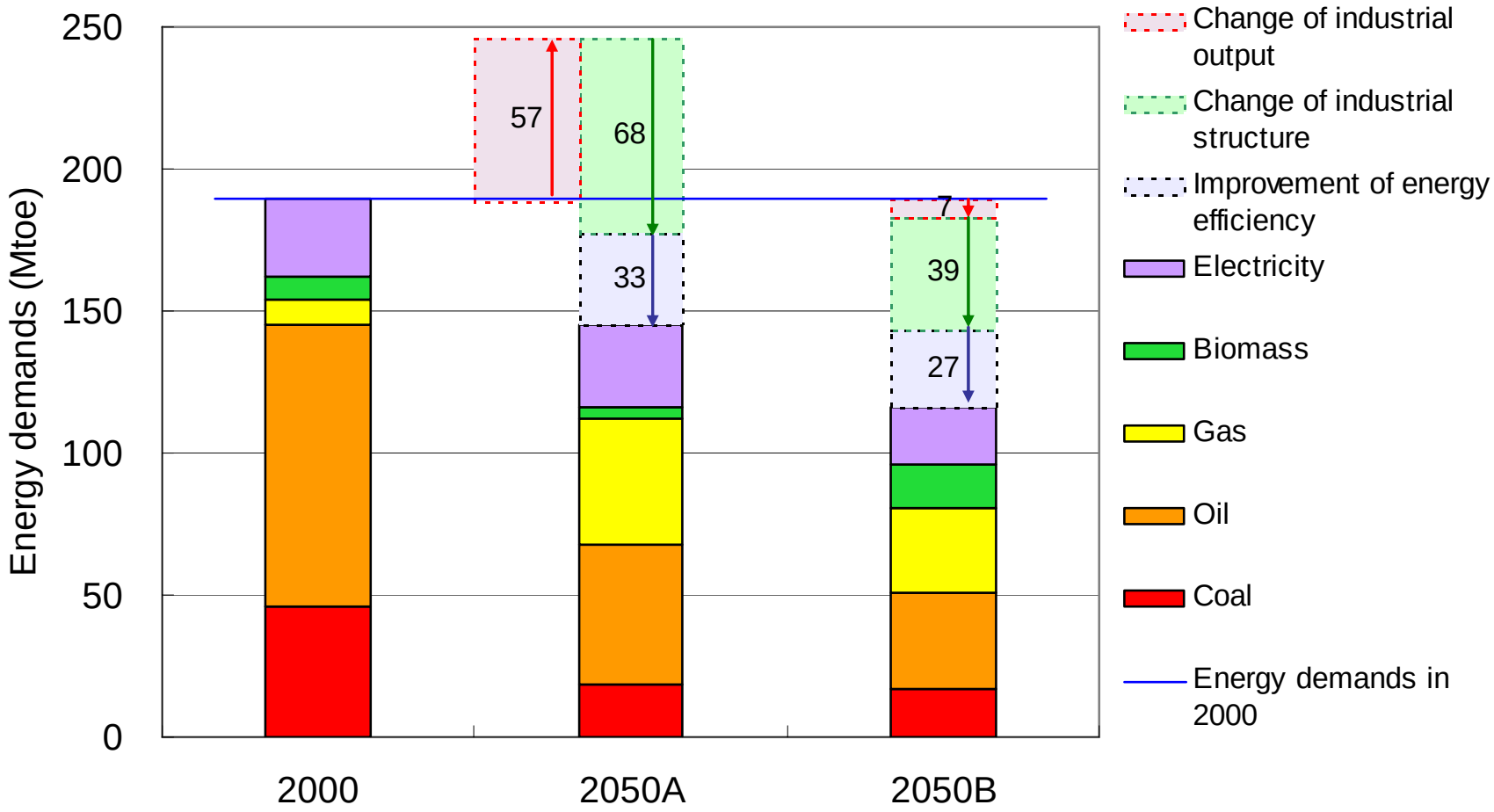
# What is Low Carbon Energy Supply System?



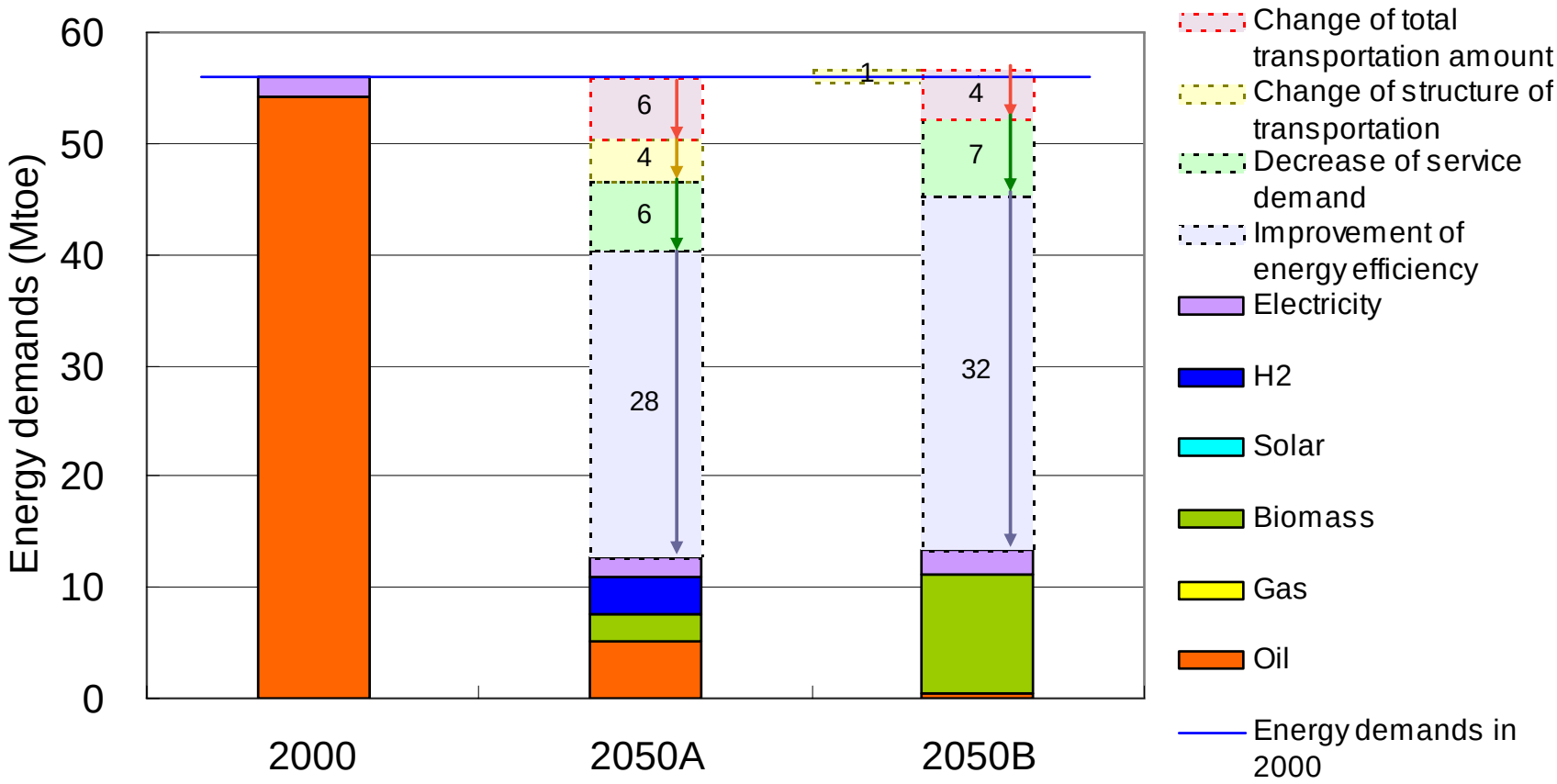

http://2050.nies.go.jp

Fujino (2005)

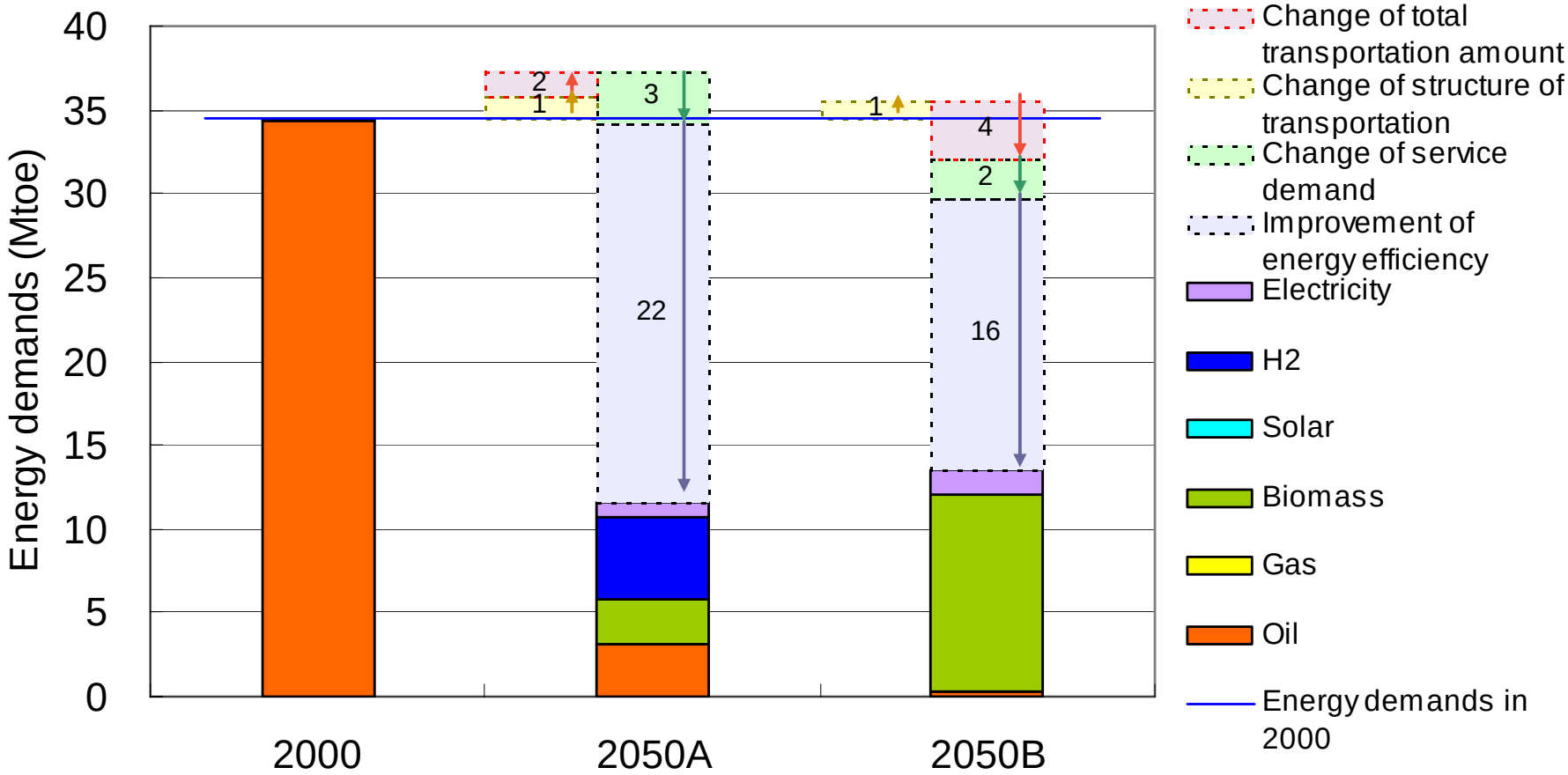
# Figure 9 CO2 reduction potentials in the industrial sector



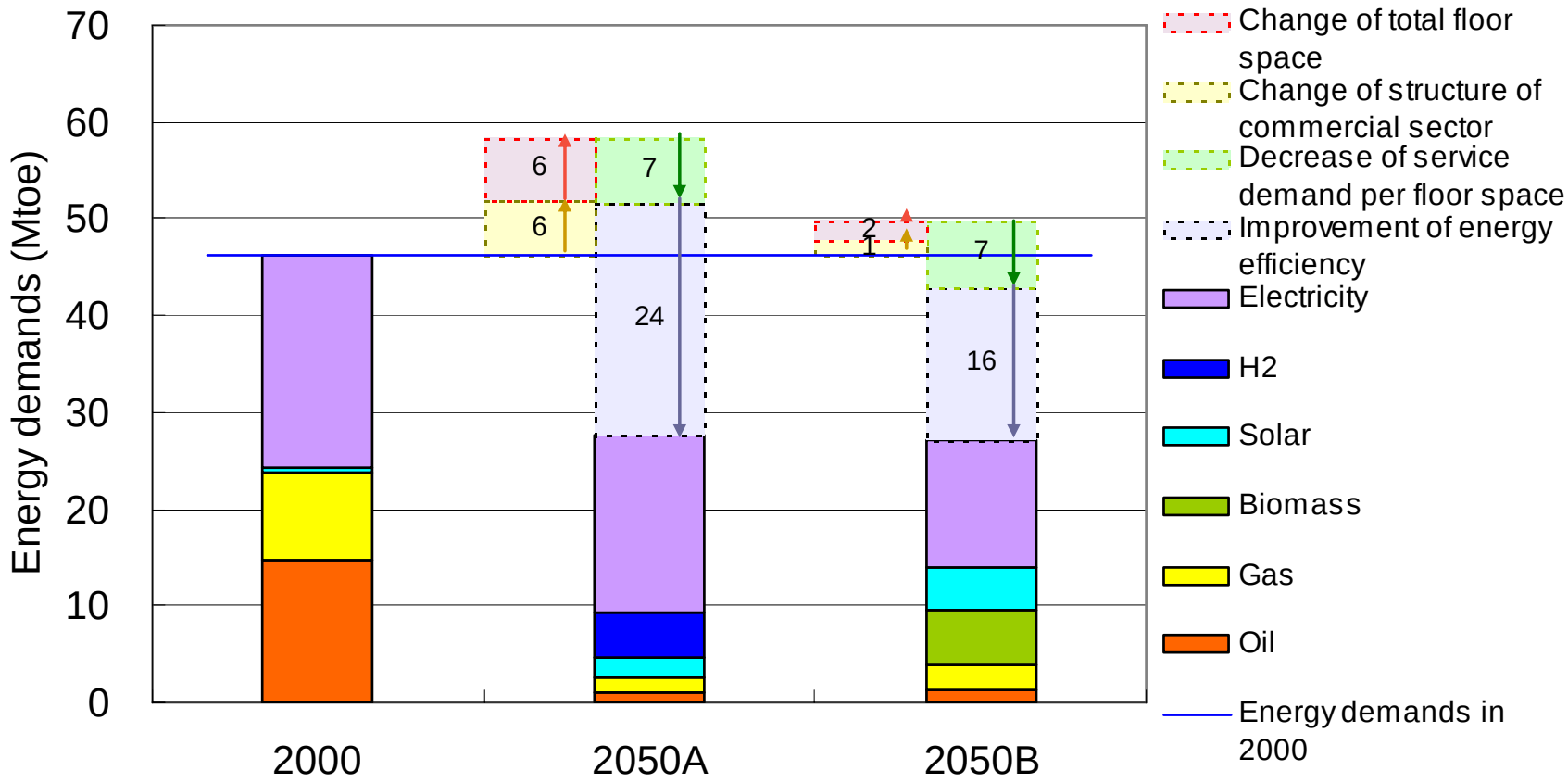
# Figure 10 CO2 reduction potentials in the passenger transportation sector



# Figure 11 CO2 reduction potentials in the freight transportation sector



# Figure 13 $CO_2$ reduction potentials in the commercial sector



# Proposal toward Low Carbon Society

- Low carbon society with 70% reduction of GHG is technically attainable, if individual stakeholders accept responsibility for their respective fields.

- *Scientists:* interpret the voice of the natural world and deliver the message clearly to policymakers
- *Citizens:* Adopt low carbon lifestyles as consumers, taxpayers, educators, waste managers, residents, and in your workplace....
- *Local communities and municipalities:* Integrate the Low Carbon Concept into long-term planning and infrastructure investment
- *Governments:* Establish a clear nationwide vision of LCS and broadcast the signal unequivocally to citizens and industries.

- This is the duty and challenge of our generation:
  - To be a responsible steward of our precious planet earth so that we can bequest it with pride to future generations.

# LCS is Risk Management

- We always face to risks if we are alive.
- Global warming is one of risks in our daily life, but it might become one of the huge/ biggest risks in some future…
- Overshoot (expect future technology  development) / Early Action (Stern Review)
- Short-term Sweet (Benefit) / Long-term Legacy
- Neo Liberalism / Eco Modernization -> Smart Regulation
- Crisis = 危(dangerous) 機(chance)
- 創(create) 新(something new) = Innovation
- Sense of Urgency for Good Design of our Society