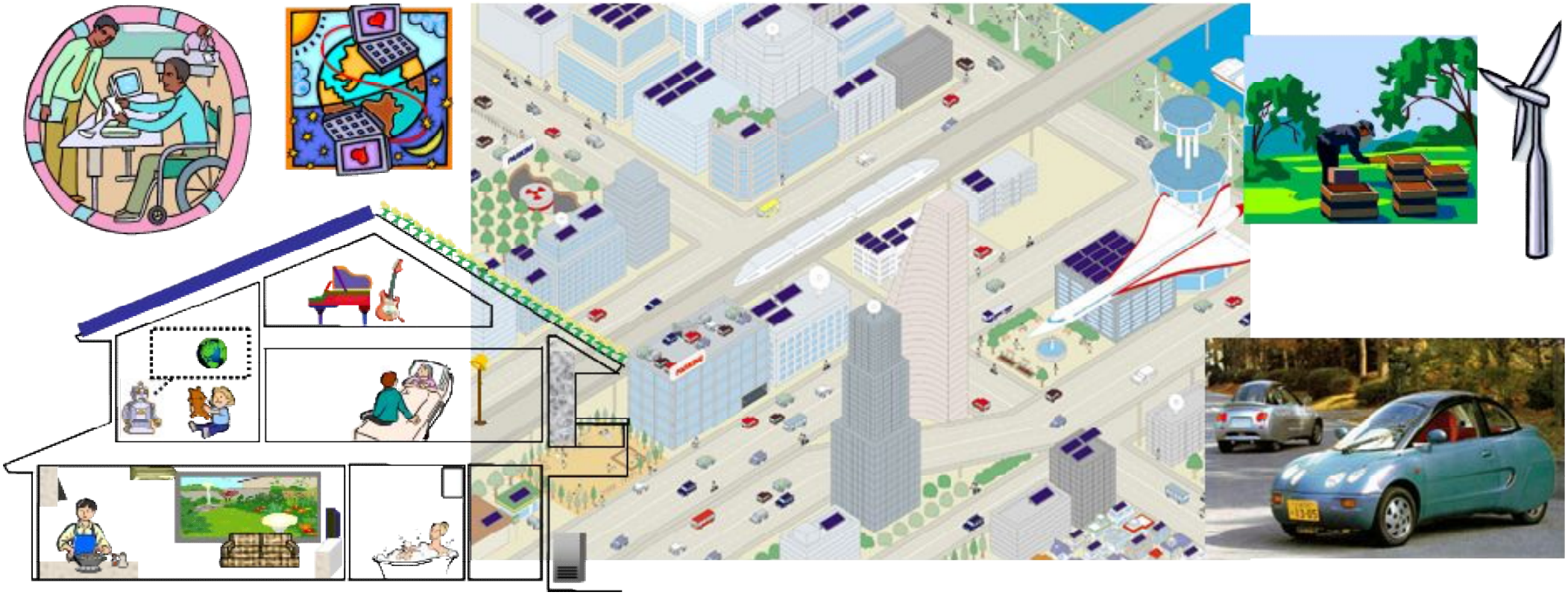
Model Analysis for Low Carbon Society (1) Japan's Case

脱温暖化
2050

http://2050.nies.go.jp



Shuichi Ashina

National Institute for Environmental Studies

The 18th Asia-Pacific Seminar on Climate Change "Building an Architecture of an Effective Future Regime", 2-3 March, 2009, Vietnam

Japan Low Carbon Society Scenarios toward 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

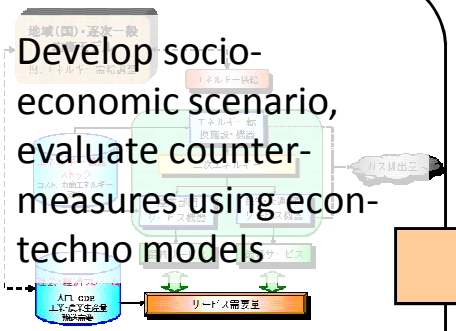
Urban structure

IT-society

Transportation system

Reduction Target study

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



GHG emission

BaU scenario

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

GHG reduction target

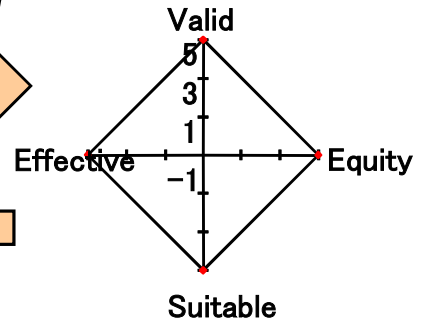
（eg. 60-80% reduction by 1990 level）

Intervention scenario

1990
2000
2010
2020
2050

Middle-term Target year

Loge-term Target year



Evaluate feasibility of GHG reduction target

Long-term Scenario Development Study

60 Researchers

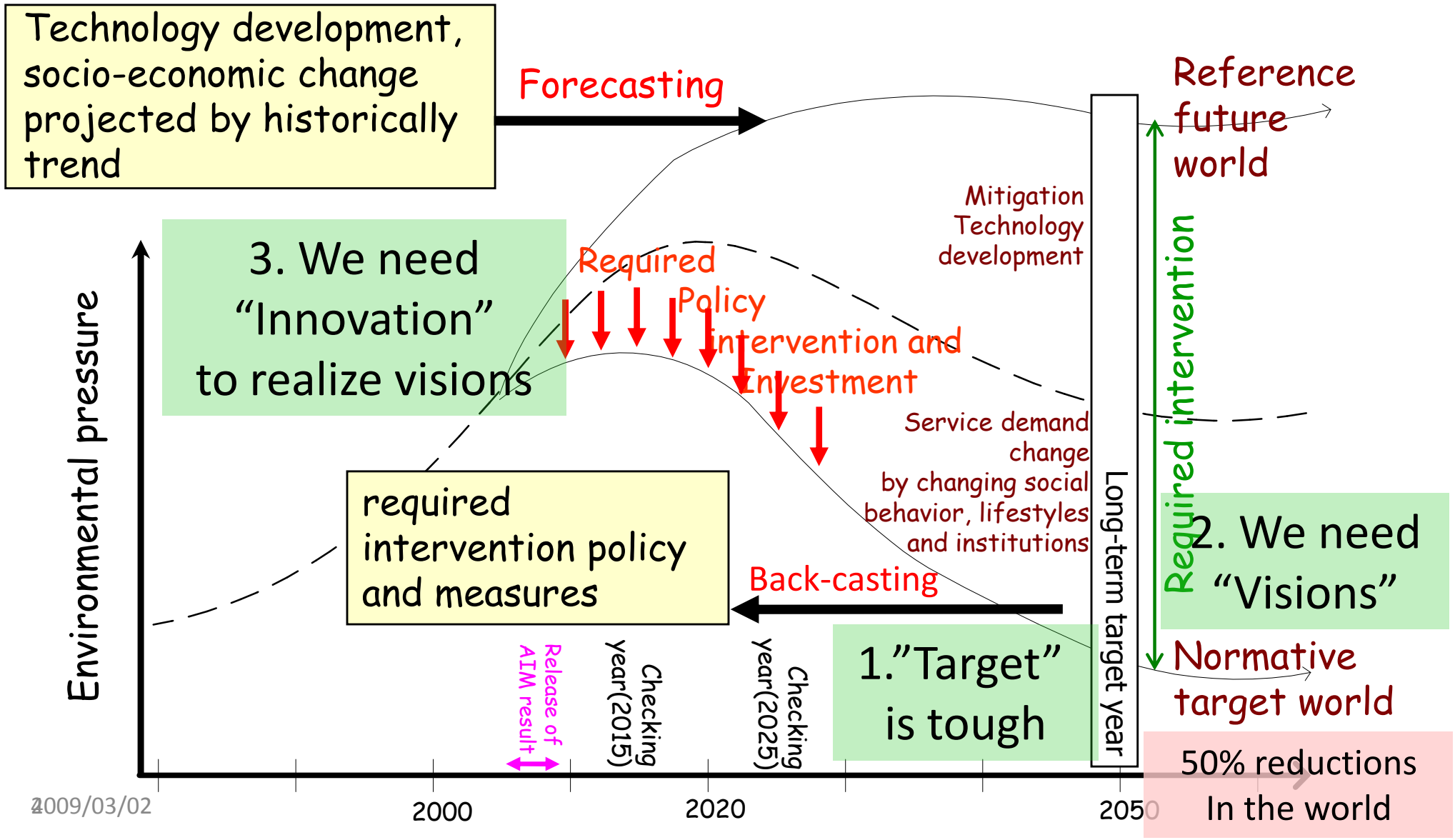
Propose the direction of long-term global warming policy

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

Japan LCS (Low-Carbon Society) (FY2004-2008)
Research Project supported by
Global Environmental Research Fund, MOEJ

Japan Low Carbon Society Scenarios toward 2050

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



Steps towards Japan LCS Scenarios

Step 1
- Depicting socio-economic visions in 2050

Step 2
- Estimating energy service demands

Step 3
- Exploring innovations for energy demands and energy supplies

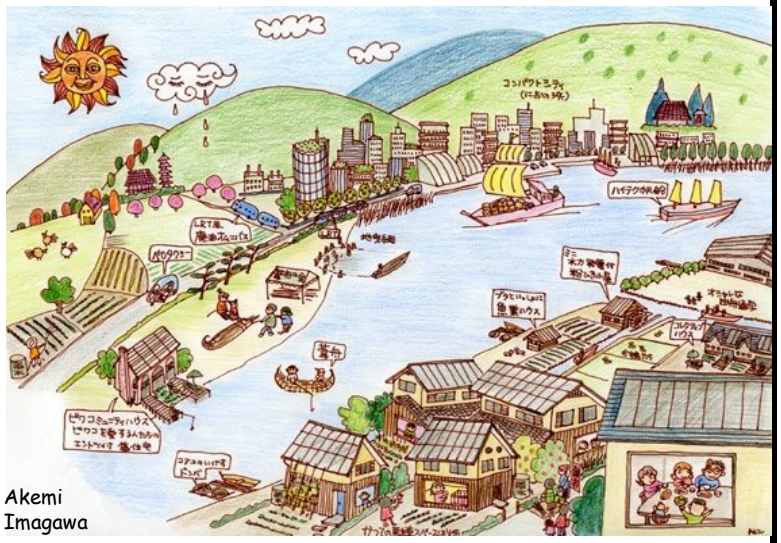
Step 4
- Quantifying energy demand and supply to estimate CO_2 emissions

Outcome 1) Feasibility study for 70% CO_2 emission reduction by 2050 below 1990 level

Step 5
- Investigating "When and Which options and How much" of each option should be introduced in order to achieve the goal.

Outcome 2) Roadmap and Dozen Actions toward LCS

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
2%/yr GDP per capita growth	1%/yr GDP per capita growth
	

We prepared models to quantify the LCSs

LCS Models
Three model groups with two time frame

Time frame		
Certain year (e.g. 2050)	Snapshot models	• describing LCS in a certain future, concretely, quantitatively, and consistently with physical, economical, technological laws.
Over the years (e.g. 2000-2050)	Transition models	• focuses on the dynamics and trend transition of the society, economic system, and the technological system.
	Backcast model	• Representing inter-temporal optimal strategy on introduction of new technologies and economic activity change in order to achieve the future targets.

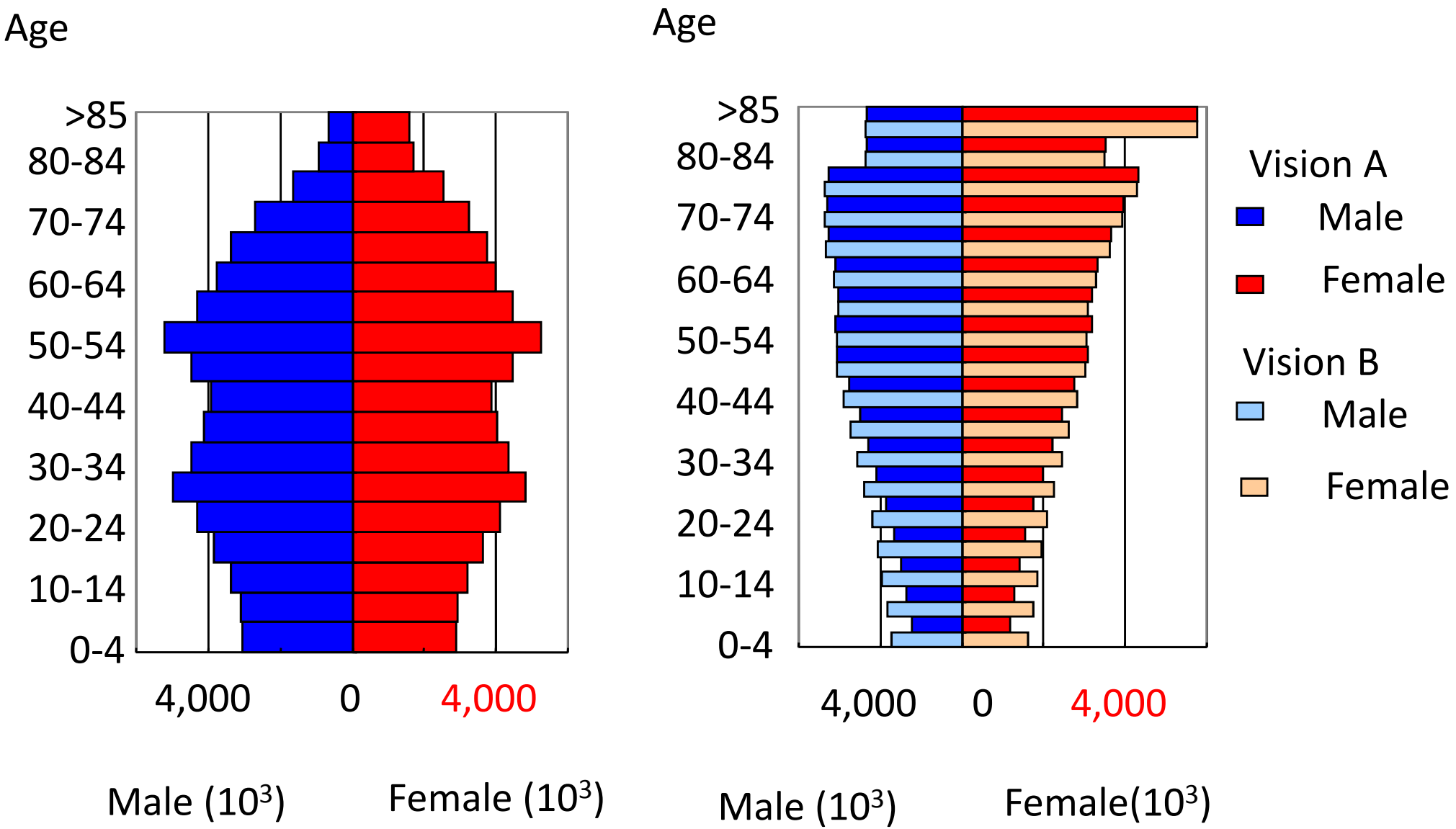
Environmental Option Database (EDB)

Stores information of activities which accompany or reduce GHGs emission.

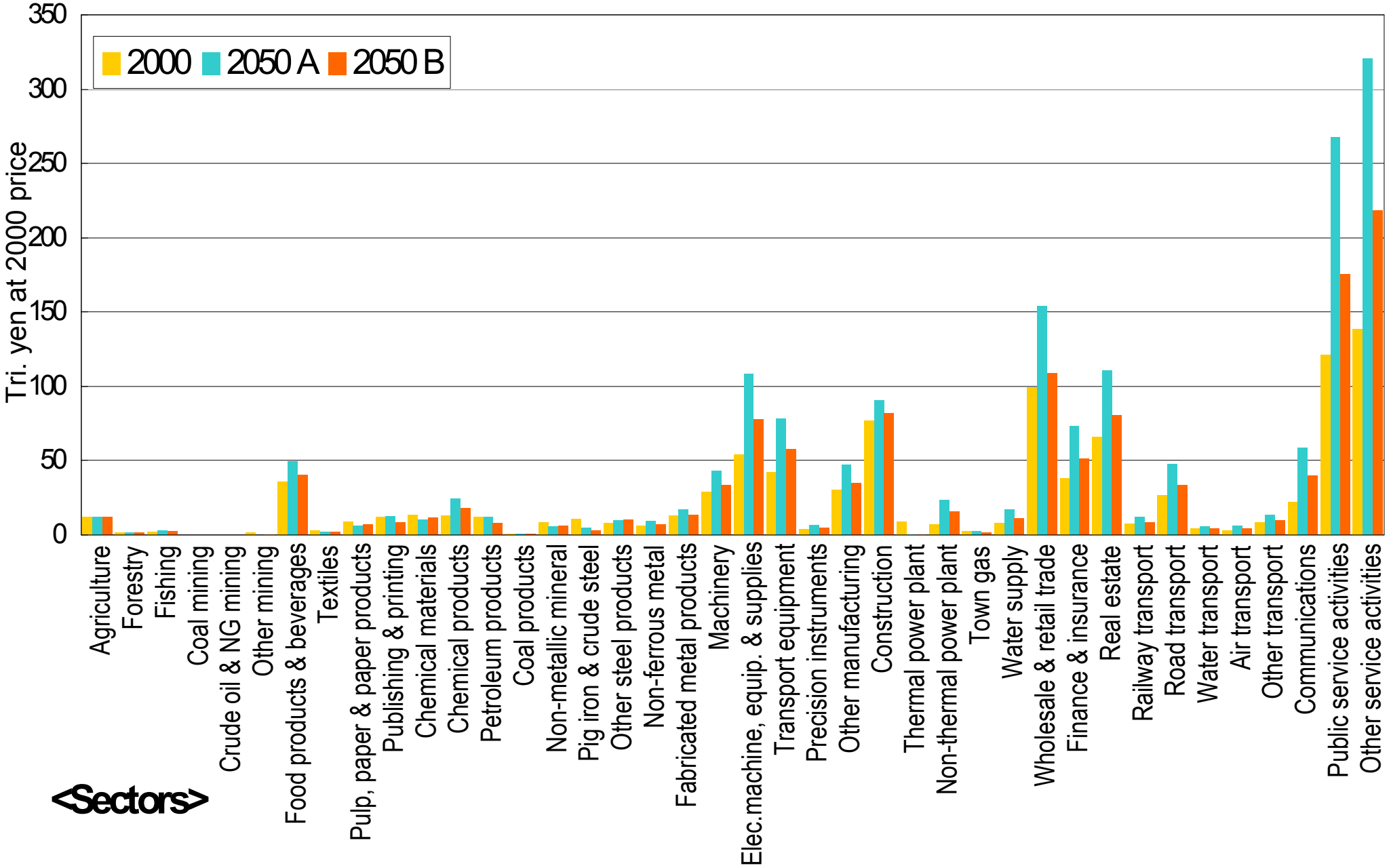
Developed snapshot and transition models

Topics to be asked	LCS Models
i) Industrial structure	1. Inter-sector and Macro Economic Model
	2. Building Dynamics Model
ii) Dwellings	
	3. Household Production and Lifestyle Model
iii) Lifestyle	
	4. Passenger Transportation Demand Model
iv) Passenger transportation	
	5. Freight Transportation Demand Model
v) Freight transportation	6. Energy Supply Model
vi) Energy supply	7. Material Stock and Flow Model
vii) Material stock/flow	8. Energy Snapshot Tool
viii) Consistency of energy balance	(1.Inter-sector and macro Economic Model)
ix) Economic consistency	
	+
	0. Population and Household Model

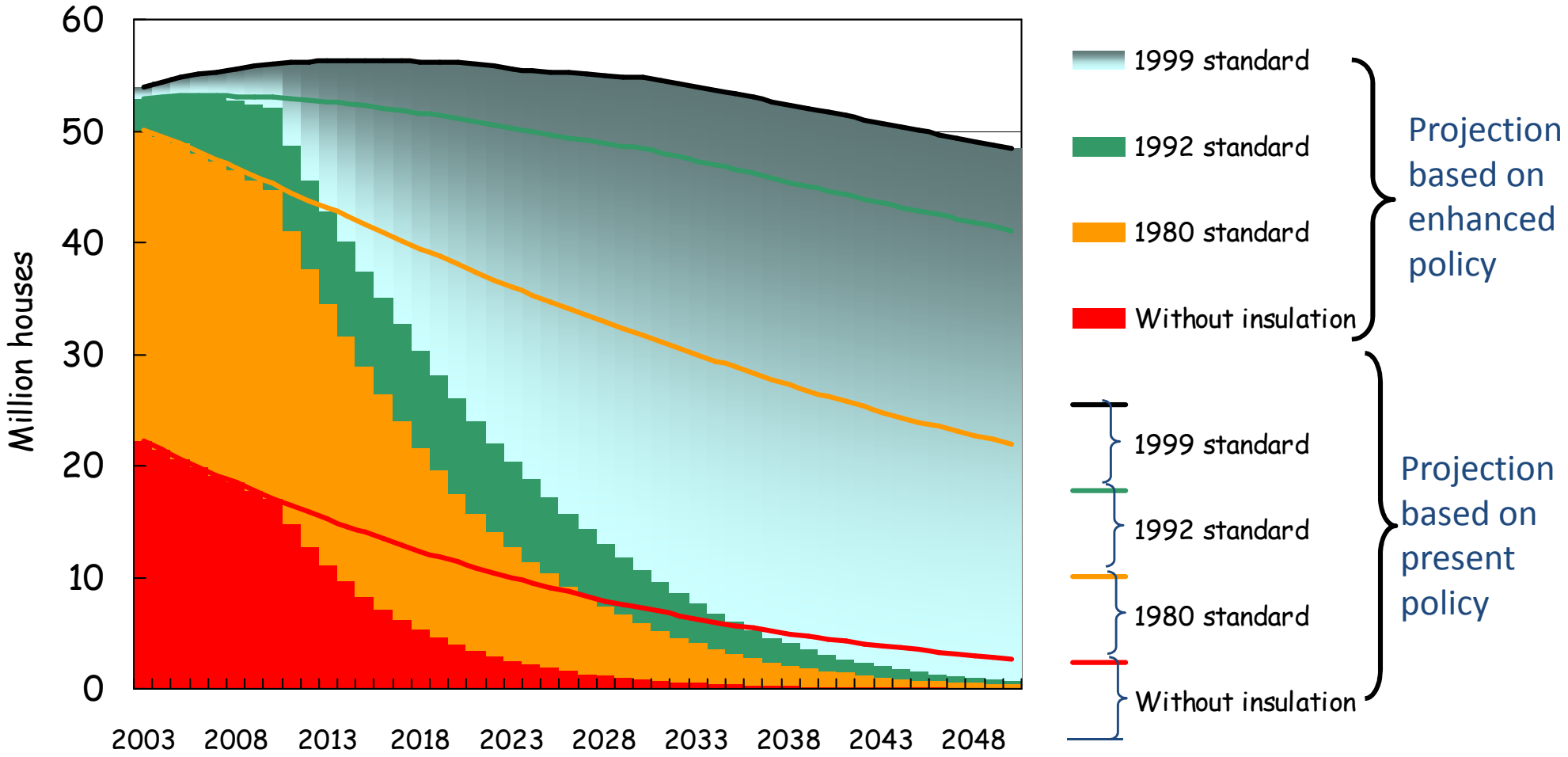
Demographic composition in Japan by Population and Household Model



Industrial Structure Change in 2050, Japan by Inter-sector and Macro Economic Model



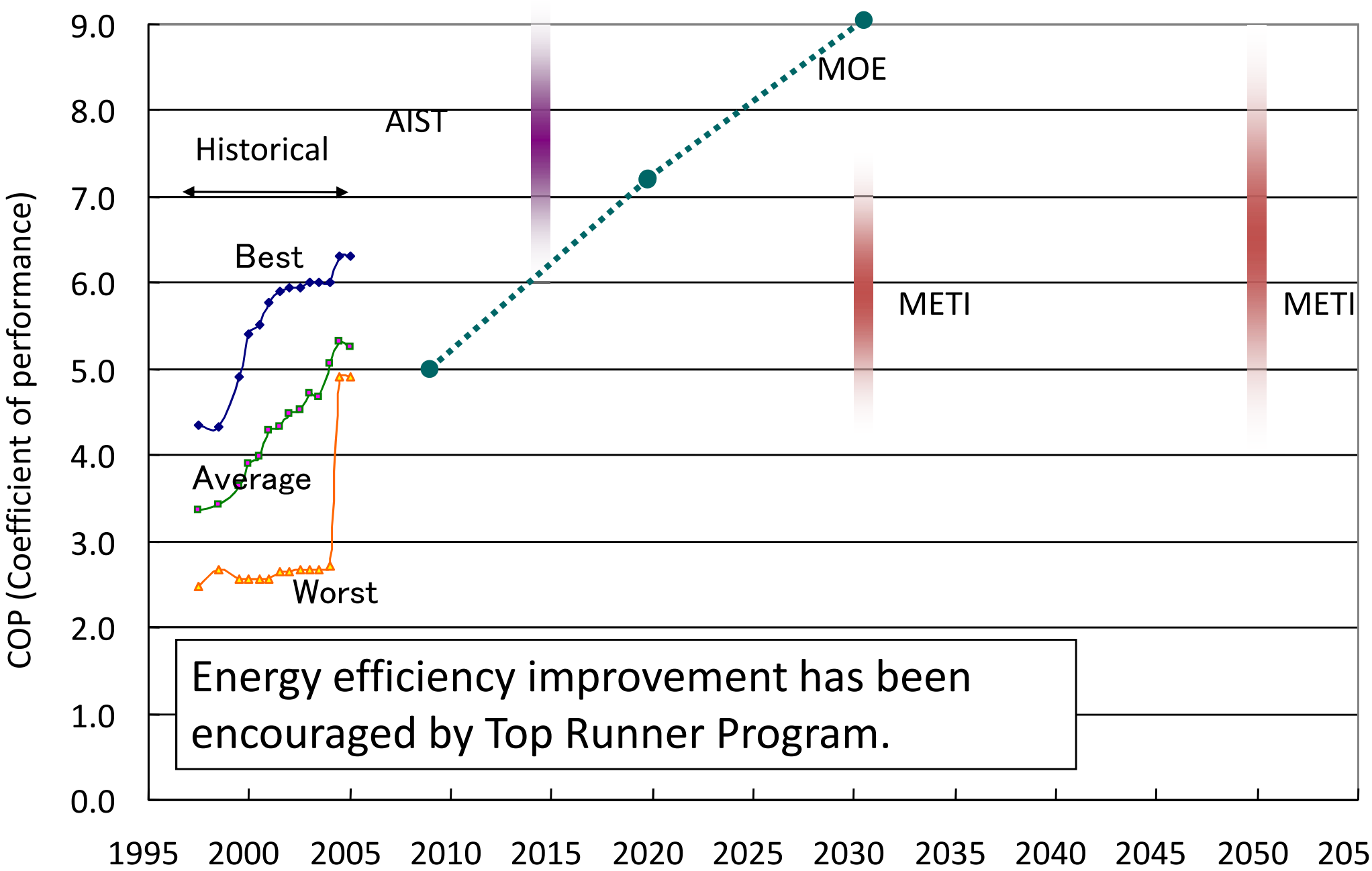
Projection of residential building stock by insulation level
by Building Dynamics Model



Quantification of Scenario A and B in 2050

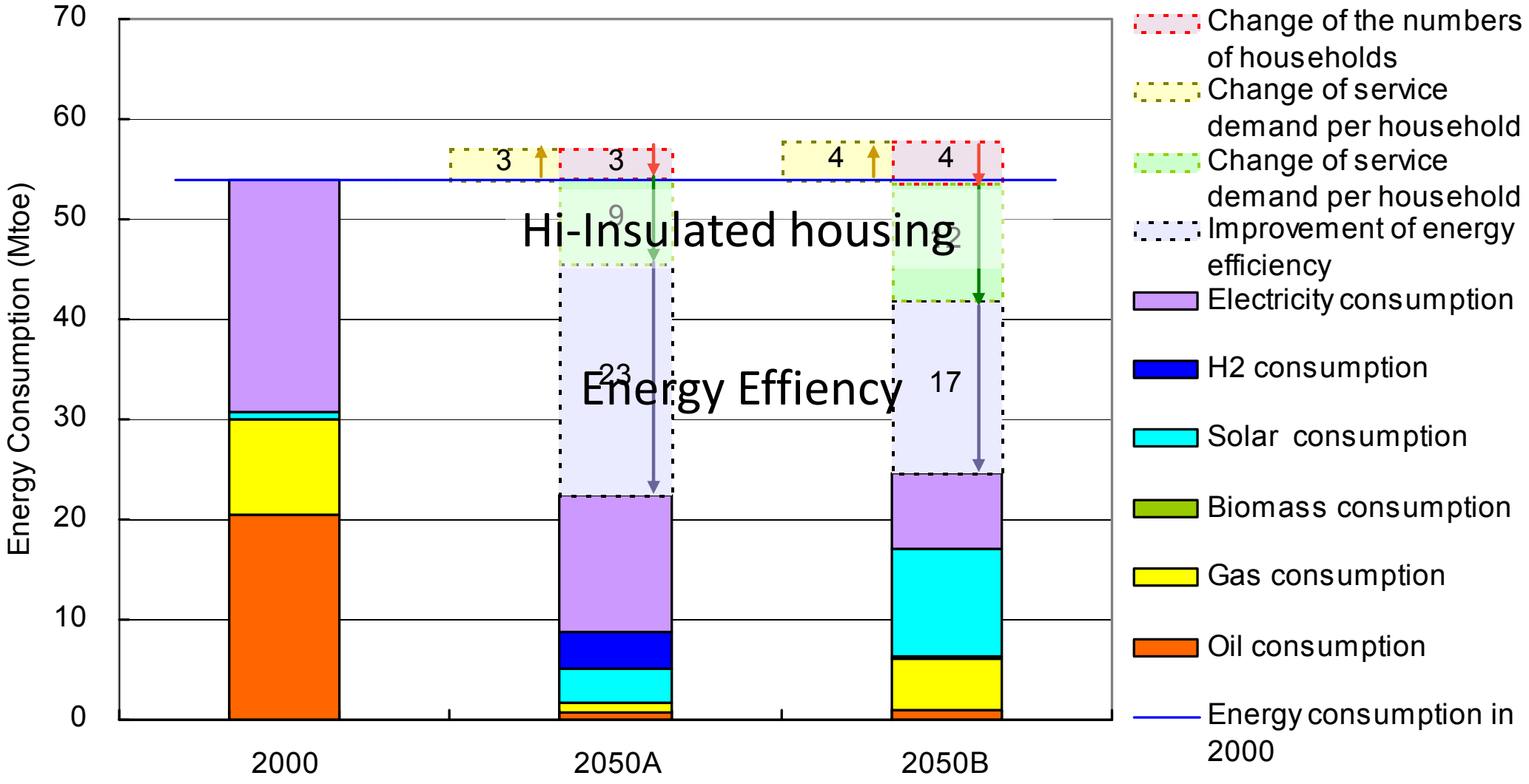
year	unit	2000	2050 A	2050 B	model
Population	Mil.	127	94 (74%)	100 (79%)	Population and Household model
Household	Mil.	47	43 (92%)	42 (90%)	
Average number of person per household		2.7	2.2	2.4	
GDP	Tril.JPY	519	1,080 (208%)	701 (135%)	Inter-sector and Macro Economic Model
Share of production					
primary	%	2%	1%	2%	
secondary	%	28%	18%	20%	
tertiary	%	71%	80%	79%	
Office floor space	Mil.m^2	1654	1,934 (117%)	1,718 (104%)	Building dynamics Model & Inter-sector and Macro Economic Model
Travel Passenger volume	bill. p･km	1,297	1045 (81%)	963 (74%)	Transportation demand model & Inter-sector and Macro Economic Model
Private car	%	53%	32%	51%	
Public transport	%	34%	52%	38%	
Walk/bycycle	%	7%	7%	8%	
Freight transport volume	bill. t･km	570	608 (107%)	490 (86%)	
Industrial production index		100	126 (126%)	90 (90%)	Inter-sector and Macro Economic Model
Steel production	Mil.t	107	67 (63%)	58 (54%)	
Etylen production	Mil.t	8	5 (60%)	3 (40%)	
Cement production	Mil.t	82	51 (62%)	47 (57%)	
Paper production	Mil.t	32	18 (57%)	26 (81%)	

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



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

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%

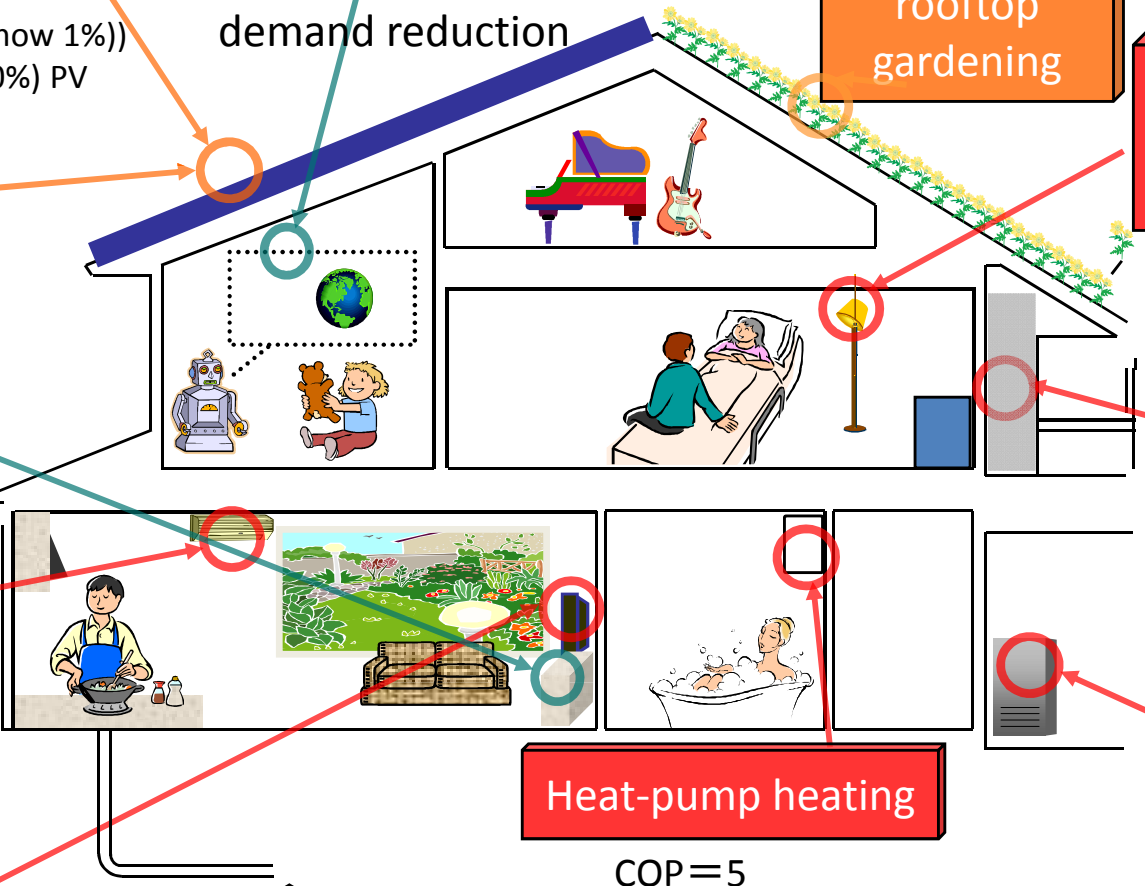
Solar heating

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

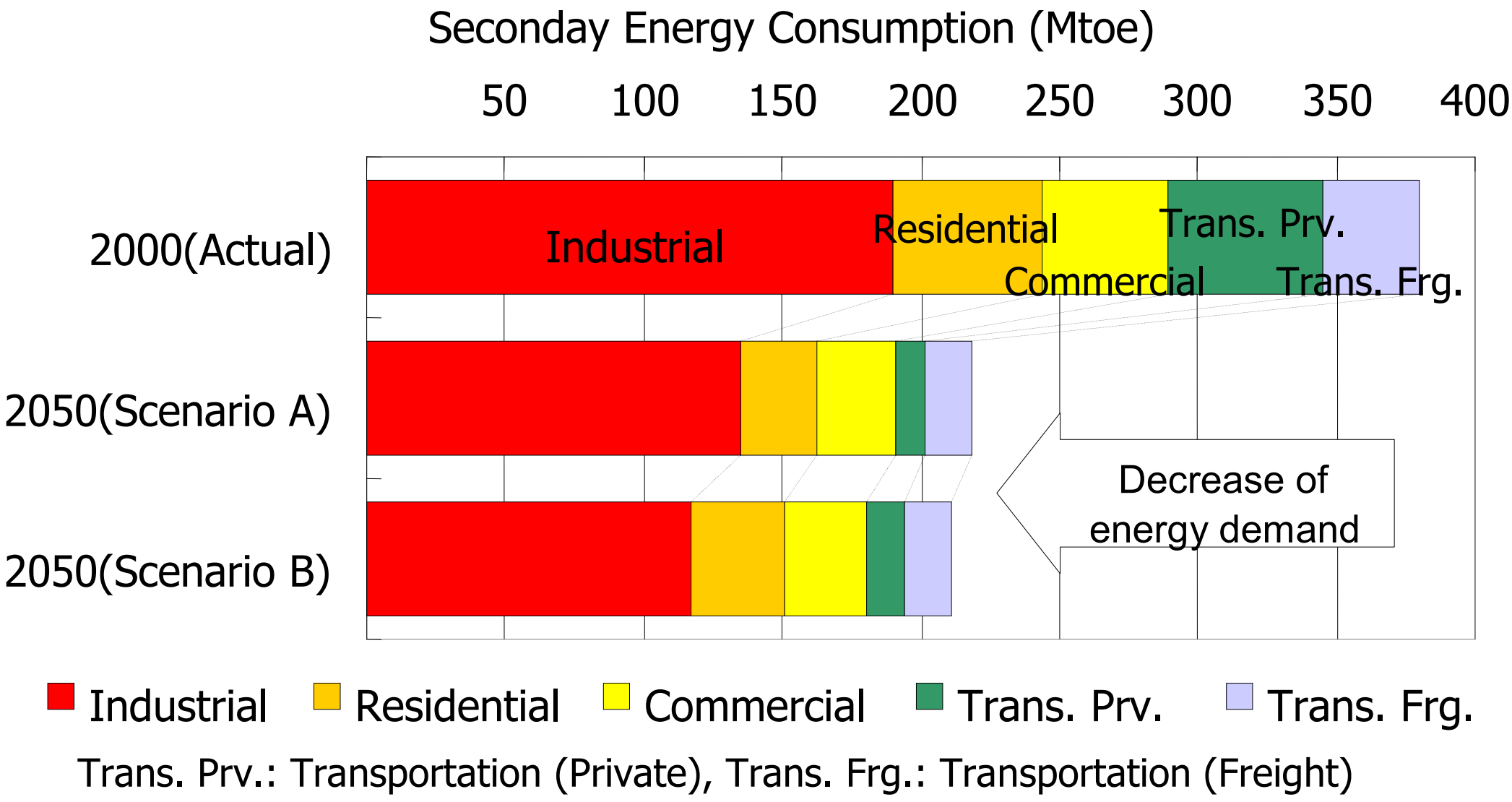
COP＝5
share 30-70%

Stand-by energy reduction

Reduce 1/3 energy demand,
share 100%

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

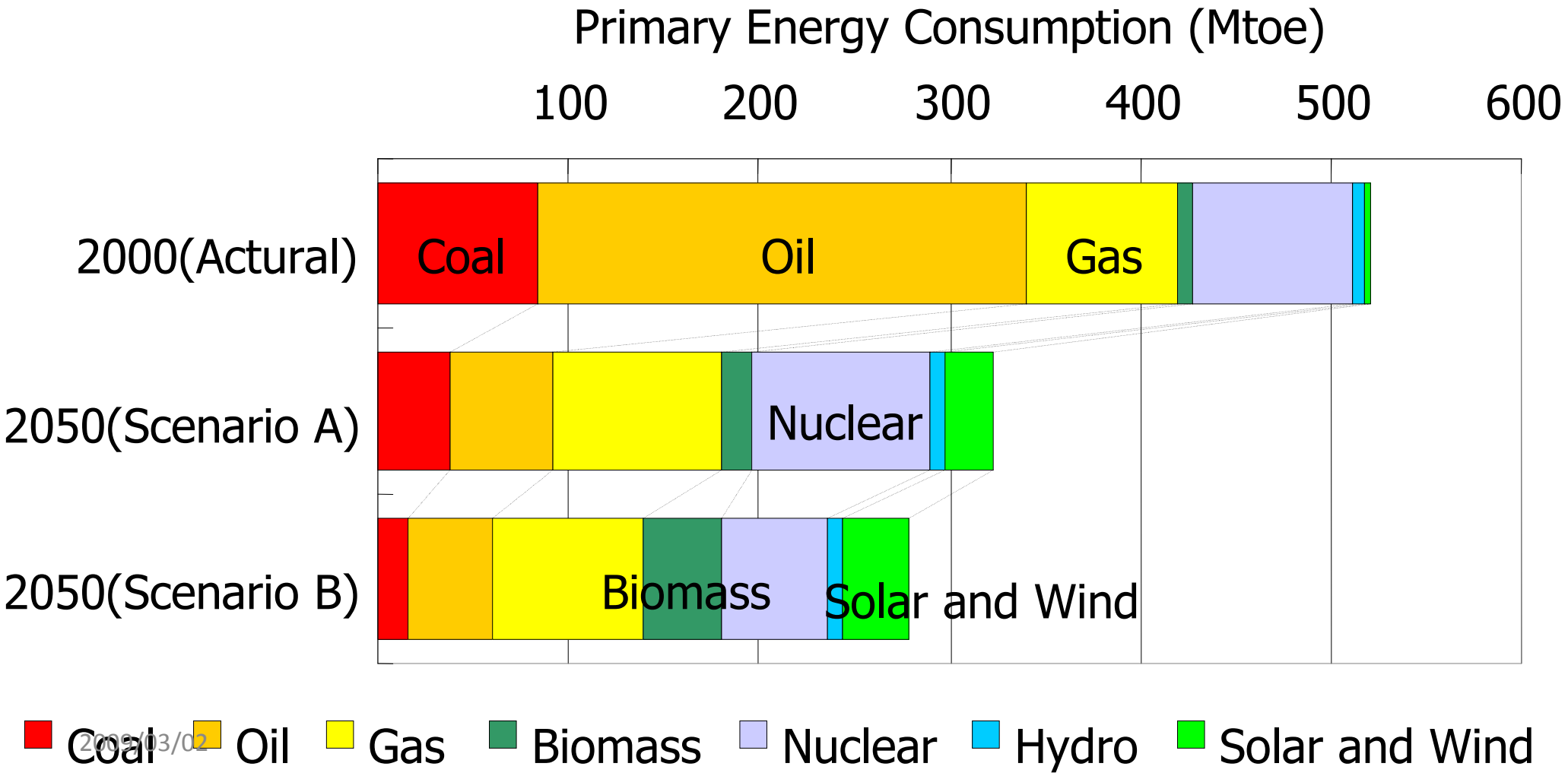
High efficiency appliances reduce energy demand and support comfortable and safe lifestyle



Possible energy demands reductions for each sector:
Industry : structural change and introduction of saving energy tech. 30-40%
Passenger Transport :land use, saving energy, carbon-intensity change 80%
Freight Transport :efficient transportation system, energy efficient 50%
Residential: high-insulated and energy-saving houses 40-50%
Commercial: high-insulated building and energy saving devices 40%

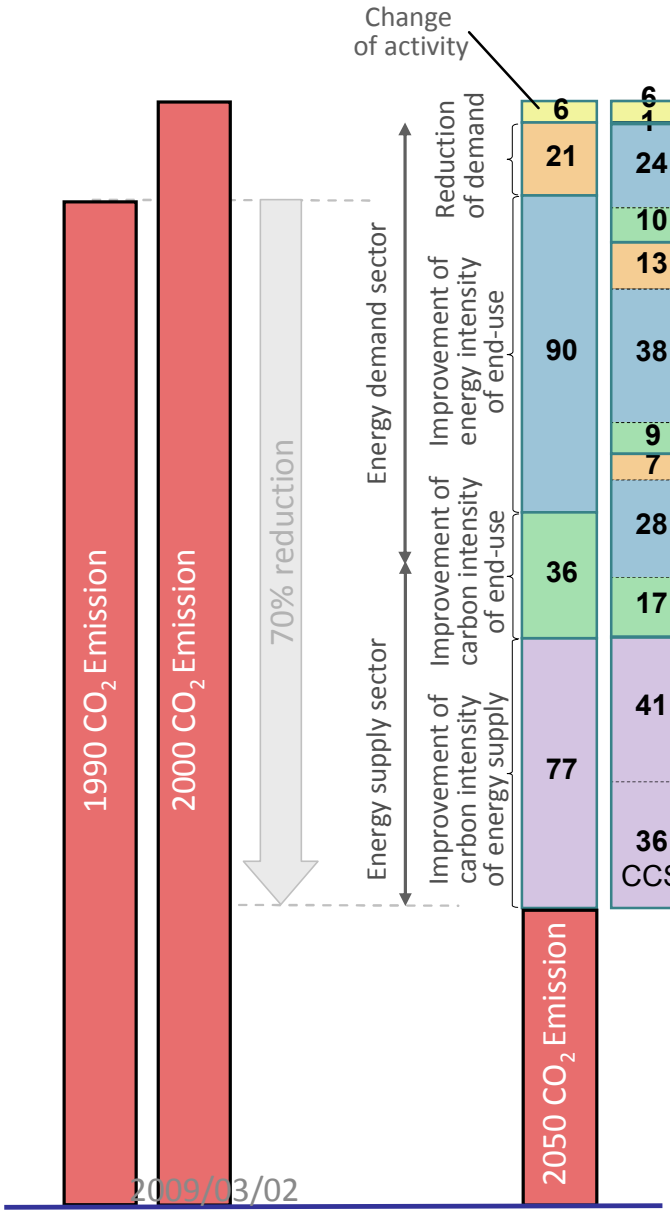
And we need low-carbon energy.

- Renewable energy
- Nuclear energy
- Fossil fuel + CCS



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



Industry

- Change of activity
  - High economic growth, Increase of service demand per household, Increase of office floor (increase)
  - Servicizing of industry, Decline in number of households, Increase of public transportation (decrease)
- Reduction of service demand
  - Farm products produced and consumed in season
- Improvement of energy intensity
- Improvement of carbon intensity
  - Fuel switch from coal and oil to natural gas

Residential & commercial

- Reduction of service demand
  - Insulation
  - Energy use management (HEMS/BEMS)
- Improvement of energy intensity
- Improvement of carbon intensity
  - Efficient heat pump air-conditioner, Efficient water heater, Efficient lighting equipment
  - Development and widespread use of fuel cell
  - All-electric house
  - Photovoltaic

Transportation

- Reduction of service demand
  - Advanced land use / Aggregation of urban function
  - Modal shift to public transportation service
- Improvement of energy intensity
- Improvement of carbon intensity
  - Widespread use of motor-driven vehicle such as electric vehicle and fuel-cell electric vehicle
  - High efficiency freight vehicle
  - Improvement of energy efficiency (train/ship/airplane)

Energy supply

- Improvement of carbon intensity
  - Fuel mix change to low carbon energy sources such as natural gas, nuclear energy, and renewable energy
  - Effective use of night power / Electricity storage
  - Hydrogen (derived from renewable energy) supply
- Carbon Capture Storage
  - Power generation without CO2 emission
  - Hydrogen production without CO2 emission

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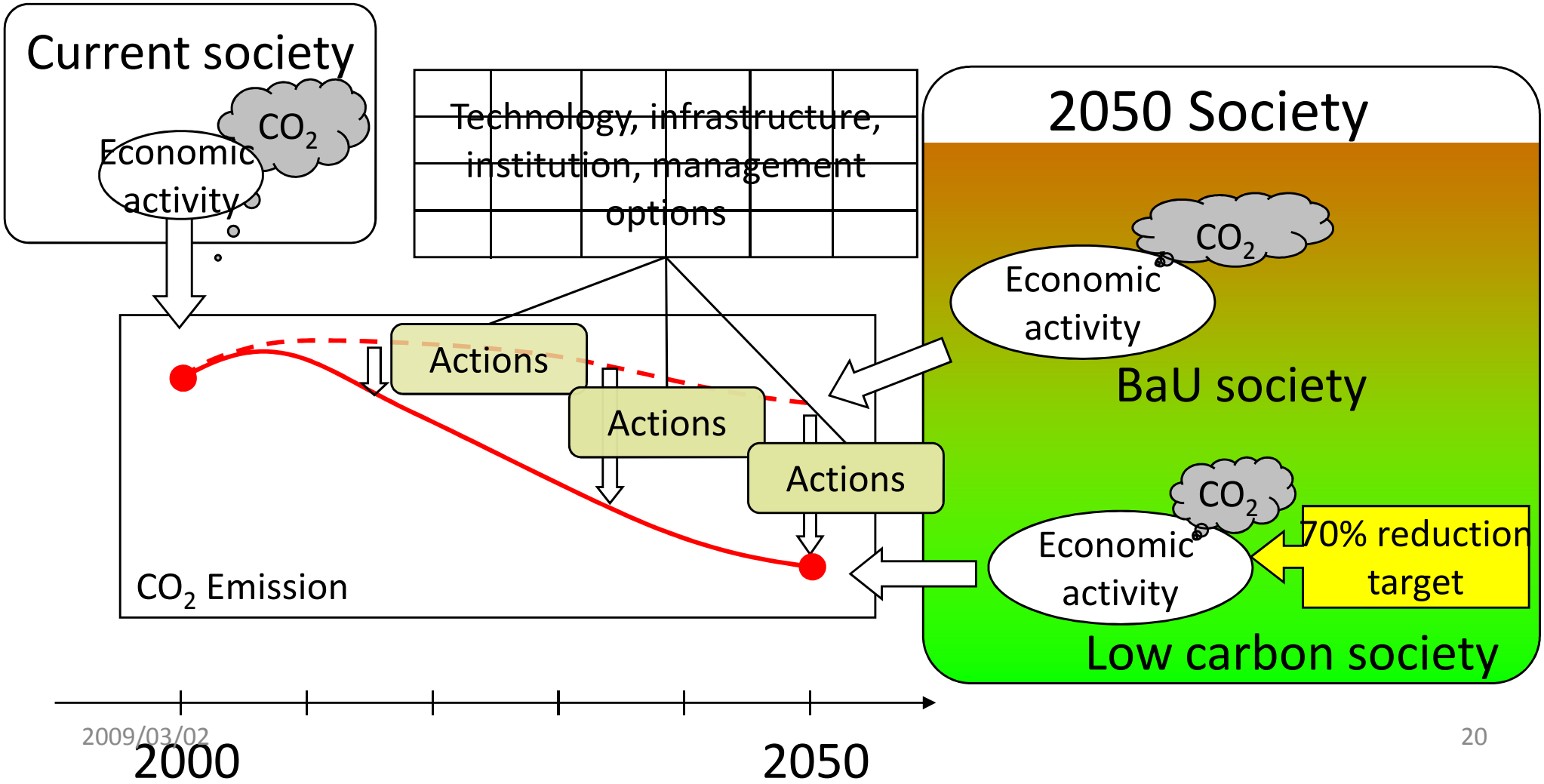
Outcome 2) Roadmap and Dozen Actions toward LCS

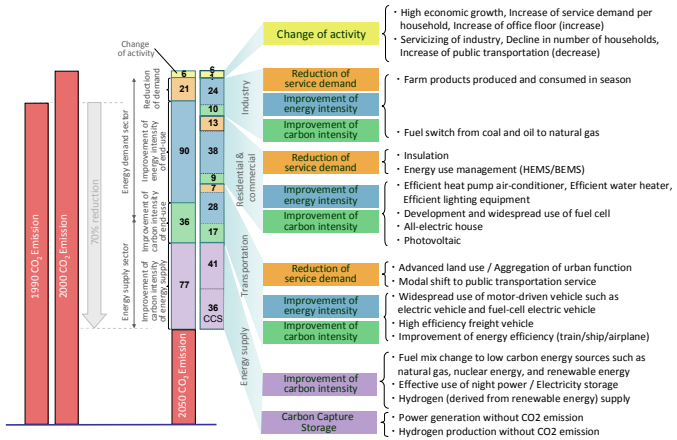
To achieve the 70% reduction goal by 2050, we investigated

- 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.

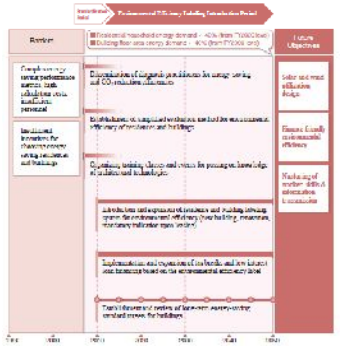


How to depict LCS roadmaps?



Target Vision in 2050

Backcast Model

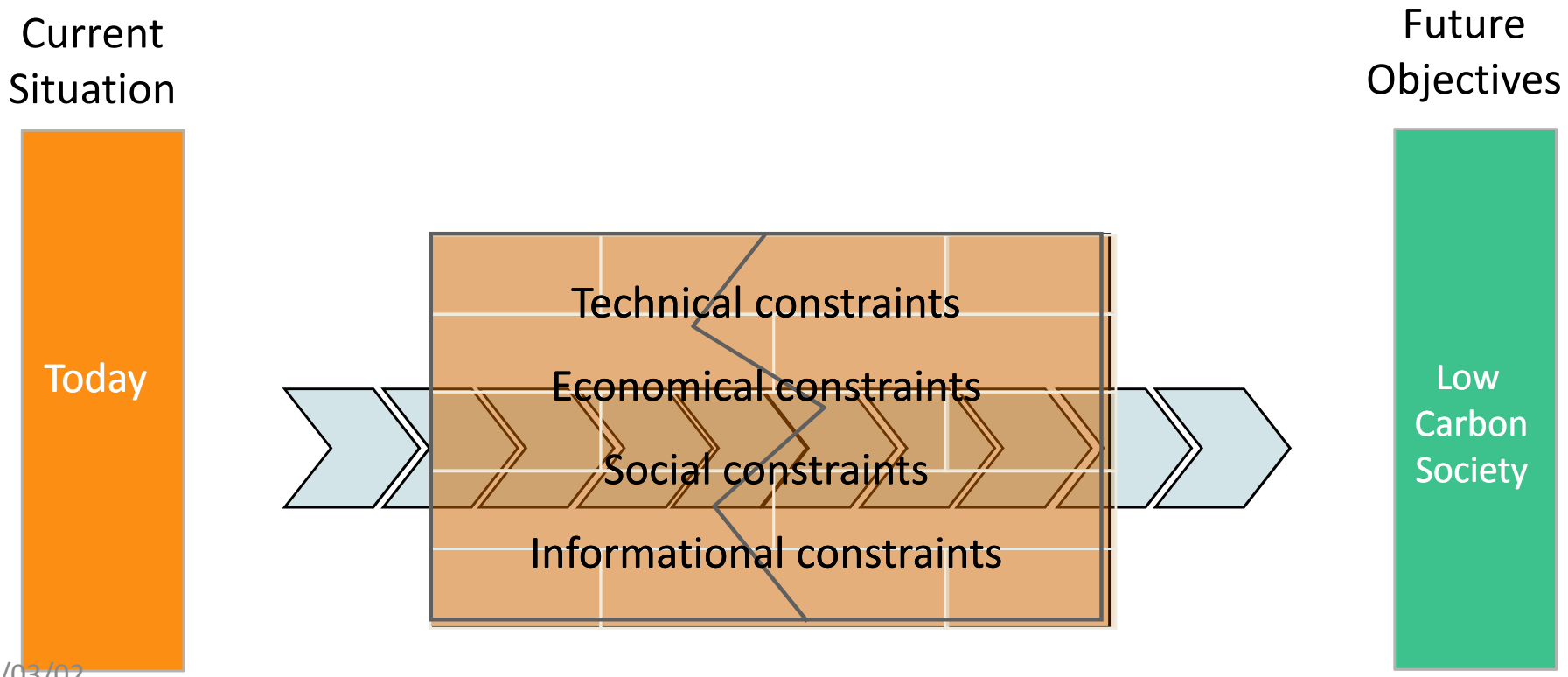


Narrative Roadmaps

Roadmaps

Constraints Analysis

- Constraints Analysis is to identify the gap between current situation and visions described in “Future objective”
- options can be defined as countermeasures to overcome the constraints
- Various types of constraints should be taken into account including;
  - ✓ Initiation constraints
  - ✓ Dissemination speed constraints (Cost, amenity, and efficiency)
  - ✓ Upper limit constraints (Physical, Social, and Technological)



1. Comfortable and Green Built Environment

Future Objectives

[Solar and Wind Utilization Design]

[Household Finance-friendly Environmental Efficiency]

[Nurturing of Worker Skills; Information Transmission]

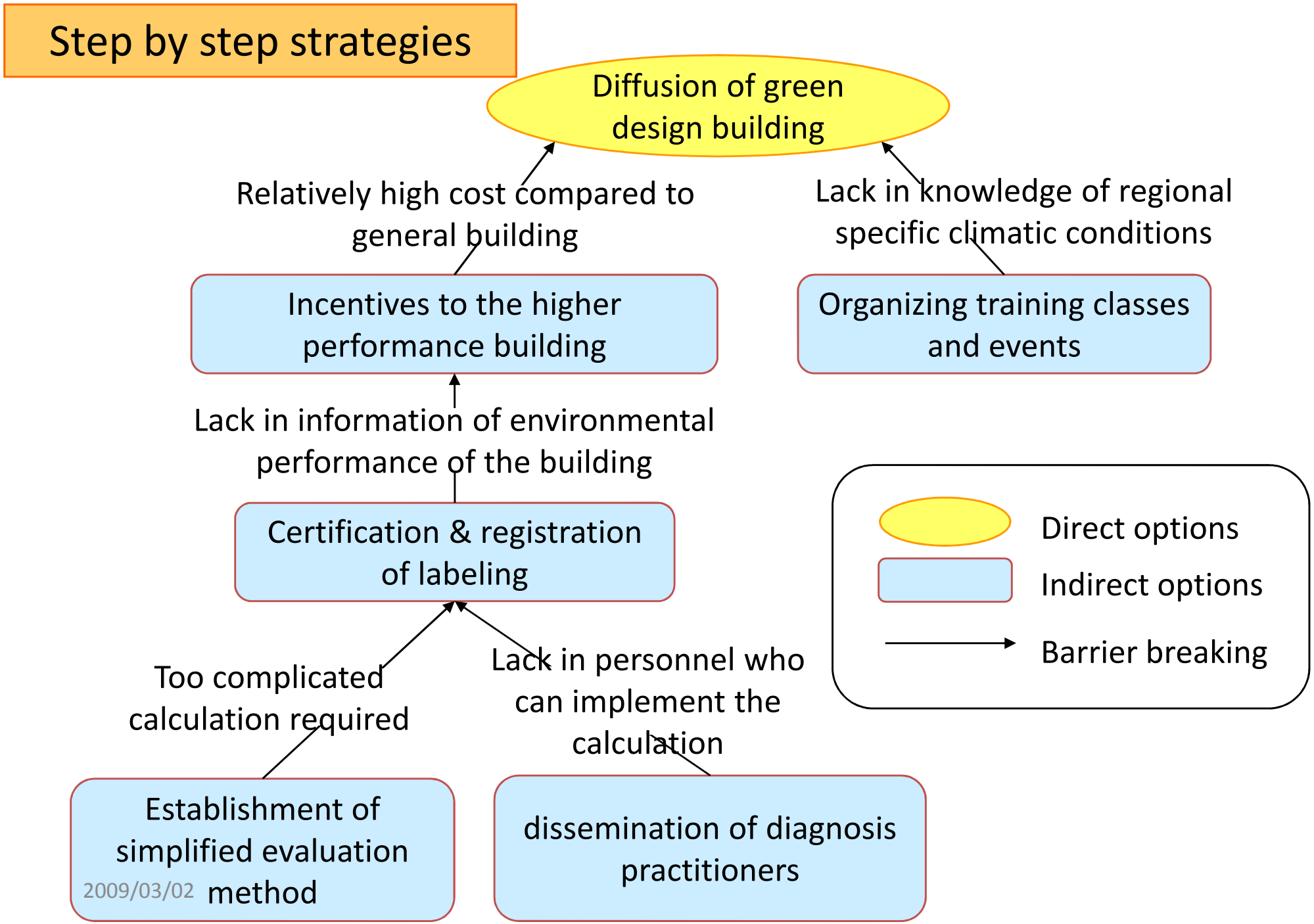
Implementation Barriers and Strategic Steps

[Standardization Period]

[Environmental Efficiency Labeling Introduction Period]

Identification of necessary actions

Step by step strategies



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.

Low-Carbon Residential/Commercial Sectors

1. Comfortable & green built environment

Keep warm/cool air in the building by active solar system and by changing building structure.

2. Anytime, anywhere appropriate appliances

Rental services relieve the burden of initial cost of high efficiency equipments, and promote service supply independent from manufacture.

3. Promoting Seasonal Local Food

Consumers select low-carbon seasonal food and can get the information about farm producers.

4. Sustainable building materials

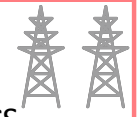
Actively use of wood feedstock and wood manufactures.

5. Environmentally enlightened business and industry

Change of office space design and use fully to low-carbon style.

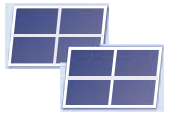
8. Low-carbon electricity

Selection of low-carbon electricity such as renewable/nuclear energy and thermal power with CCS.



9. Local renewable resources for local demand

Active selection of regional solar/wind energies.

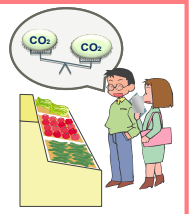


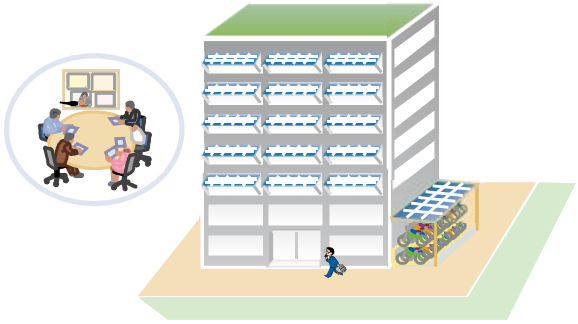
10. Next generation fuels

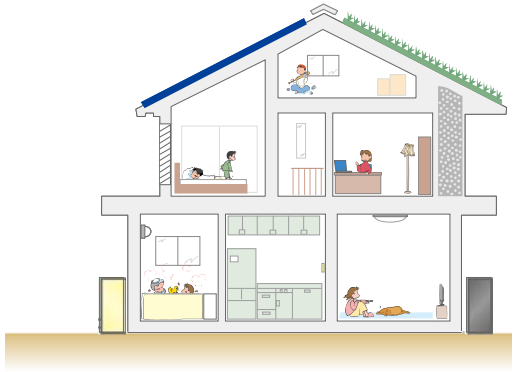
Simultaneous supply of heat and electricity by fuel cell.

11. Labeling to encourage smart and rational choices

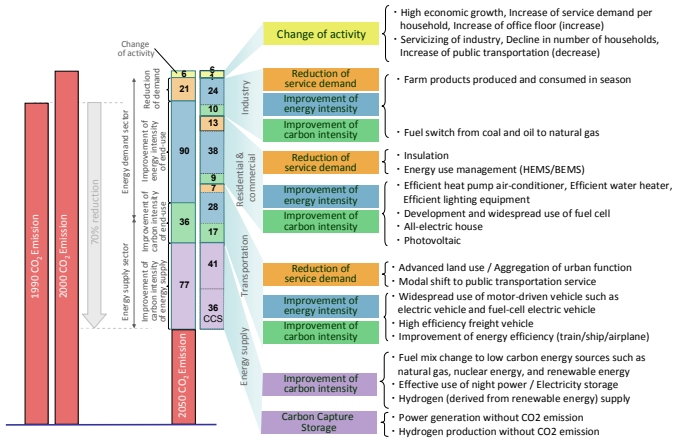
Disclosing the amount of CO2 emission makes consumers select low-carbon products in affordable way.





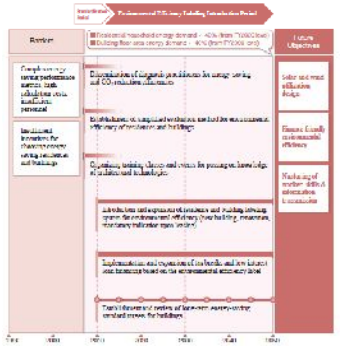


How to depict LCS roadmaps?



Target Vision in 2050

Backcast Model



Narrative Roadmaps

Roadmaps

Backcast Model: Overview

- Investigating "When and Which options and How much" of each option (countermeasures and policies) should be introduced in order to achieve the goal with keeping consistency of energy/economy.

Input

- Future target vision
- Social/Economical conditions
- Set of options

And, each options'

- Sequential order
- Elapsed time
- Kick-off period

Output

- Feasibility of the target
- Roadmaps
- CO_2/Cost trajectories

Why did we develop the Backcast Model?
To involve…

- Investigating "When and Which options and How much" of each option (countermeasures and policies) should be introduced in order to achieve the goal with keeping consistency of energy/economy.

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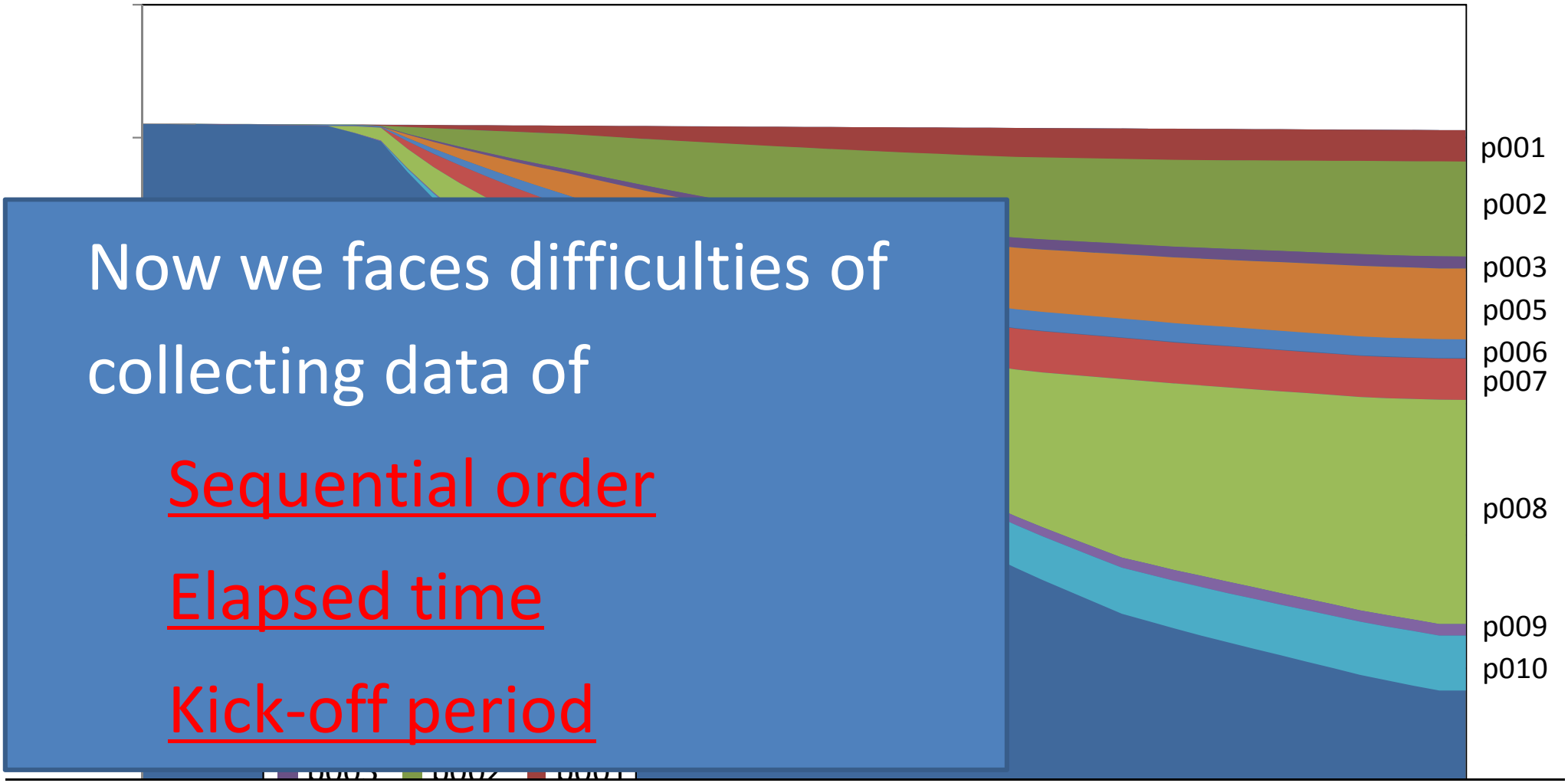
Preliminary results: CO_2 Emissions

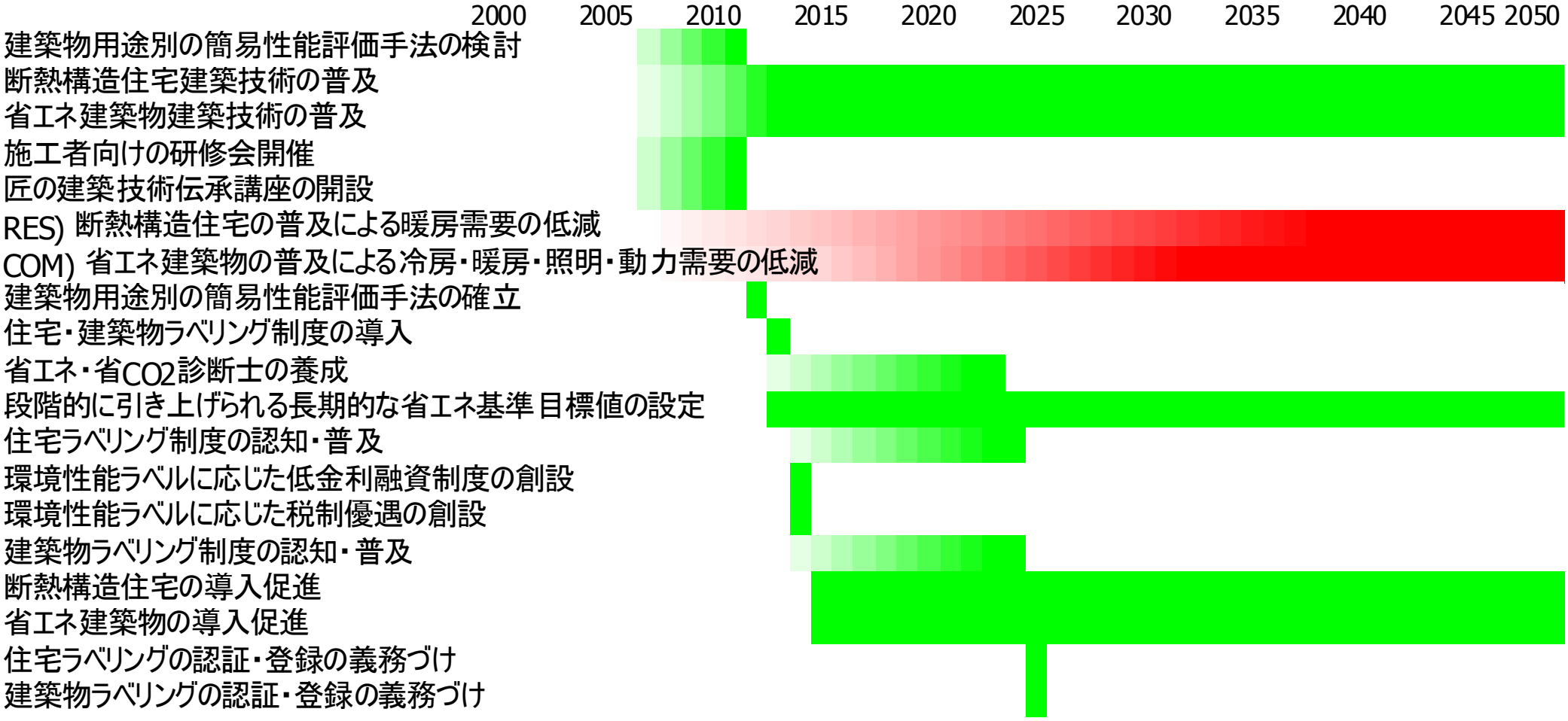


Now we faces difficulties of collecting data of

- Sequential order
- Elapsed time
- Kick-off period

p001. Confortable and Green Built Environment
p002. Anytime, Anywhere Appropriate Appliances
p003. Promoting Seasonal Local Food
p004. Sustainable Building Materials
p005. Environmentally Enlightened Business and Industry
p006. Swift and Smooth Logistics
p007. Pedestrian Friendly City Design
p008. Low-Carbon Electricity
p009. Local Renewable Resources for Local Demand
p010. Next Generation Fuels
p011. Labeling to Encourage Smart and Rational Choices
p012. Low-Carbon Society Leadership

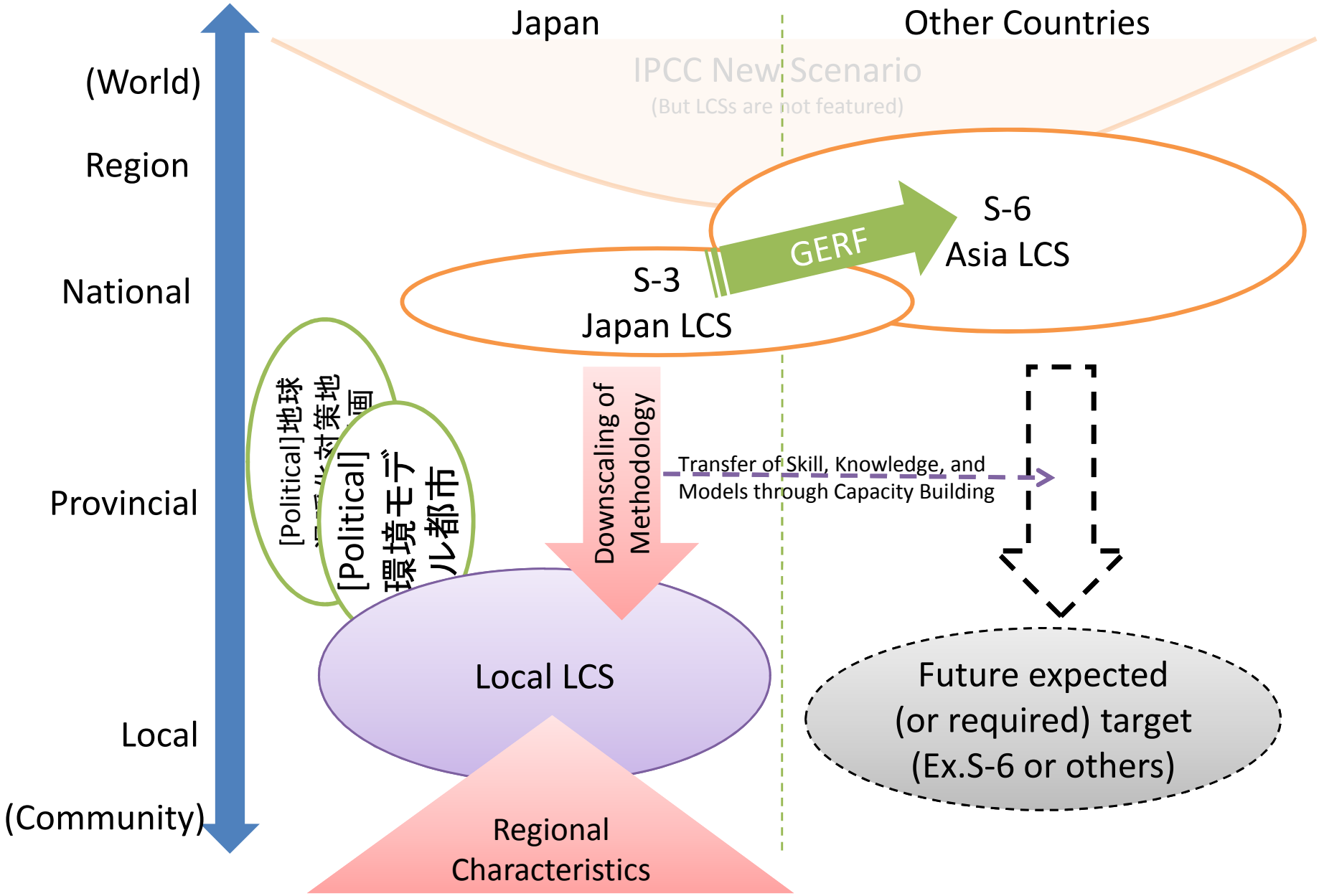
Anticipated results of Backcast model: Roadmap



Red line indicates options for CO2 reduction

Green line indicates options of non-CO2 reduction (Policies etc.)

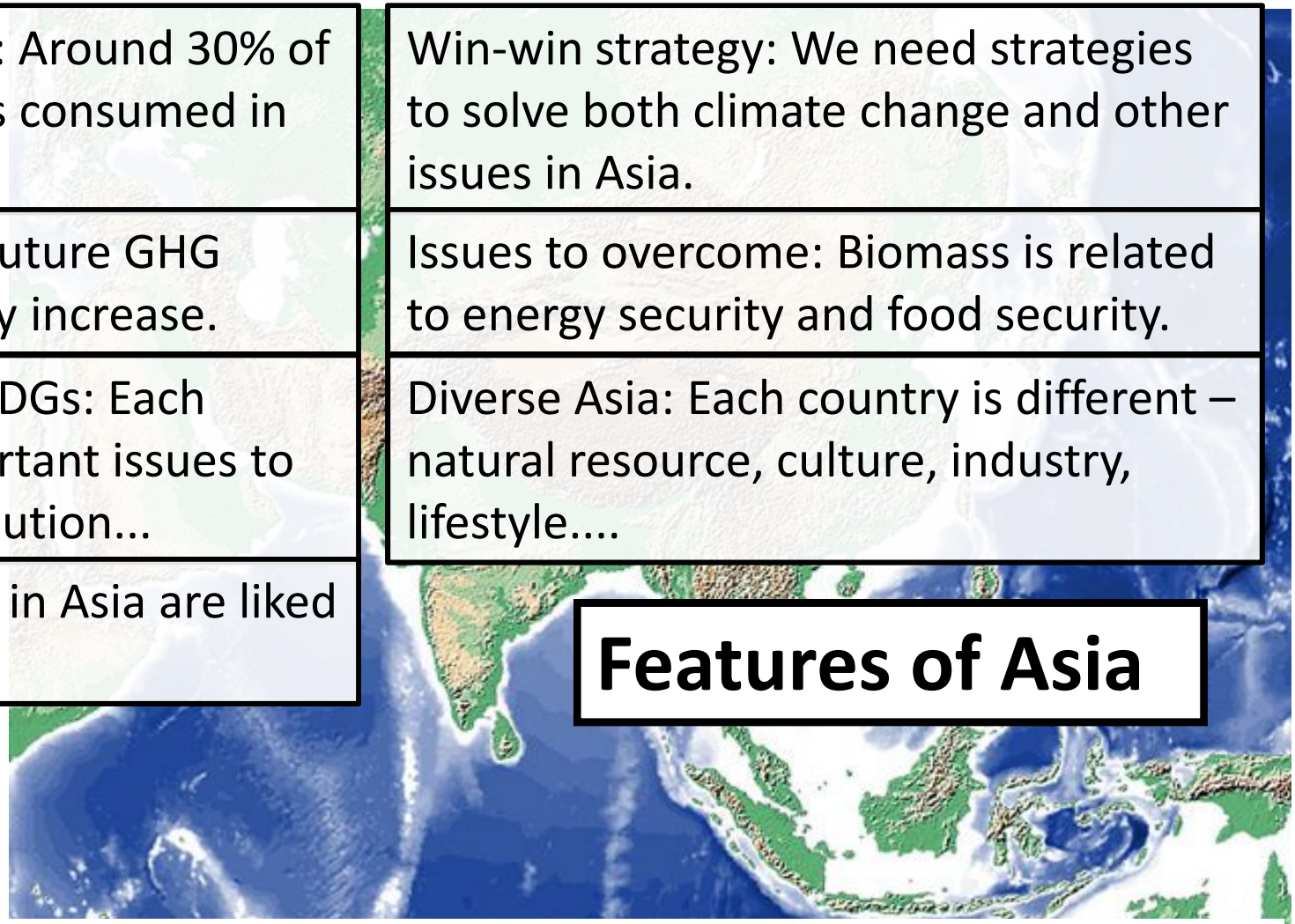
Next Step: Asia Low-Carbon Study



Importance on scenario analysis for Asia

In order to develop the low carbon world, it is important to develop middle-long term scenarios toward low carbon Asia and to assess various policy options in this area.

Huge economic activity: Around 30% of global primary energy is consumed in Asia	Win-win strategy: We need strategies to solve both climate change and other issues in Asia.
Developing countries: Future GHG emissions will drastically increase.	Issues to overcome: Biomass is related to energy security and food security.
Other issues such as MDGs: Each country has many important issues to be solved –poverty, pollution...	Diverse Asia: Each country is different – natural resource, culture, industry, lifestyle....
Globalization: Activities in Asia are liked to the global activities.	



Features of Asia

Masui, T. (2009). Introduction of Advancement of Low-Carbon Society Scenario Studies in Asian Countries, Japan Low-Carbon Society Scenarios toward 2050 Project Symposium, 12 Feb, 2009 at Tokyo.

Steps of Low-Carbon Society Scenario Studies in Asian countries

- Clarification of targets to achieve low carbon society and to solve other issues simultaneously in each country/city
- Sharing cross-cutting issues among countries and considering strategies toward low carbon society
- Quantitative research applying the integrated assessment models to each country/city
- Developing the consistent low carbon scenarios and designing the road map to achieve the low carbon society for each country/city

Masui, T. (2009). Introduction of Advancement of Low-Carbon Society Scenario Studies in Asian Countries, Japan Low-Carbon Society Scenarios toward 2050 Project Symposium, 12 Feb, 2009 at Tokyo.


Thank you
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