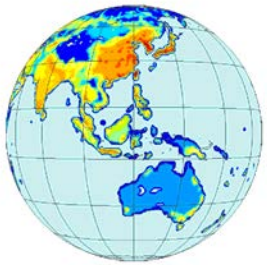
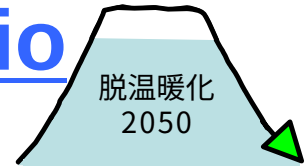


Model Development for Japan Low Carbon Society Scenario toward 2050

Junichi FUJINO
National Institute for Environmental Studies (NIES)

Japan Low-carbon society scenario



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

Industrial Structure

Technology

Institution

Management

Propose GHG policy to realize low-carbon society

Social system Reform to introduce countermeasures

Build visions of Japan Low-carbon society 2050

GHG Reduction Target Setting

Reduction target

GHG emissions

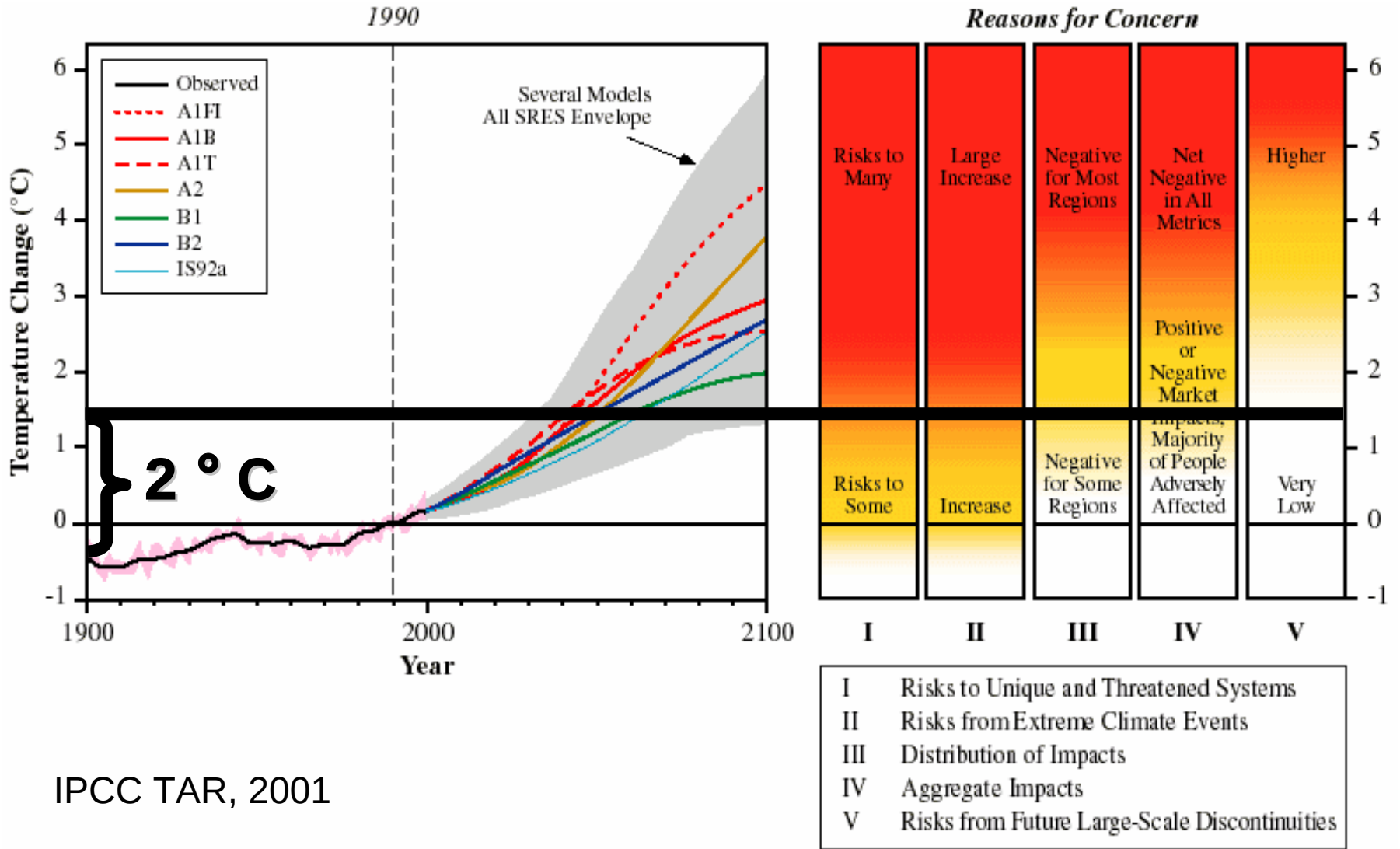
1990 2000 2008 2010 2012 2020 2030 2040 2050

Kyoto protocol

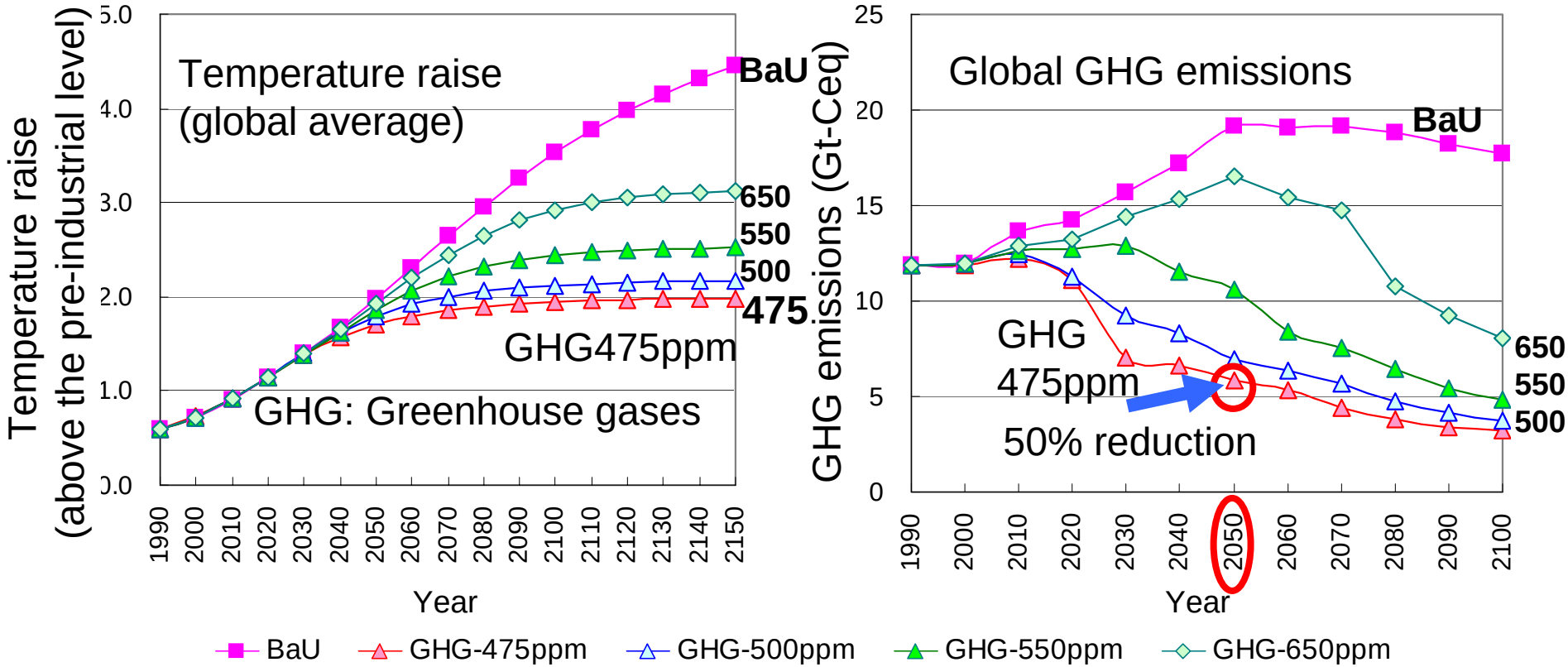
Most of current infrastructure rebuilt

[FY2004-2006(+2years), Global Environmental Research Program, MOEJ]

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



IPCC TAR, 2001



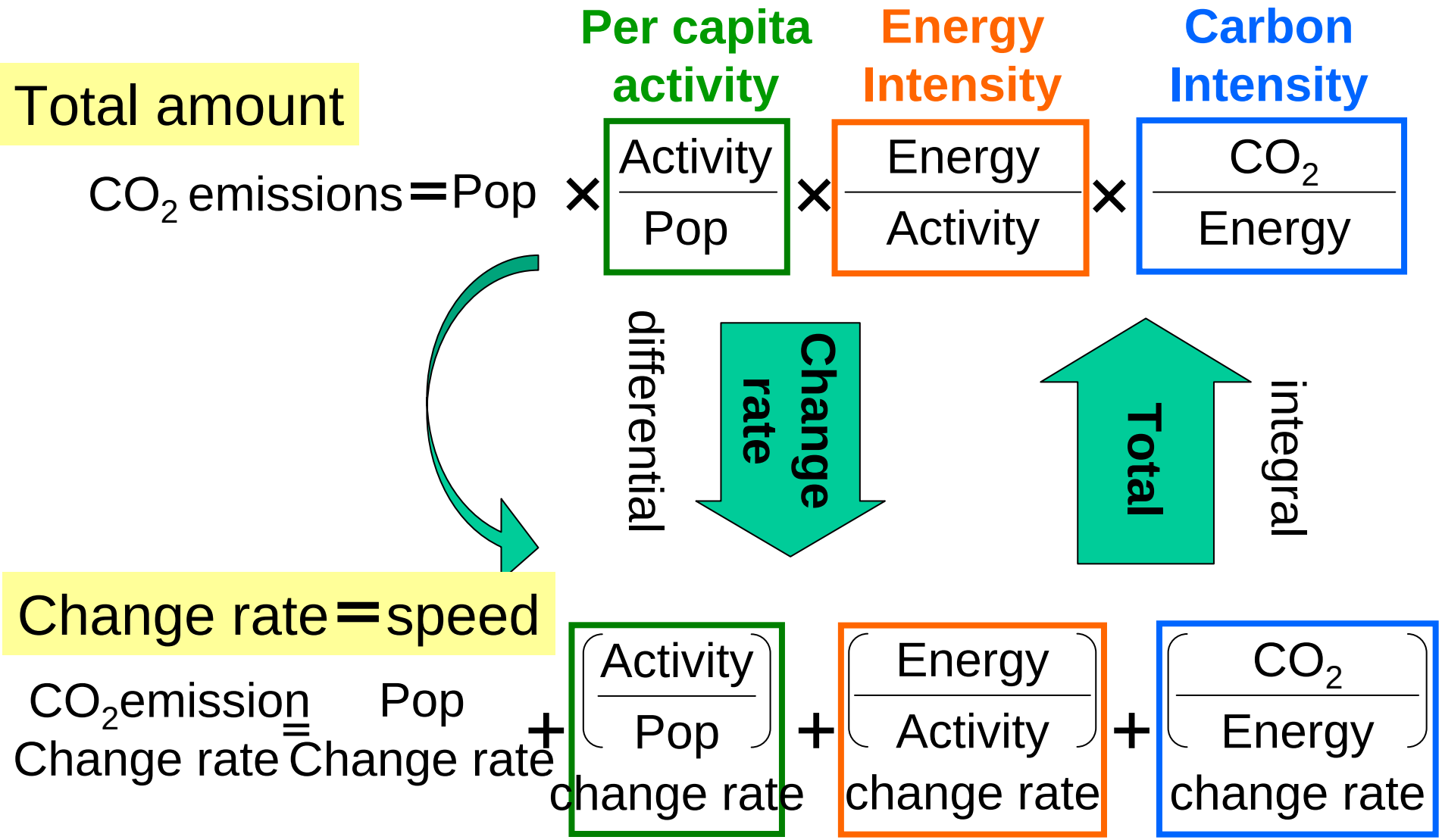
•It is estimated that around 50% GHG reductions in 2050 are required to control temperature raise below 2C

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

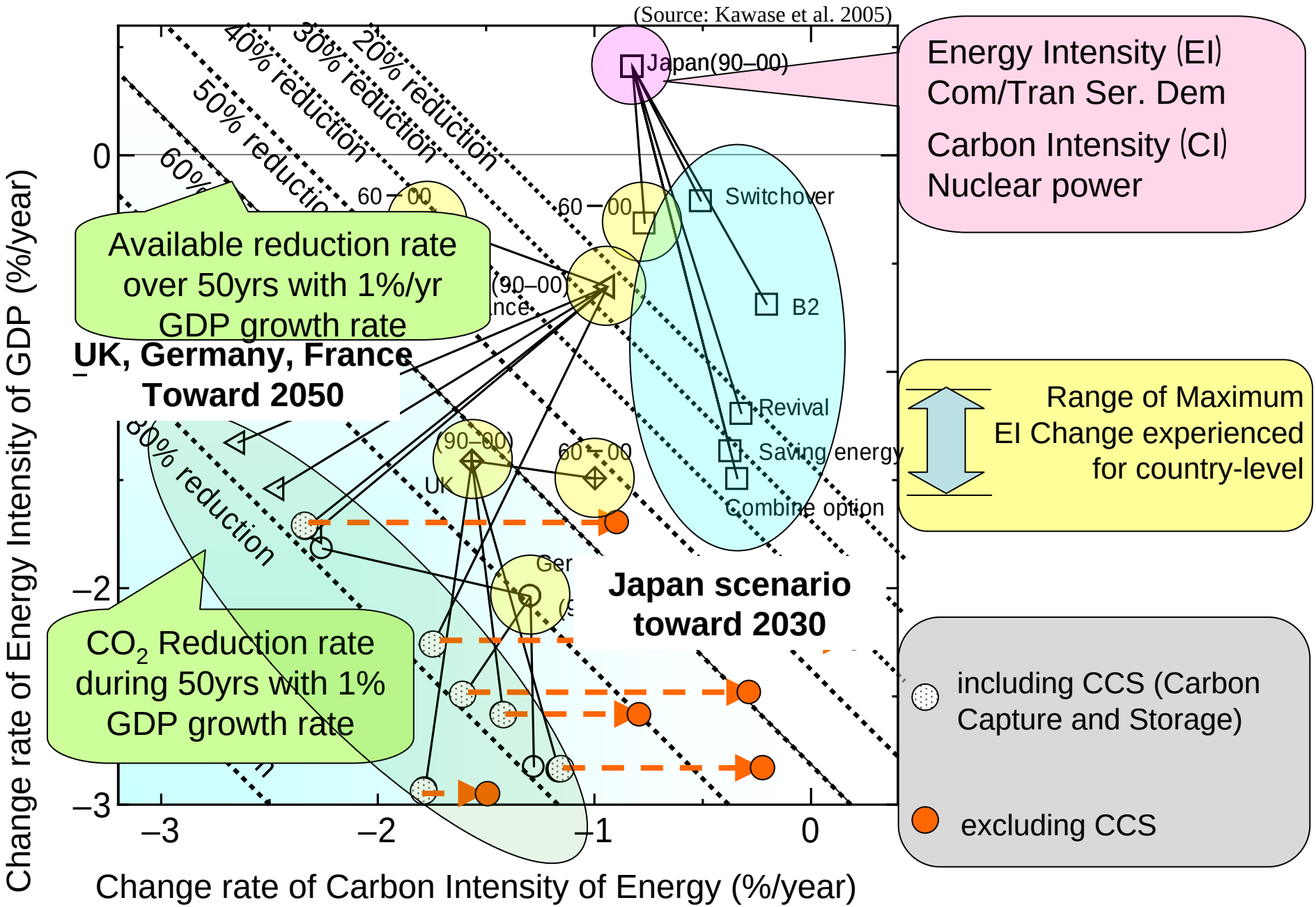
•Impacts will be occurred even in 2C temp control.
•Adaptation is necessary.

Calculated by AIM/Impact[policy] Model

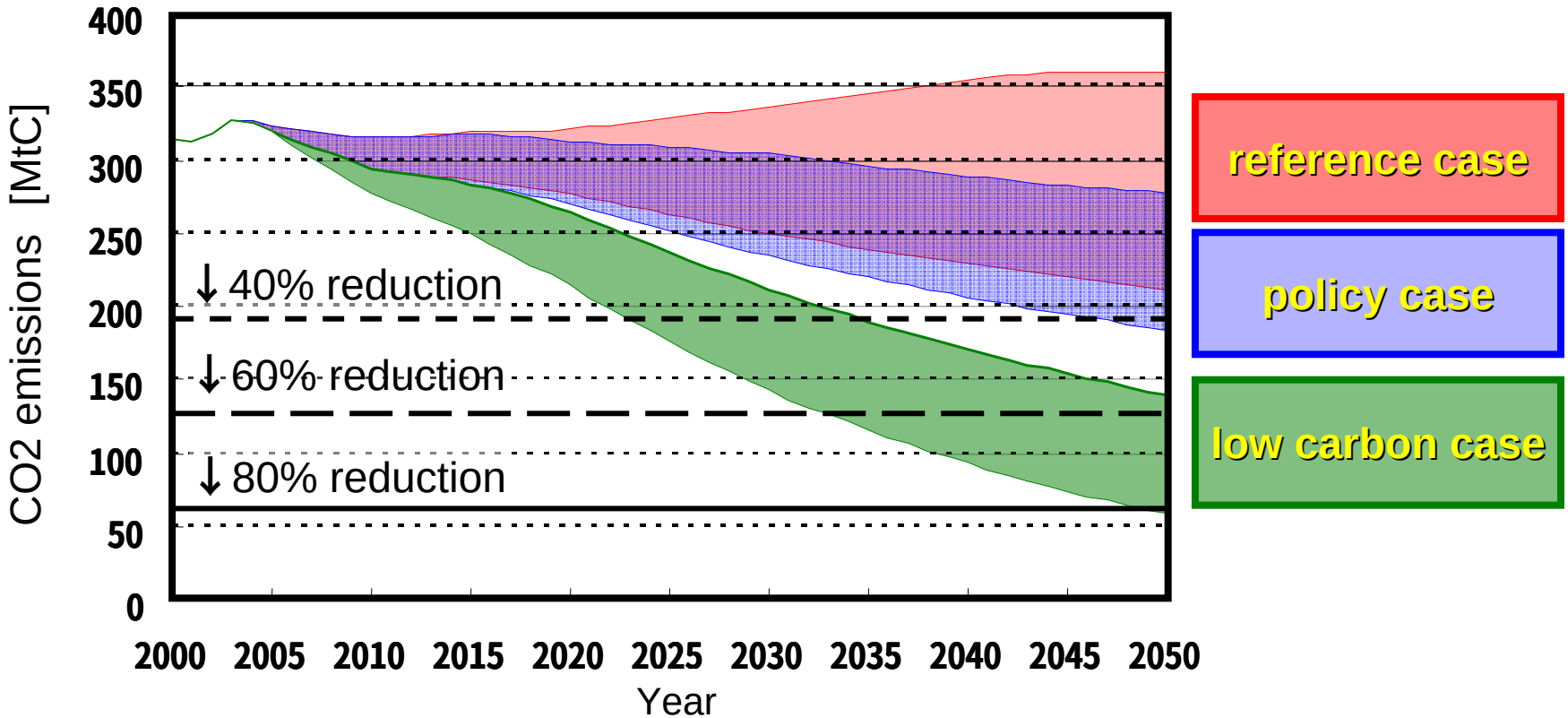
How to reduce GHG emissions ?



How fast we have to reduce GHG emissions?

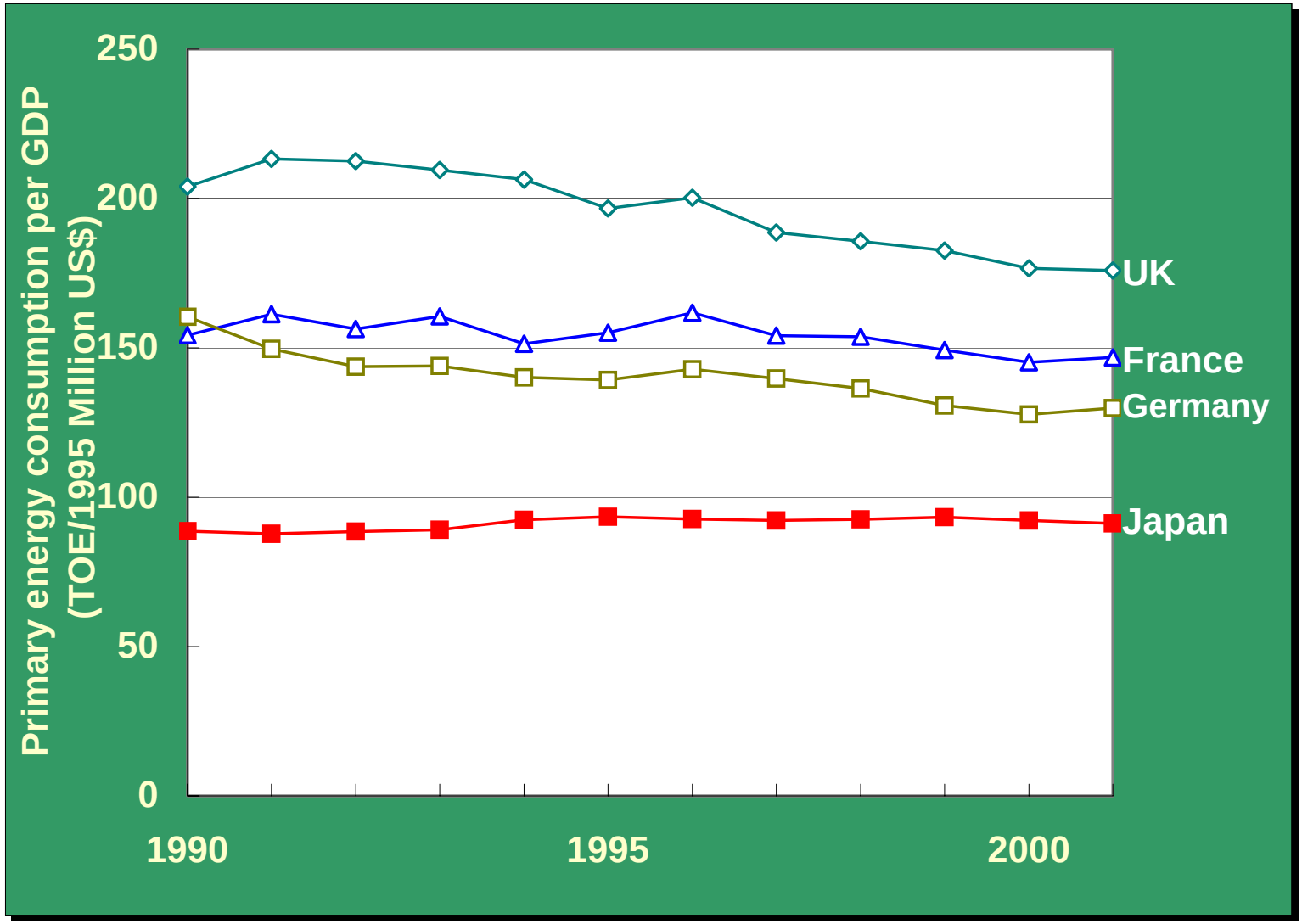


Path toward Low Carbon Society



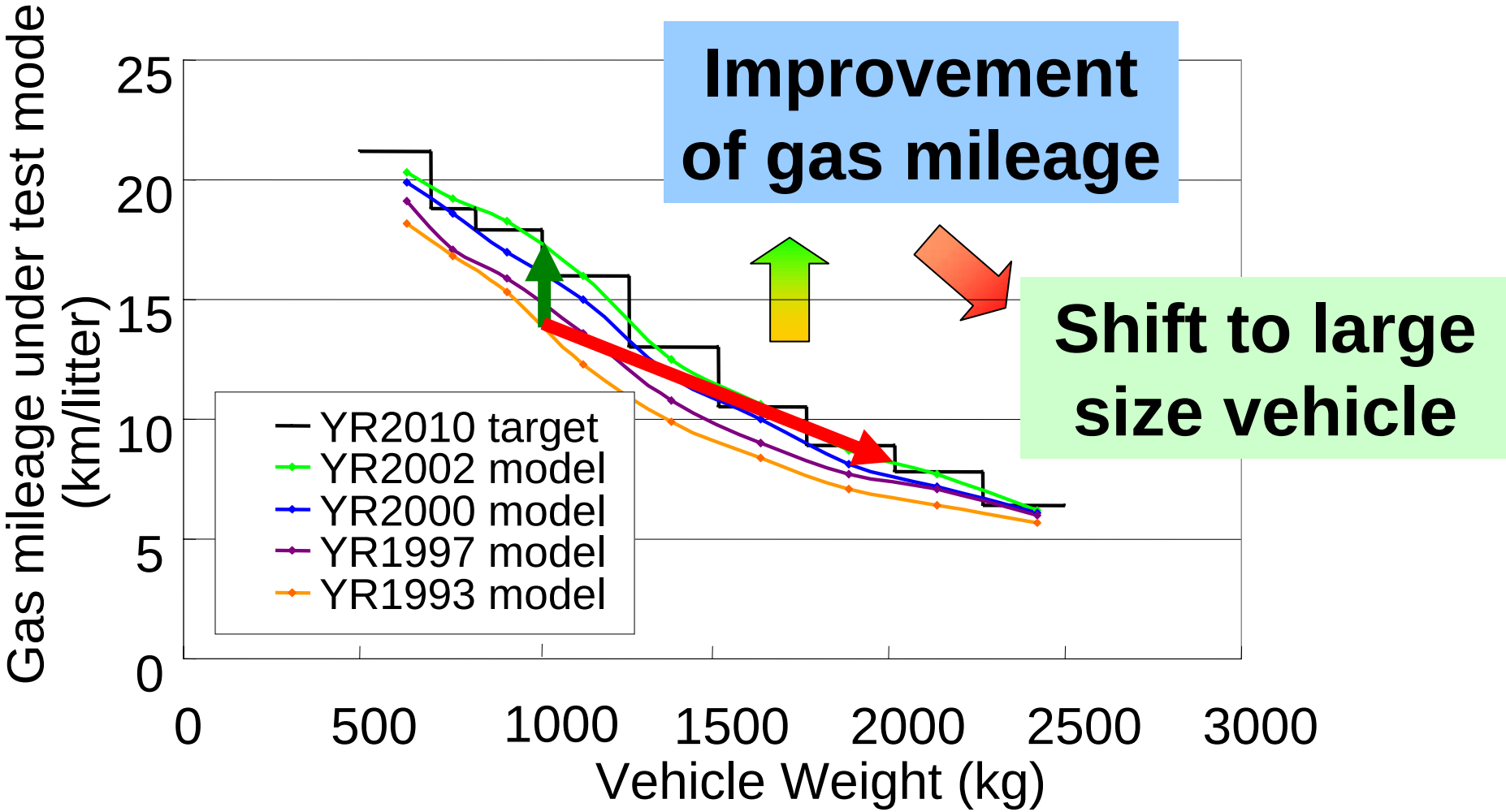
Energy Saving devices
Energy Supply change

Urban System Change
Industry Structure Change
Information Technology
Renewable energy
Consumption Behavior



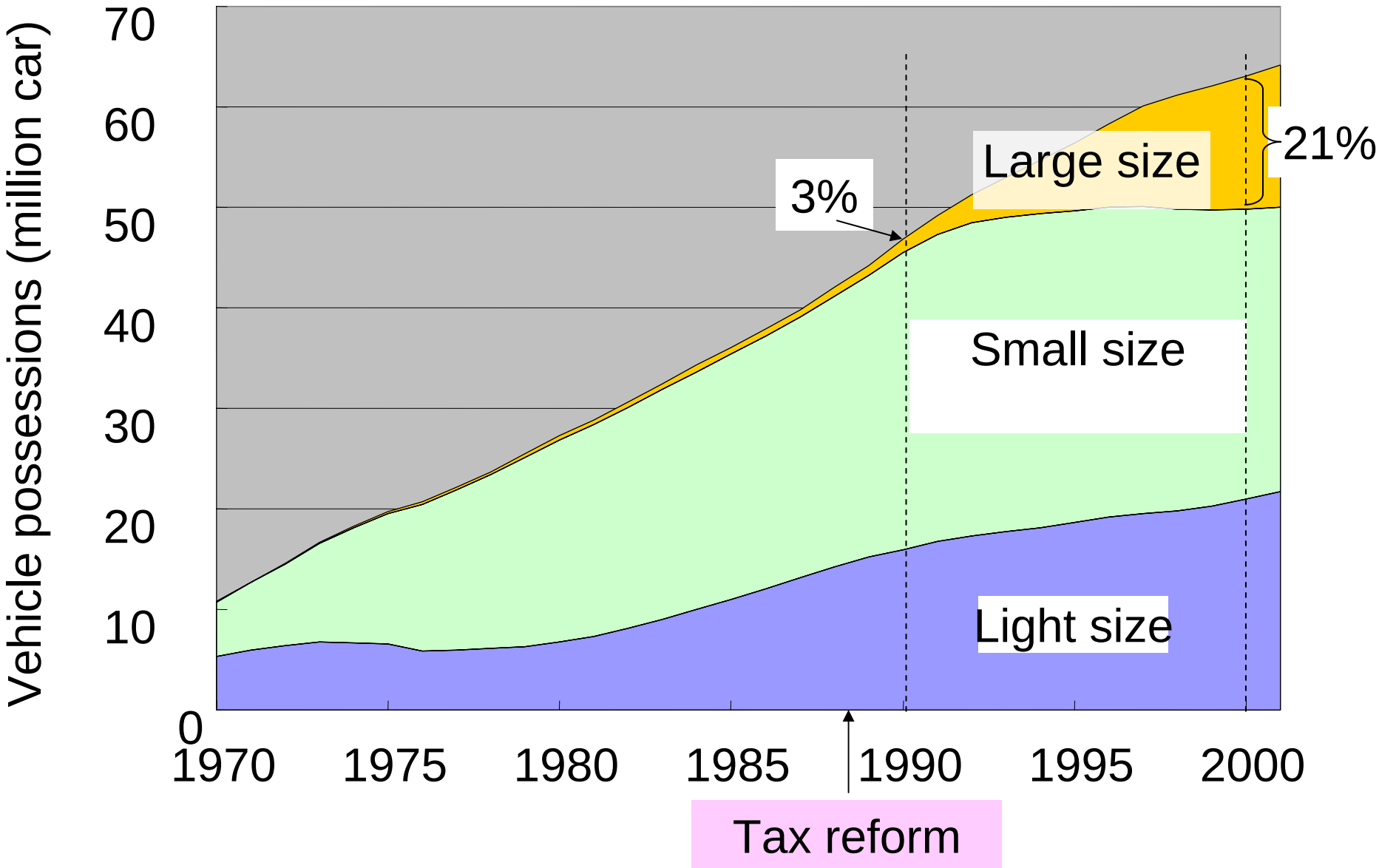
Energy Intensity

Technology has been developed. How about behavior?



Data source: Ministry of Land, Infrastructure and Transport

Tax reform promotes shift to large size vehicle…



Data source: Automobile Inspection & Registration Association

Example of EDB Card [Advanced technology]

Hybrid vehicle

Environmental Option Data Sheet Sheet No.: 1

Outputs Database | Inputs Database

Option	Gasoline hybrid vehicle
Code	TR_HYBRID
Environmental Issue	[CC]: Climate Change
Sector	[TR]: Transporation sector
Description	A car with two different power units (motor and engine). Drive using the motor allows improved mileage, low noise, low exhaust emissions and so on. Since there is no need to provide special energy supply infrastructure like that required by electric cars for recharging, this represents a basic car technology that will lead to future fuel cell cars.
Technical Barrier	Since multiple power sources are used, the biggest issues are achieving a small, lightweight system, and reducing prices.
Social Barrier	
Secondary Effect	Generally contribute to reducing emissions of atmospheric pollutants such as NOx. Also reduce noise.

Basic Unit	Name	Value	Unit
	Unit	1	Unit

Operating Rate: 100.0 %

Output	Value	Unit	Reference
[TR_CAC]: Freight Trns. (Vehicle)		トンキロ	

Input	Value	Unit	Reference
[OLG]: Gasoline		kgoe/Year	

Installation Potential | Installation | Available Year: 1997 | Retirement Year: 9999 | Lifetime: 10 | Additional Manpowe: 0 | Alternative Option | URL Link | Contact Detail

Outputs Database | Inputs Database

EDB - develop intervention scenarios

Example of EDB Card [Infrastructure]

Public transportation priority system

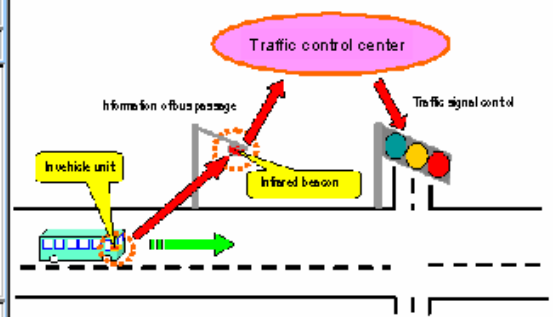
Environmental Option Data Sheet Sheet No.: 2

Outputs Database | Inputs Database

Technology	Public Transportation Priority System(PTPS)
Code	TR_PTPS
Environmental Issue	[CC]: Climate Change
Sector	[TR]: Transporation sector
Description	PTPS supports public transportation vehicles such as buses by giving them priority in transit. The traffic control center grasps the traveling situation of buses on the road by means of infrared beacons installed on the roads, and responds by creating dedicated/priority bus lanes, warning illegally traveling vehicles, executing priority traffic signal control, etc. Among the merits of this system are improved convenience for users, promotion of the use of mass public transportation, securing of regular bus operations, reduction of bus stopping times at traffic signals, reduction of illegal traveling in dedicated bus lanes, ensuring the safety of buses, etc.
Technical Barrier	
Social Barrier	
Secondary Effect	

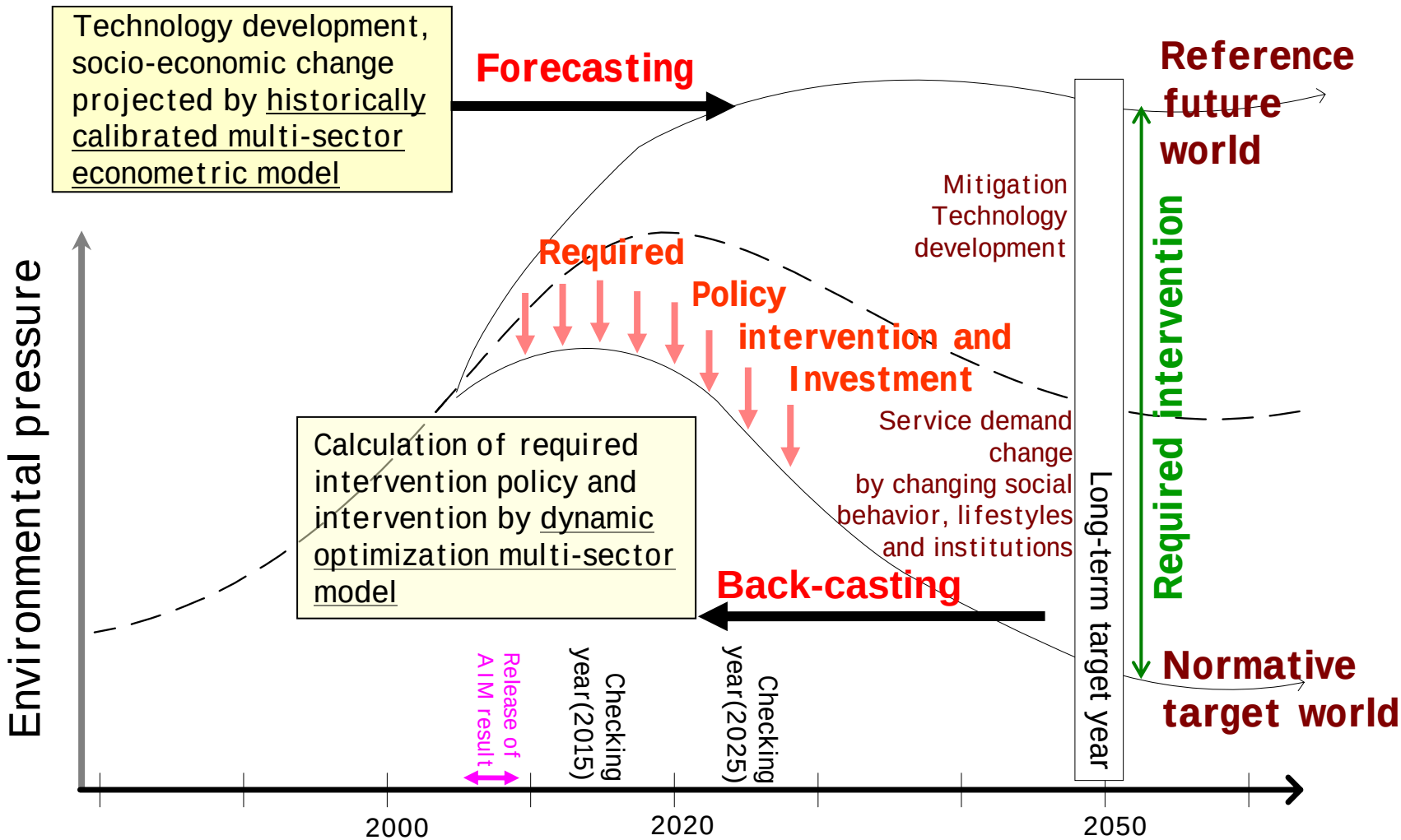
Basic Unit	Name	Value	Unit

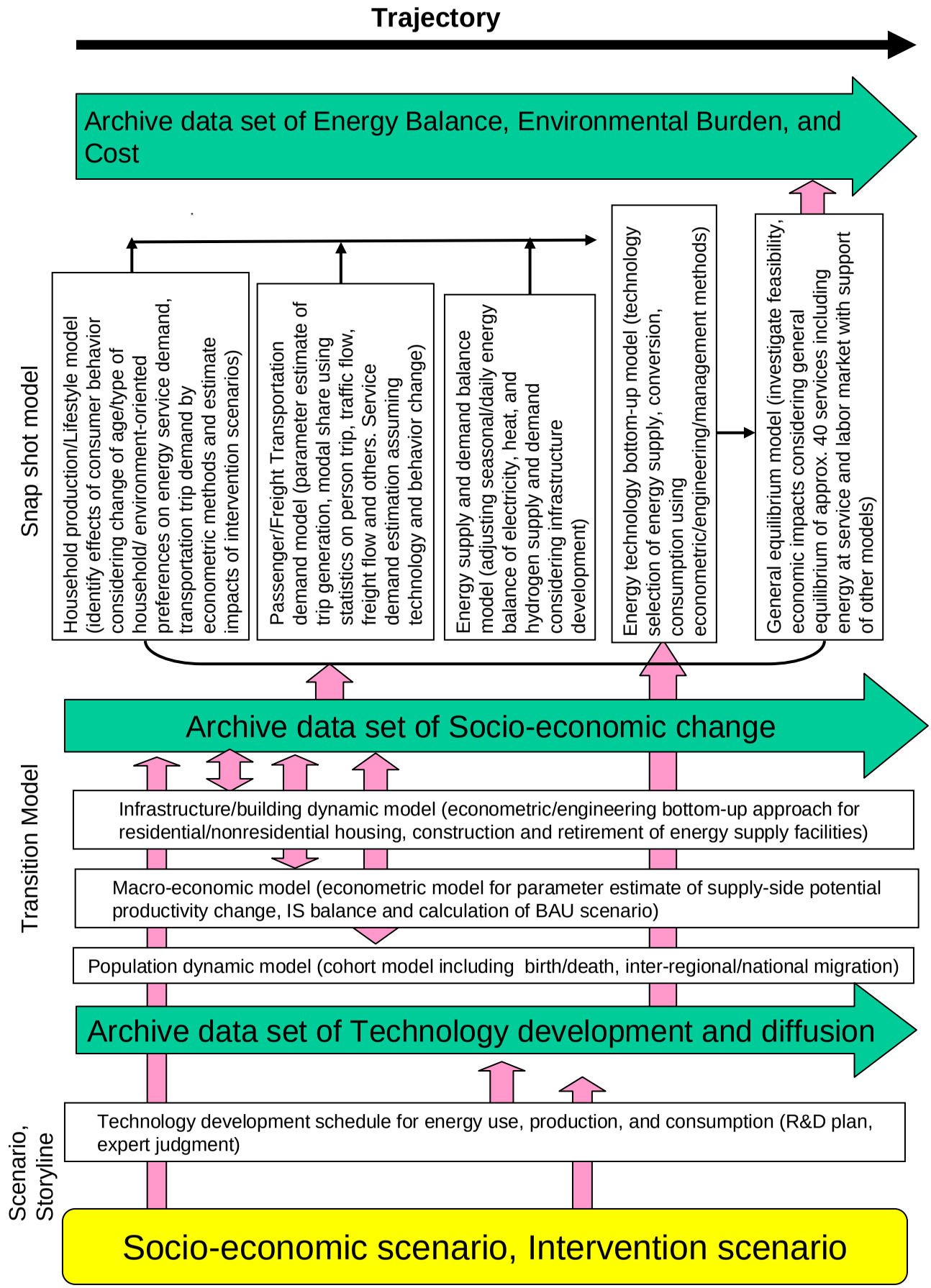
Operating Rate	100.0	%
Output		

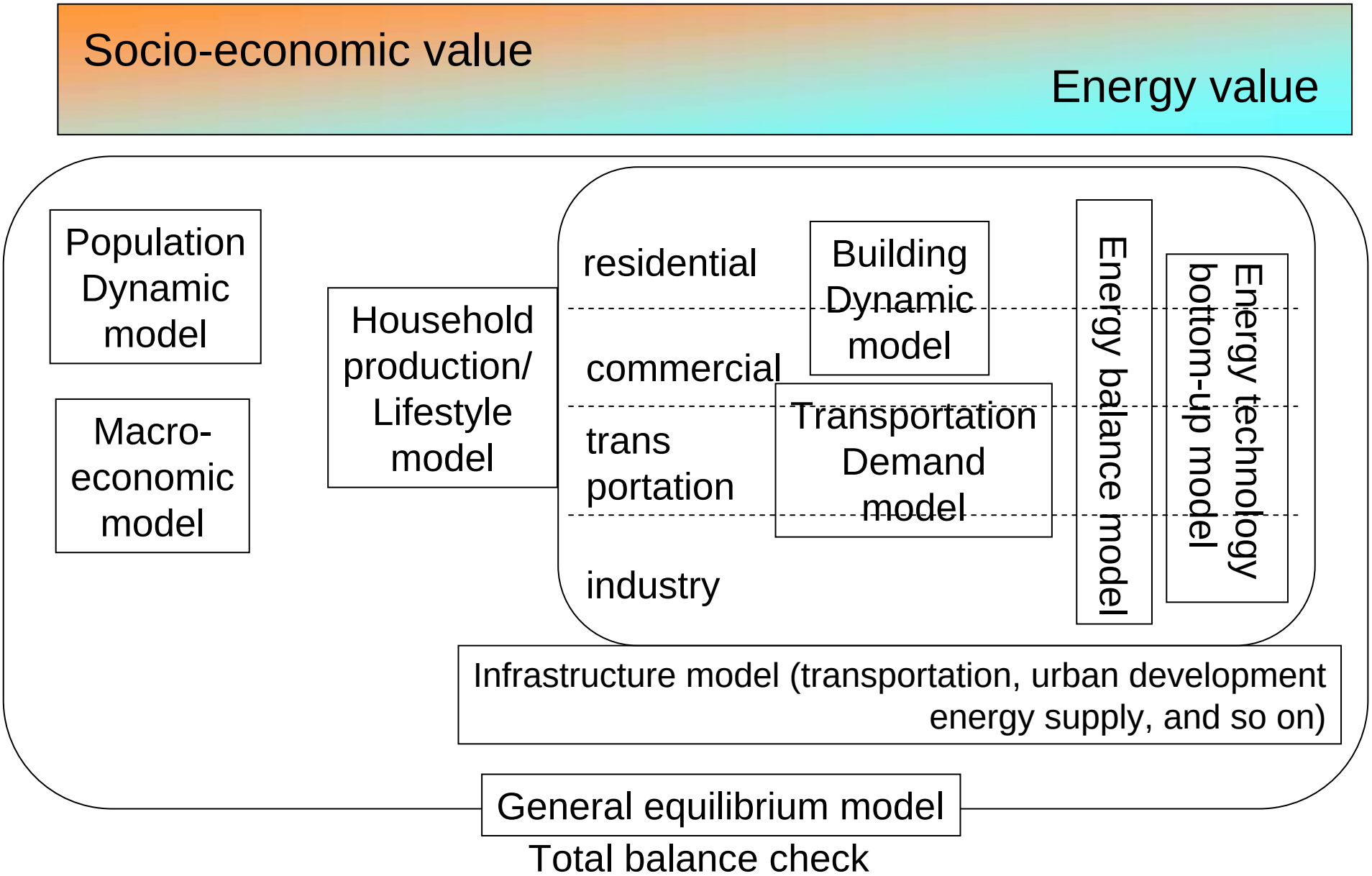


Public Transportation Priority System

Back-casting from future target world by the macro-economy and industry structure dynamics model



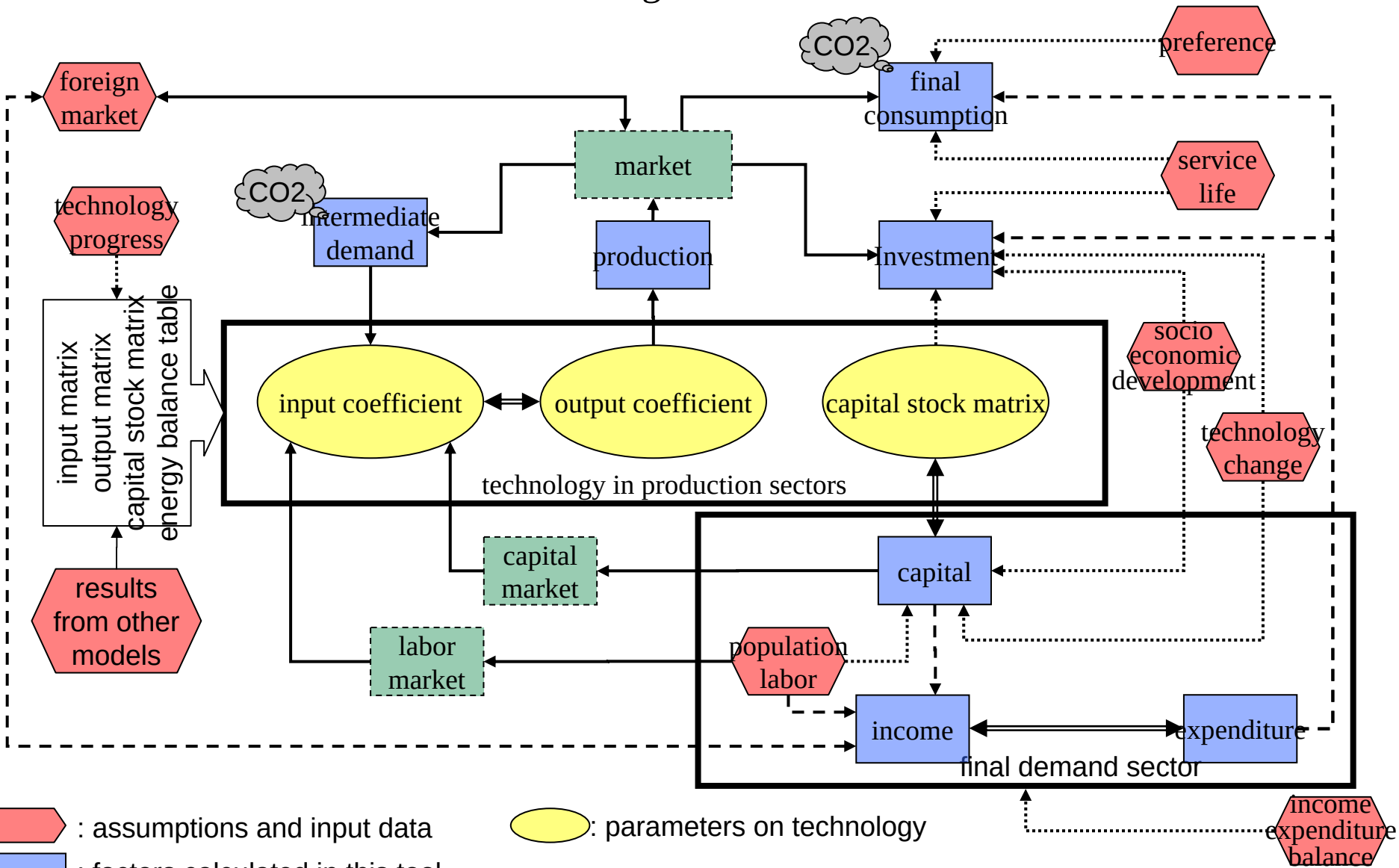

Trajectory
Archive data set of Energy Balance, Environmental Burden, and Cost
Snap shot model
Household production/Lifestyle model (identify effects of consumer behavior considering change of age/type of household/ environment-oriented preferences on energy service demand, transportation trip demand by econometric methods and estimate impacts of intervention scenarios)
Passenger/Freight Transportation demand model (parameter estimate of trip generation, modal share using statistics on person trip, traffic flow, freight flow and others. Service demand estimation assuming technology and behavior change)
Energy supply and demand balance model (adjusting seasonal/daily energy balance of electricity, heat, and hydrogen supply and demand considering infrastructure development)
Energy technology bottom-up model (technology selection of energy supply, conversion, consumption using econometric/engineering/management methods)
General equilibrium model (investigate feasibility, economic impacts considering general equilibrium of approx. 40 services including energy at service and labor market with support of other models)
Archive data set of Socio-economic change
Transition Model
Infrastructure/building dynamic model (econometric/engineering bottom-up approach for residential/nonresidential housing, construction and retirement of energy supply facilities)
Macro-economic model (econometric model for parameter estimate of supply-side potential productivity change, IS balance and calculation of BAU scenario)
Population dynamic model (cohort model including birth/death, inter-regional/national migration)
Archive data set of Technology development and diffusion
Scenario, Storyline
Technology development schedule for energy use, production, and consumption (R&D plan, expert judgment)
Socio-economic scenario, Intervention scenario



Models for 2050 scenario development

CGE model

Image of tool



Population dynamic model

Population (Period T-1)

Survivorship rate

Province-wise survivorship rate

Province-wise population (T-1)

Birth rate

Province-wise birth rate

Int. Migration rate (Japanese)

Province-wise migration rate

Int. Migration Rate (Outsider)

Province-wise Population (T)

Population (Period T)

Climatic Div. share

Landuse Cls. share

Province-wise headship rate

Headship rate

Landuse Cls. -wise household number (T)

Passenger / Freight transportation model

Household Number (Period T)

Province-wise household Number (T)

Climatic Div-wise household number (T)

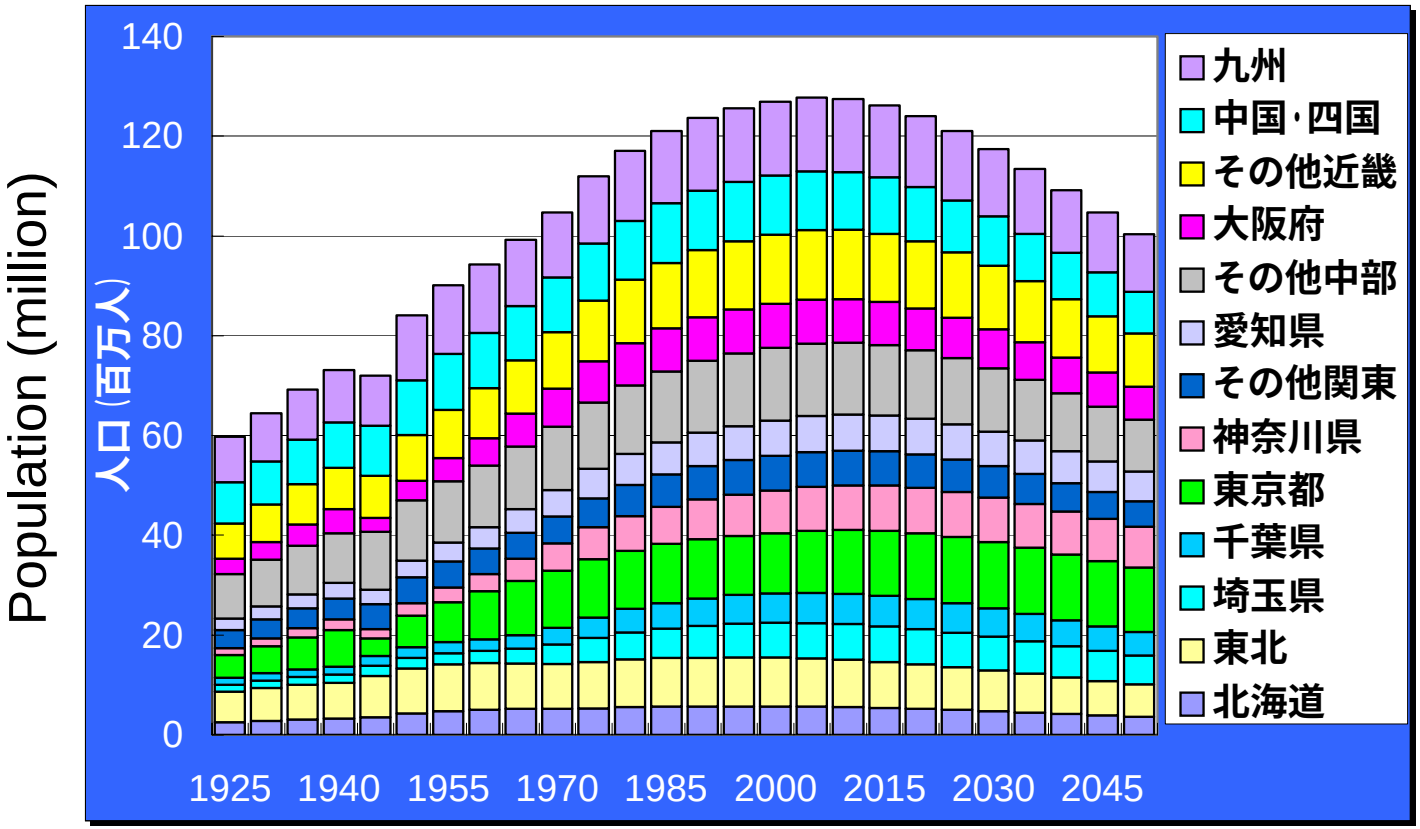
Energy service demand model: Residential sector

Landuse (10)：
i. Three largest metropolitan area：
  i-1. Cities
  i-2 Lowland farming
  i-3 Intermediate & mountainous area
ii. Hub cities
  ii-1. Cities
  ii-2 Lowland farming
  ii-3 Intermediate & mountainous area
iii. Prefectural hub cities
iv. Others
  iv-1. Cities
  iv-2 Lowland farming
  iv-3 Intermediate & mountainous area

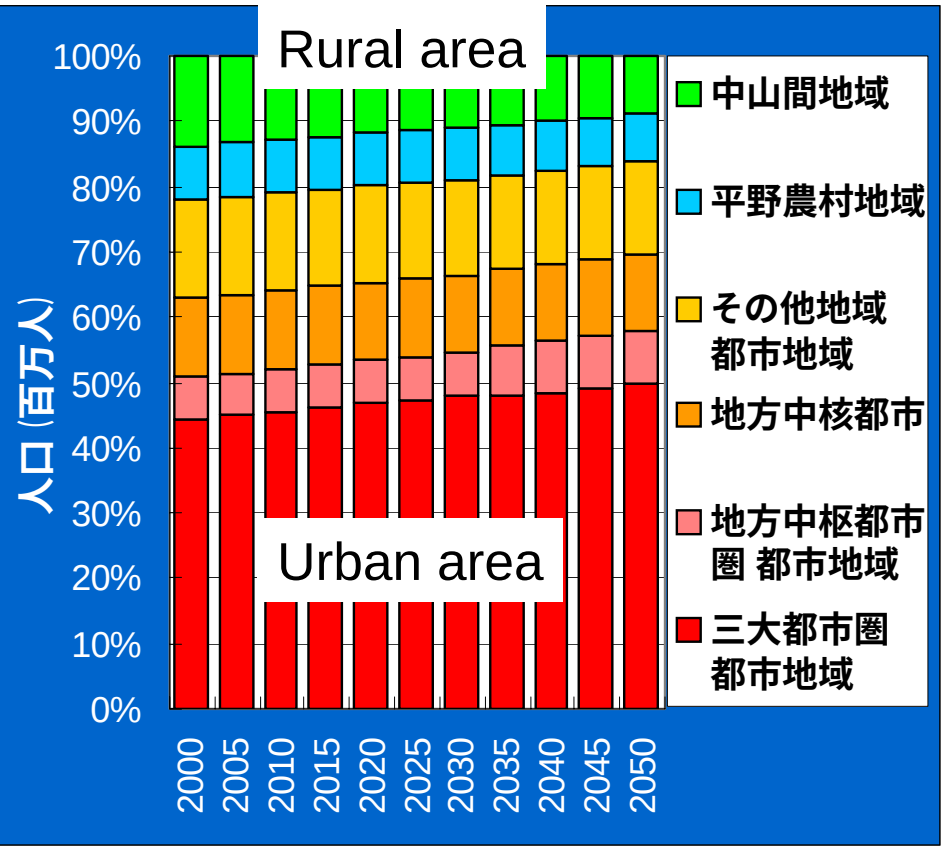
Climate(6)：
i. Hokkaido,
ii.Aomori, Iwate, Akita
iii.Miyagi, Yamagata, Fukushima, Tochigi, Nagano, Niigata
iv.Ibaragi - Kumamoto （Except **I ～III, V ,VI**）
v.Miyazaki, Kagoshima
vi.Okinawa

：Endogenous Variables
：Exogenous Variables
：Data flow
：Consistency assurance

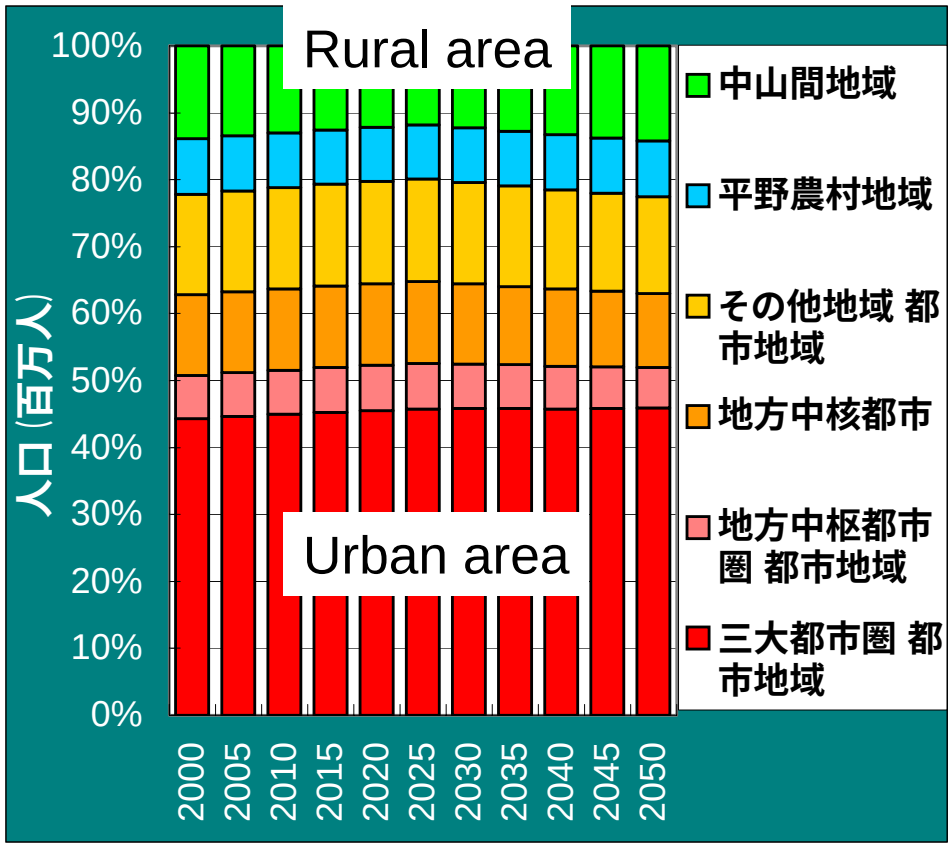
Population estimation (Japan total)



Population estimation (migration rate change case)

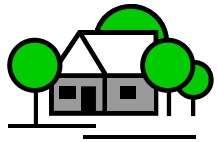


Extraportation of current trend



Rural shift after 2025

Building dynamic model (housing)



●Type
Detached house,
Collective house

●Construction
Wooden construction,
Steel framed reinforced concrete structure,
Steel structure,
Others

●Insulation level
Conventional,
Former standard,
New standard,
Next-generation standard

∗ Number of housing units (year T-1)

Equilibrium number of housing units (year T-1)

Empty rate

Number of households by family

Population dynamic model

Real disposable income, Land price index, Long-term interest rate

Number of new housing units (year T)

Residual ratio

Rebuilding rate

shares by prefecture

Shares by insulation level

Shares by type, construction

Ideal housing standard by family

Average area

Target area, Unit cost of building work

∗ Residual number (year T)

∗ Number of new housing units (year T)

Macro economic model

Unit cost of building work

∗ Number of housing units (year T)

Real private housing investment for addition and betterment (year T)

Real private housing investment for new construction (year T)

Energy service demand model, residential

∗means estimation by prefecture(47), by climate division(6), by type(2), by construction(4), by insulation level(4).

: endogenous variable

: exogenous variable

: Data flow

: Consistency assurance

Energy service demand model, residential

: endogenous variable
: exogenous variable
: Data flow
: Consistency assurance

Number of households [Climate division]

Population dynamic model

Average area [Climate division]

Insulation level [Climate division]

Building dynamic model (housing)

Energy price

Real disposable income

Macro economic model

Heating degree-day

Cooling degree-day

Female worker rate

Retirement rate

Diffusion rate of air conditioner

Scenario

Estimating module

Service demand for warming

Service demand for cooling

Service demand for hot water

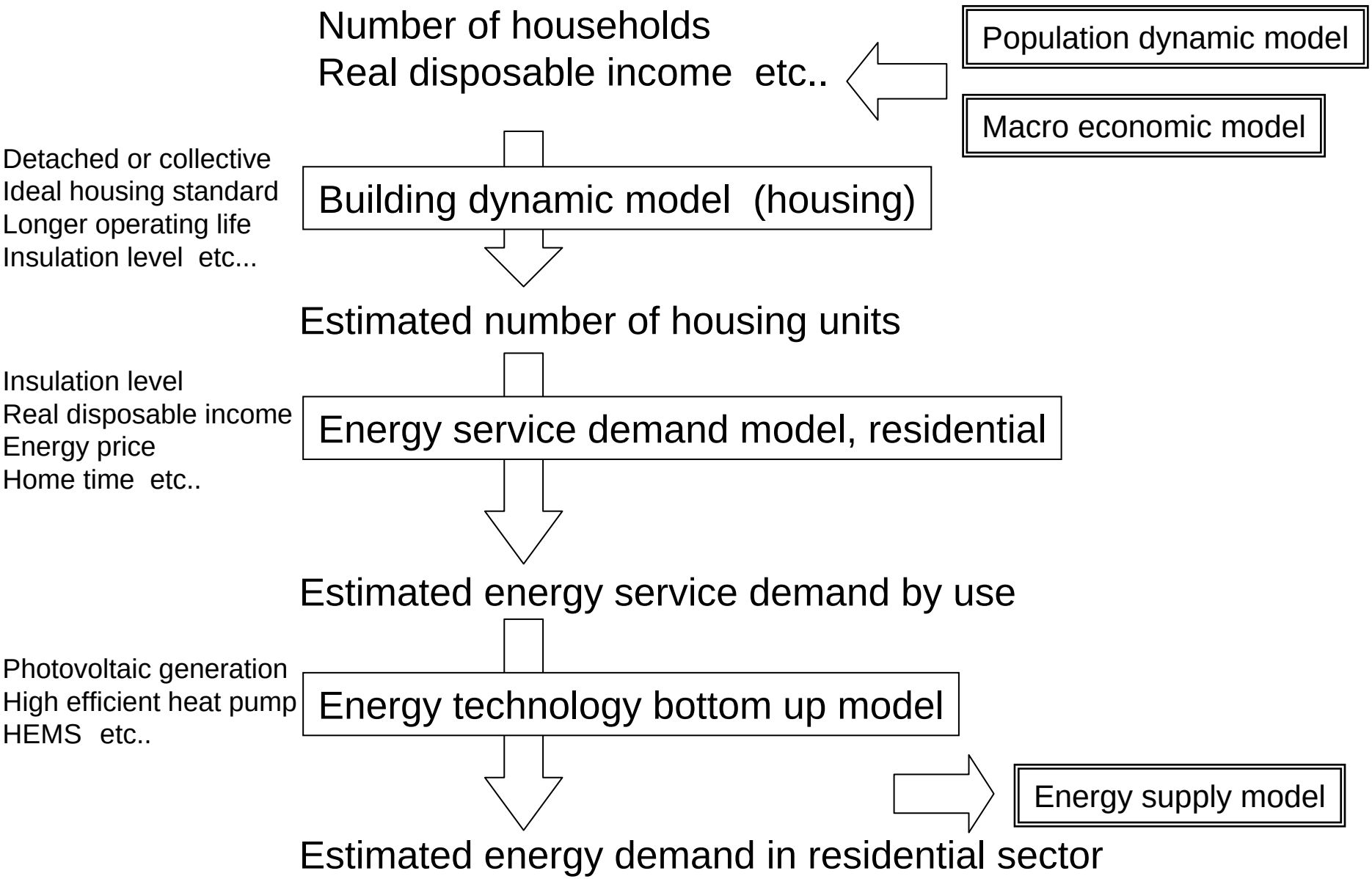
Service demand for cooking

Service demand for lighting

Service demand for other appliances

Energy technology bottom up model

Residential sector modeling



Passenger Transportation Model

Population [Aviation, Area]

License

Employment

Population dynamic model

Macro economic model

Population [Aviation, Area]

Population [Aviation]

Trip Generation Coefficient

Modal Share

Average Trip Distance

Trip Generation Coefficient

Modal Share

Average Trip Distance

Intra-Area Transportation

Inter-Area Transportation

Net-Total Conversion ratio

Passenger Transportation [Persons-km]

Intra-Area Transportation

Inter-Area Transportation

[Passenger Transportation Model]

- Calculate future passenger transportation demand change associated with population dispersal
- Exogenous Variables;
  - Trip Generation Coefficient,
  - Service Share by Facilities,
  - Average Trip Distance

●Intra-Area Transportation（Based on Nationwide PT Survey）

Trip within community

-Work: Commute to office

-School: Commute to school

-Return: Return home

-Business：Trip for Business

-Private：Shopping & Others

●Inter-Area Transportation（Based on Japanese Travel Survey）

- Trip Between community
- Business：Business Trip

-Tourism：Travel for sightseeing

-Private：Homecoming

※Exclude commute to office/school and return

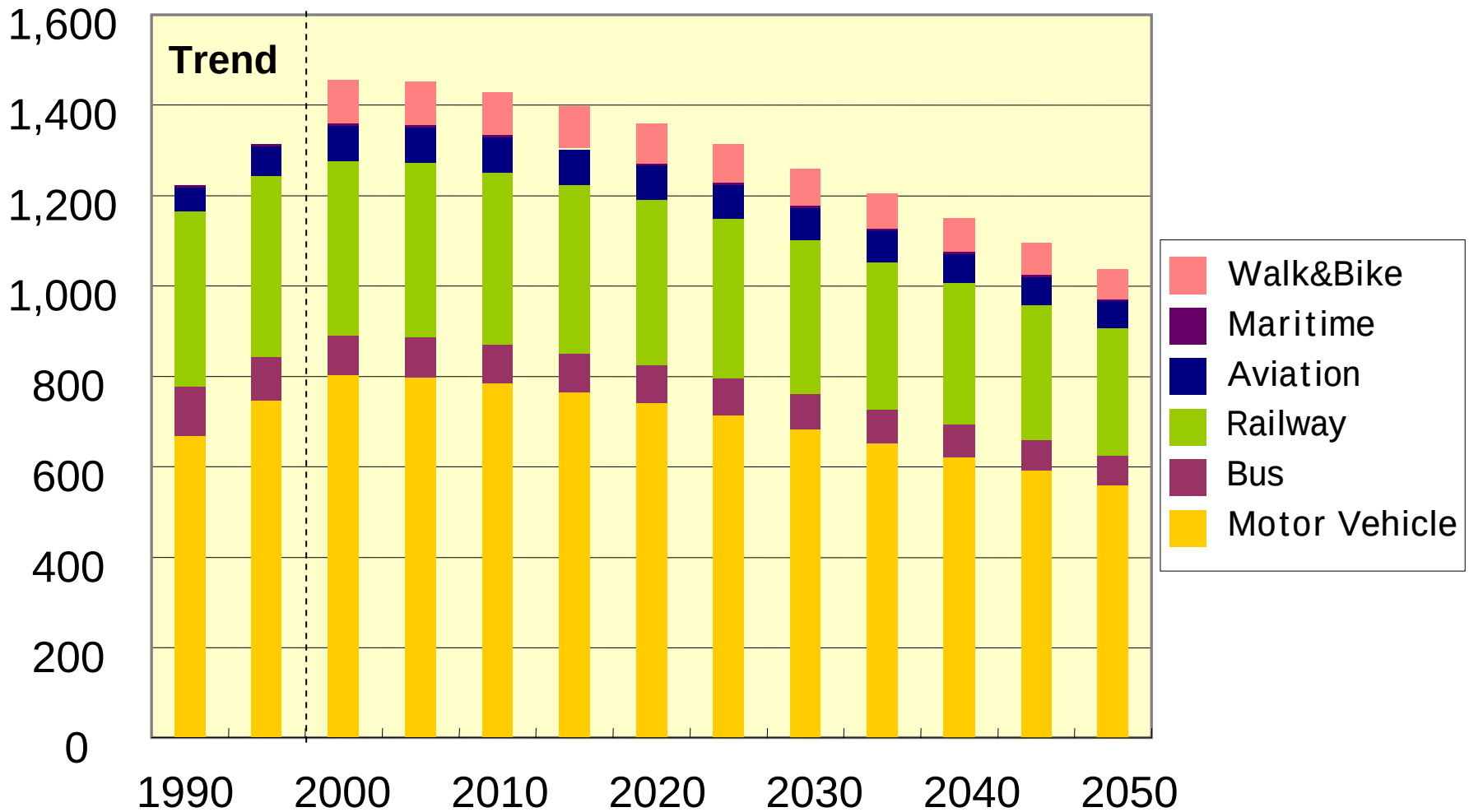
：Data Flow

：Consistency assurance

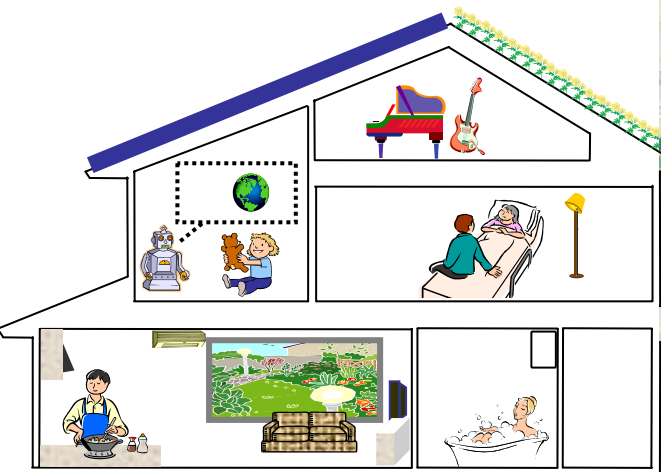
：Endogenous Variables

：Exogenous Variables

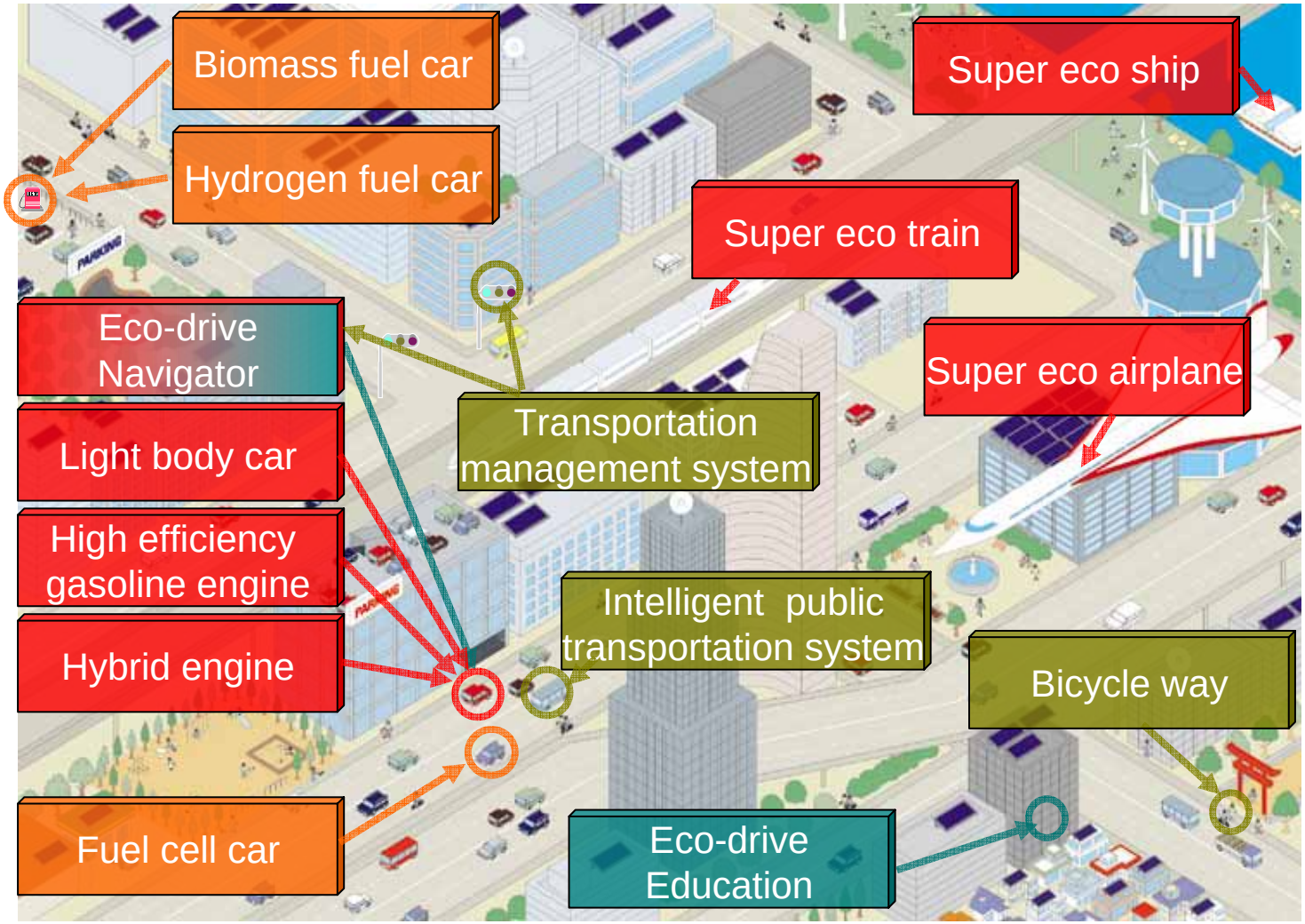
Simulation Results (Billion Person-km)



Snapshot of 2050 Japan
70% reduction scenario



2050 Transportation



Compact city

Green logistics

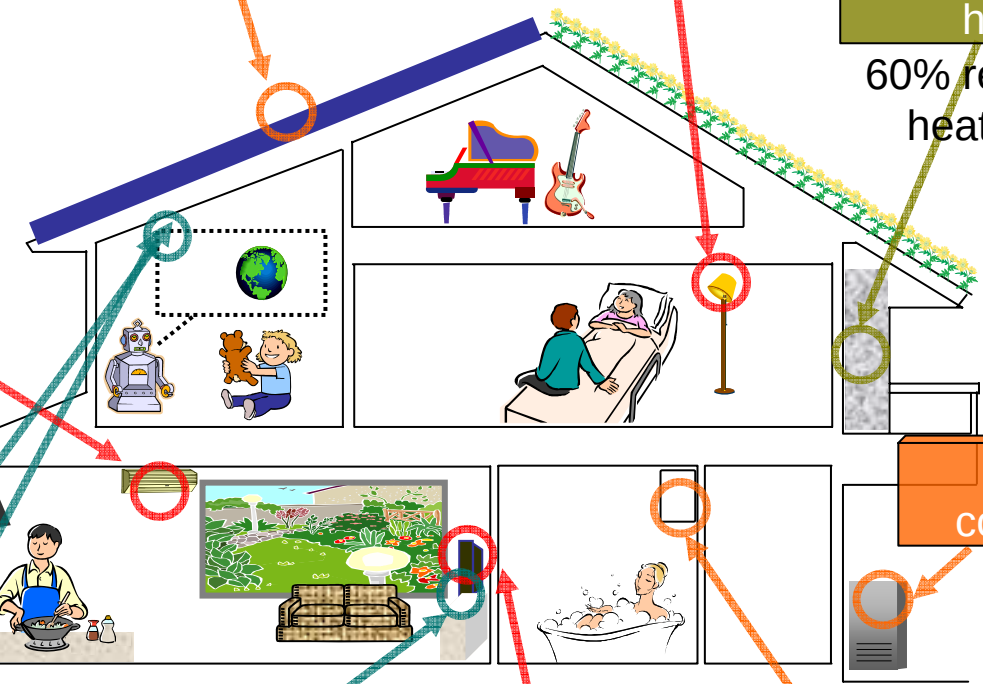
Efficient vehicle

New energy

Infrastructure

Eco-drive

2050 Residential



PV on roof

3-4kW

LED light

Light eff=300%

Heat insulation house

60% reduction of heat demand

10-20% reduction

Super high efficiency air-conditioner

COP=8

Fuel cell cogeneration

Environment Education

Eco-life Navigation

10-20% reduction

HEMS (Home Energy Management System)

Stand-by energy reduction

33% reduction

Hot water supply by heat pump or solar heating

COP=5

Efficient use

New energy

Infrastructure

Eco-lifestyle

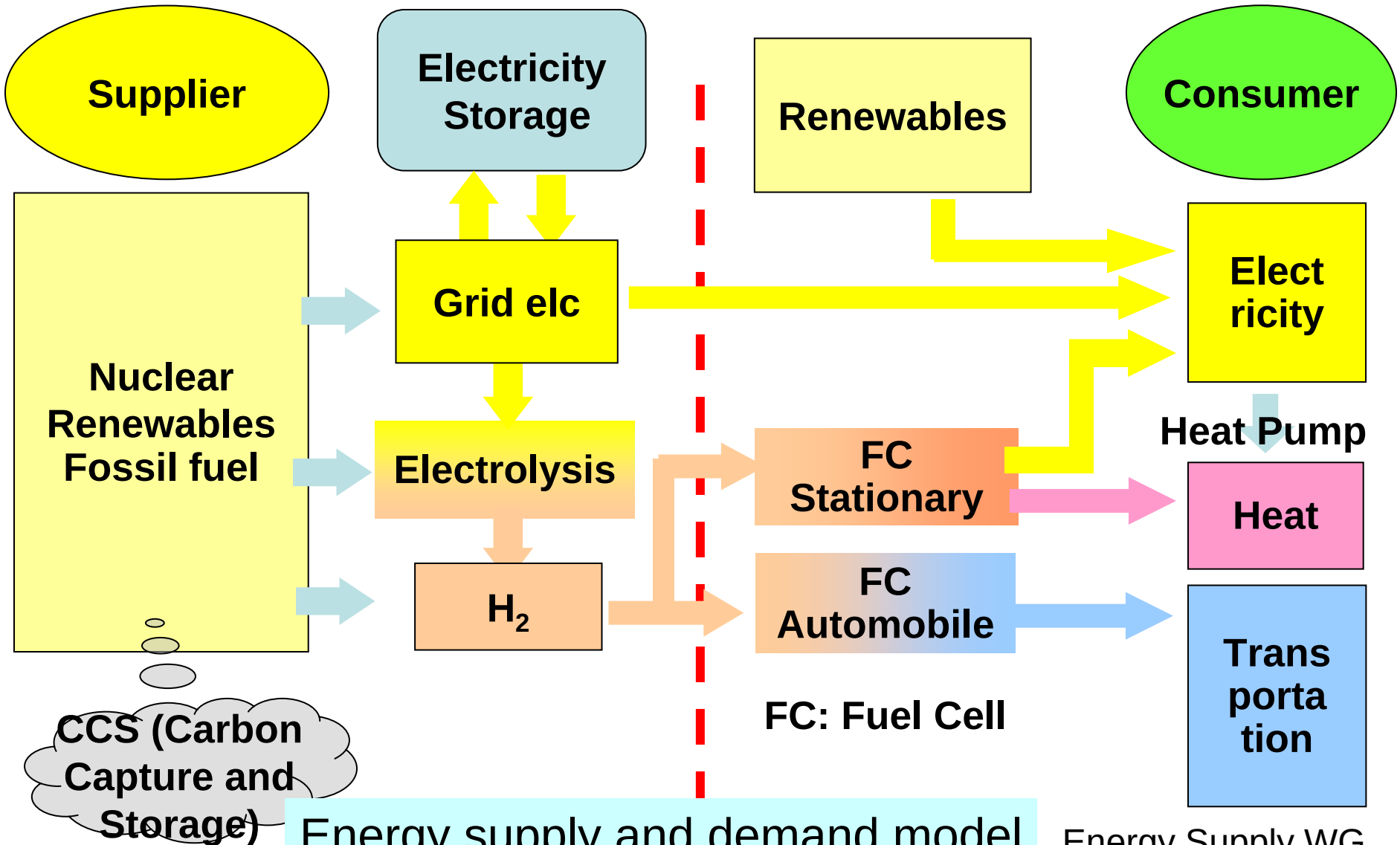
70% reduction scenario: demand side

・Population: 100.5 million, GDP：1137trillion yen (twice as 2000 level)
・GDP growth rate: 1.5%/yr (per capita GDP growth rate: 2%/yr)

Sector	Service	2020-2050
Residential	Cooling and Heating	Population decrease, House space increase →
	Hot water, cooking	Population decrease ↘
	Lighting	Population decrease, House space increase →
	Others	Population decrease ↘
Commercial	Cooling and Heating	Commercial sector increase ↗
	Hot water, cooking	Commercial sector increase ↗
	Lighting	Commercial sector increase ↗
	Others	Commercial sector increase ↗
Transportation	Automobiles	Population decrease ↘
	Railway, Air, Sea	Population decrease ↘
Industry	Production	Past trend

CGE, Macro economic, Population dynamics
Household production, Building dynamics, Transportation demand

Possible Energy Supply System for the Future

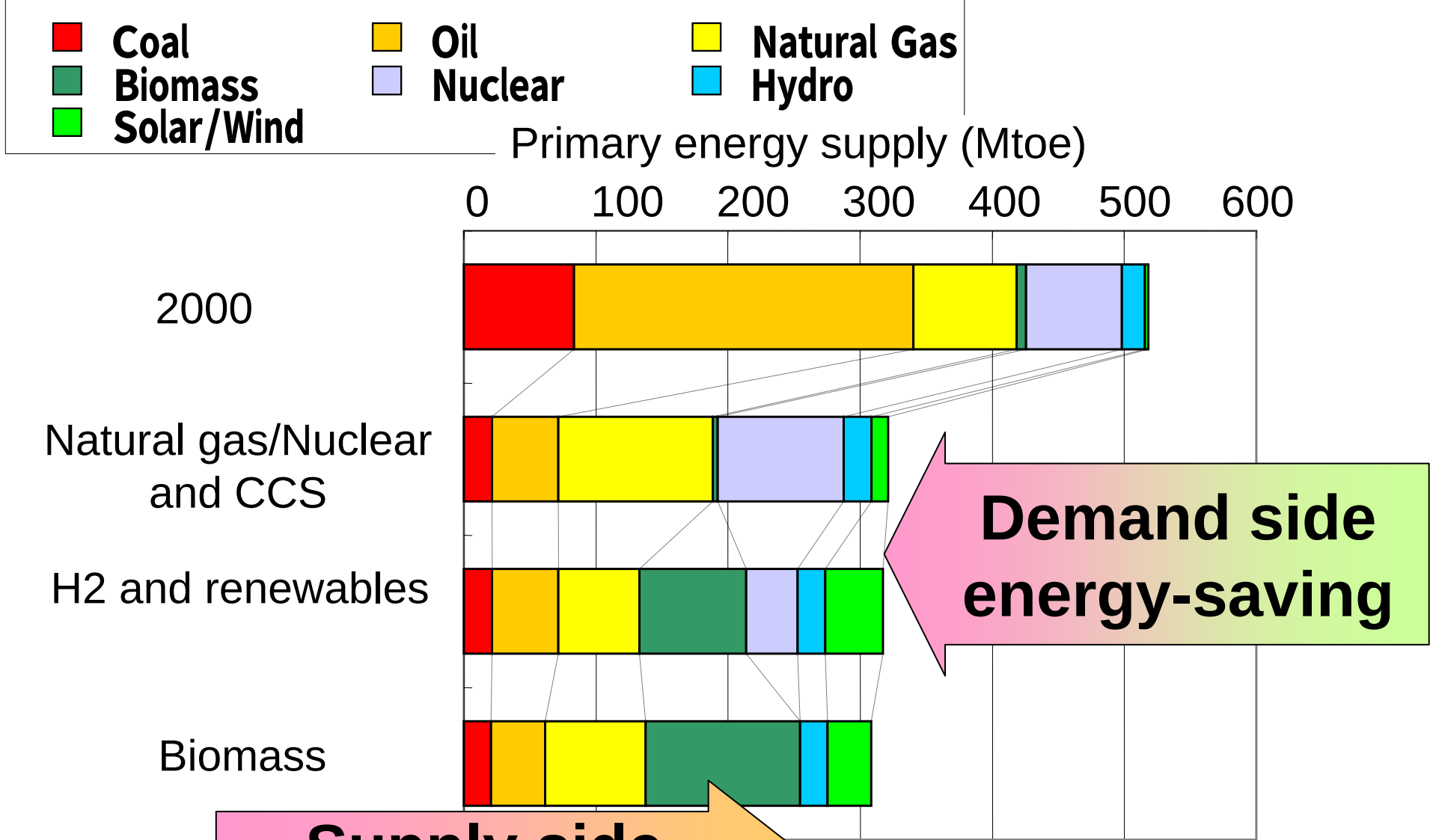


Energy supply scenario

1. Natural gas/Nuclear and CCS scenario
   - Nuclear energy in electricity mix increase (50%)
   - FCV diffusion (100%)
   - H2 production by natural gas with CCS
2. H2 and renewables scenario
   - No additional nuclear plant (max lifetime = 60yrs)
   - FCV diffusion (100%)
   - H2 production by biomass and wind
   - biomass energy import
3. Biomass scenario
   - Nuclear phase-out
   - No H2, bio-fuel+hybrid
   - large amount of biomass energy import

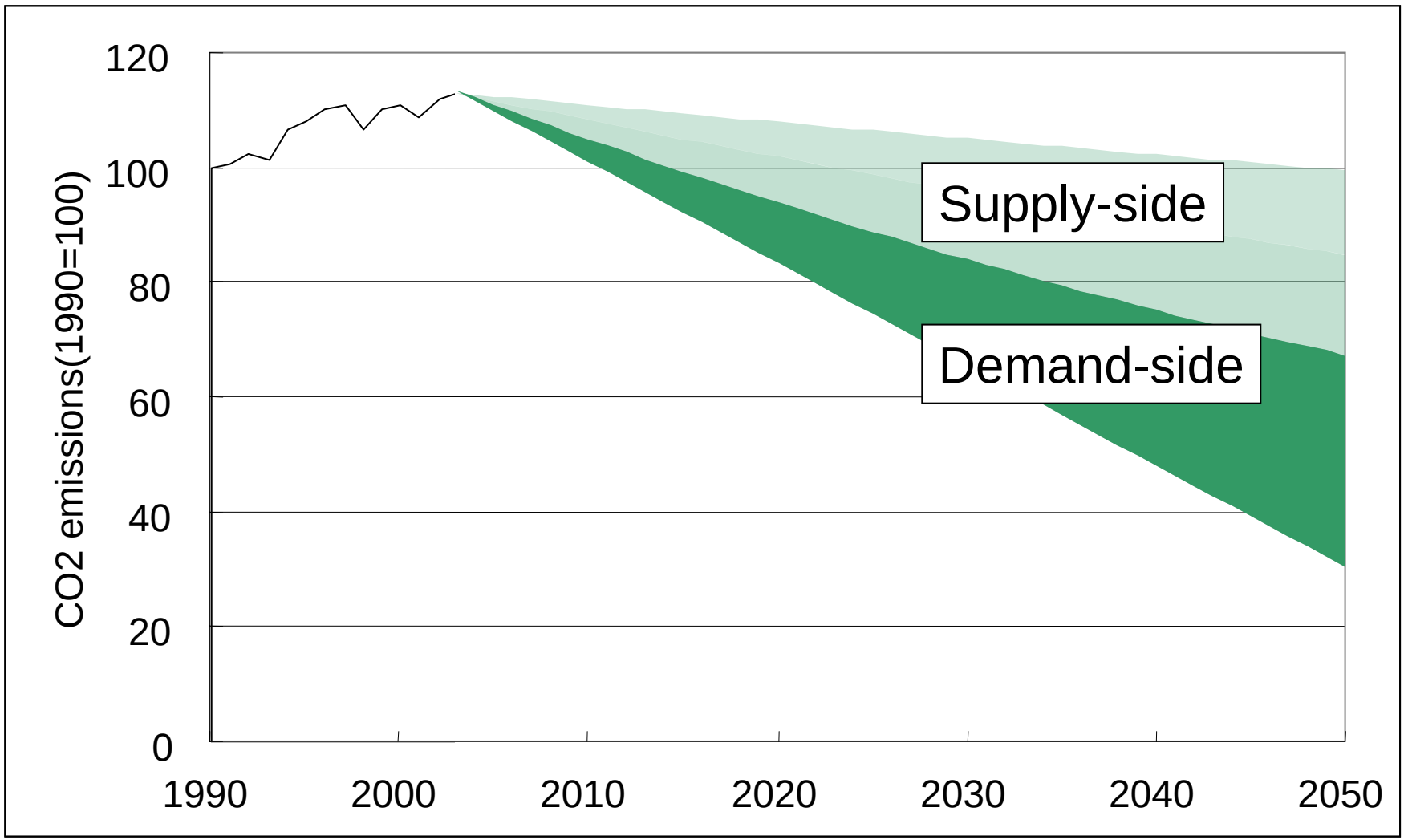
	Case1	Case2	Case3
Nuclear share in Elc system.	50%	24% *1	0%
CCS	30MtC/yr	–	–
FCV diffusion rate	100%	100%	–
FC in residential sector	10%	10%	–
H2 source	Natural Gas	Biomass +Wind	–
Wind power (GW)	2.5	35	5
Solar heating share	10%	70%	70%
PV (GW)	42	86	86
Biomass Production (Mtoe)	3.9	24	24
Biomass Import (Mtoe)	-	57	93

*1：Including nuclear plants in current plan, 60yrs lifetime



Preliminary calculation for primary energy mix to achieve 70% CO2 reductions in 2050

Supply-side and Demand-side countermeasures



Key messages 1

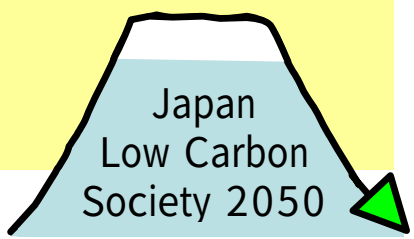
1. **Large amount of GHG reductions are required**

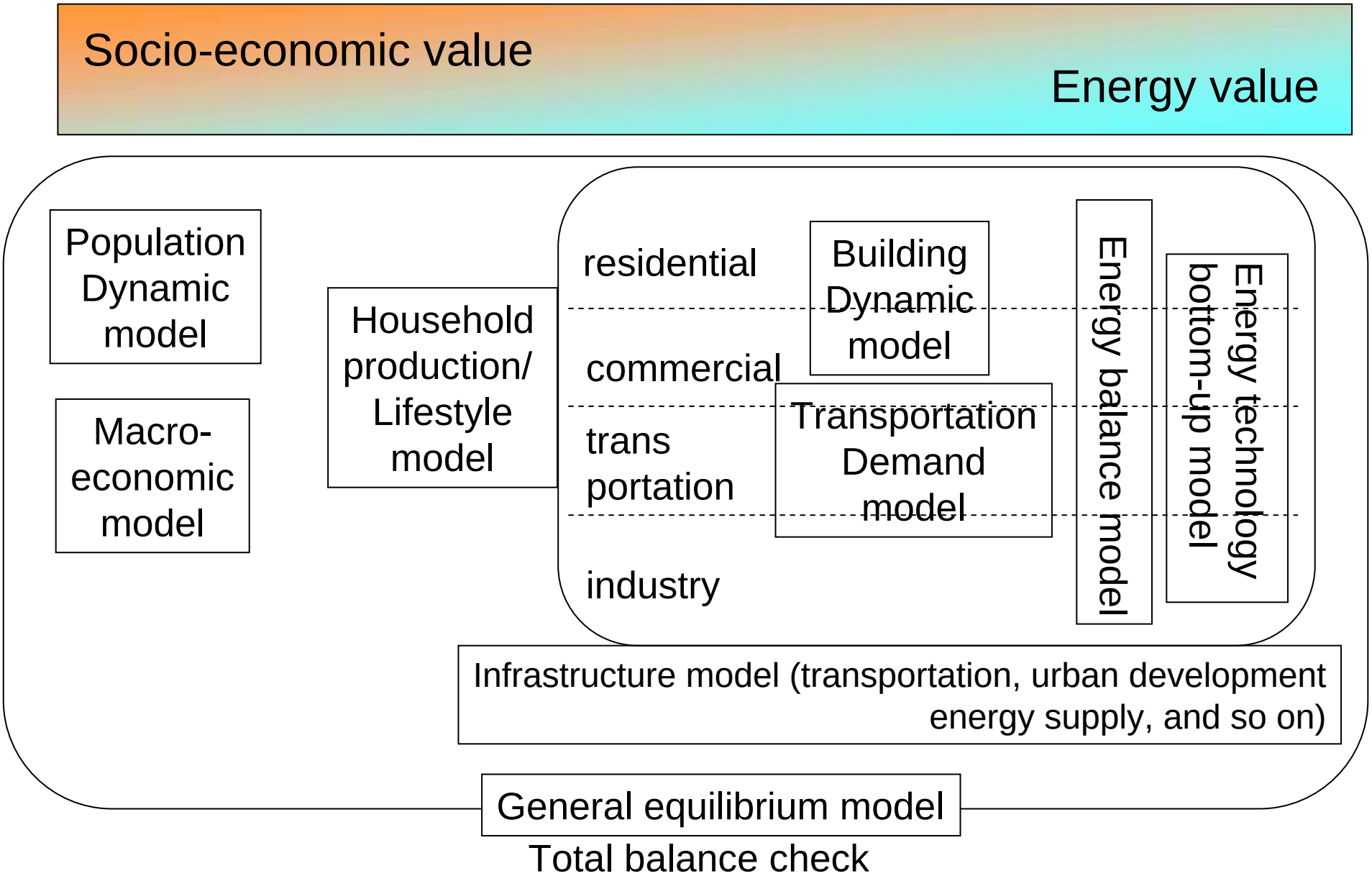
   It is estimated that around 50% GHG reductions in 2050 are required to control temperature raise below 2C.

2. **Both supply-side and demand-side reductions are required**

   Well mix of technology development, diffusion of GHG reduction options by behaviors, institutions which help GHG reduction

3. **It's time to action. It takes time to change social system, infrastructure… Our experience can apply to Asia-Pacific countries.**





Models for 2050 scenario development

Key messages 2

This model framework can apply to different environmental problems in Asia-Pacific countries, such as material recycling in China, ecosystem conservation in India, air pollution in Thailand.

- **SDB (Strategic DataBase) stores various countermeasures for sustainable development**

2. **Back-casting is effective to seek the pathway toward favorable visions**

3. **CGE is the center model to assess consistent scenario**