

# Scenarios/Modeling/Backcasting: Tools and examples of low-carbon cities

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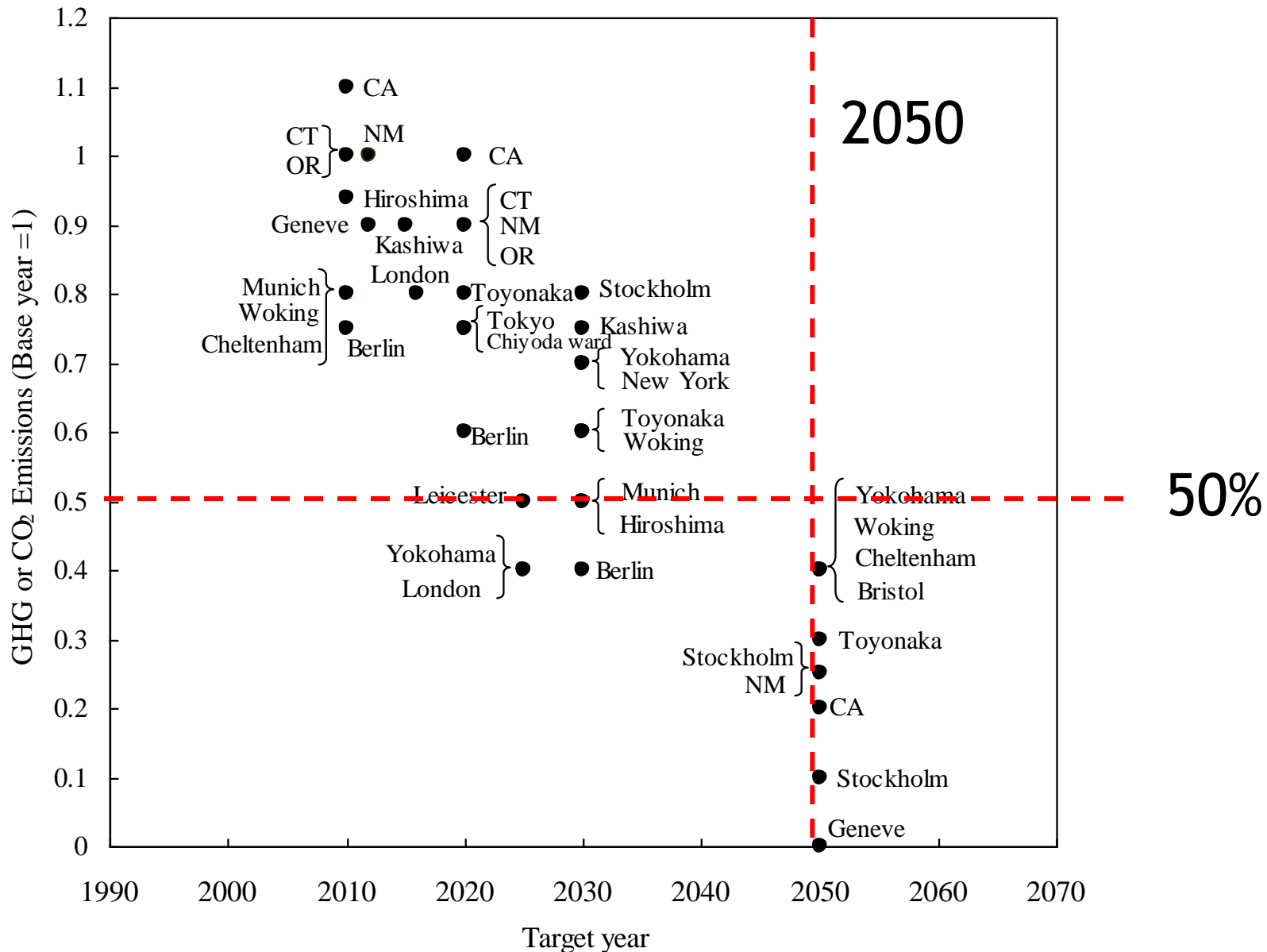
Sustainable and Low-carbon development in Indonesia and Asia: Dialogues  
between policy makers and scientists

IPB International Conference Centre, Bogor, Indonesia

# Contents

- Local Low-carbon society targets
- Methodology
- AIM tools for Local LCS
  - Extended snapshot tool (ExSS)
  - Socio-economic design template (SED template)
  - Backcasting tool (BCT)
  - Analytic hierarchy process tool (AHP tool )
  - Input-Output table reconciliation tool (IOTR)
- An example in Shiga prefecture

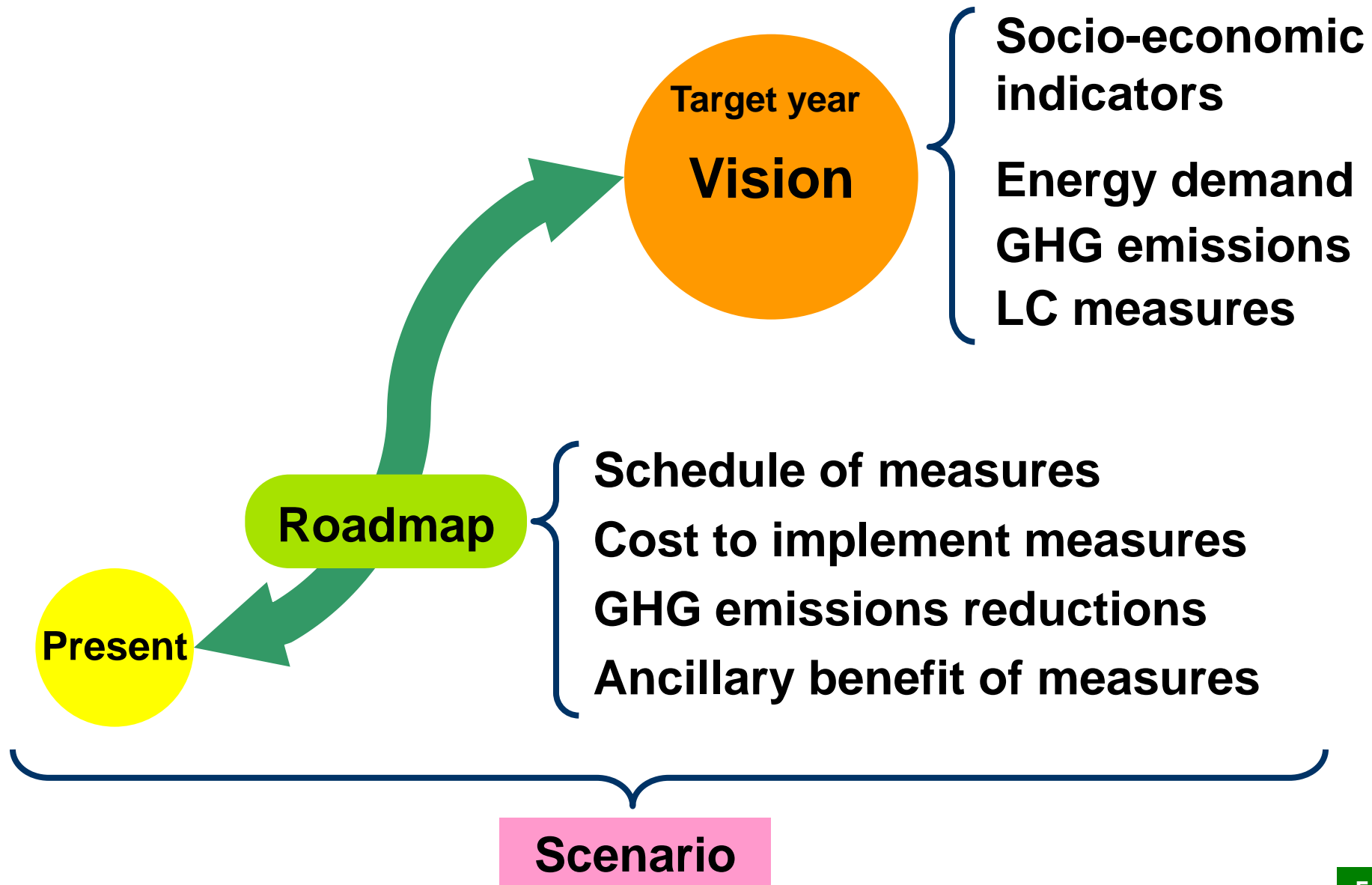
# Local low-carbon society targets



# A methodology to develop Local low-carbon society scenarios

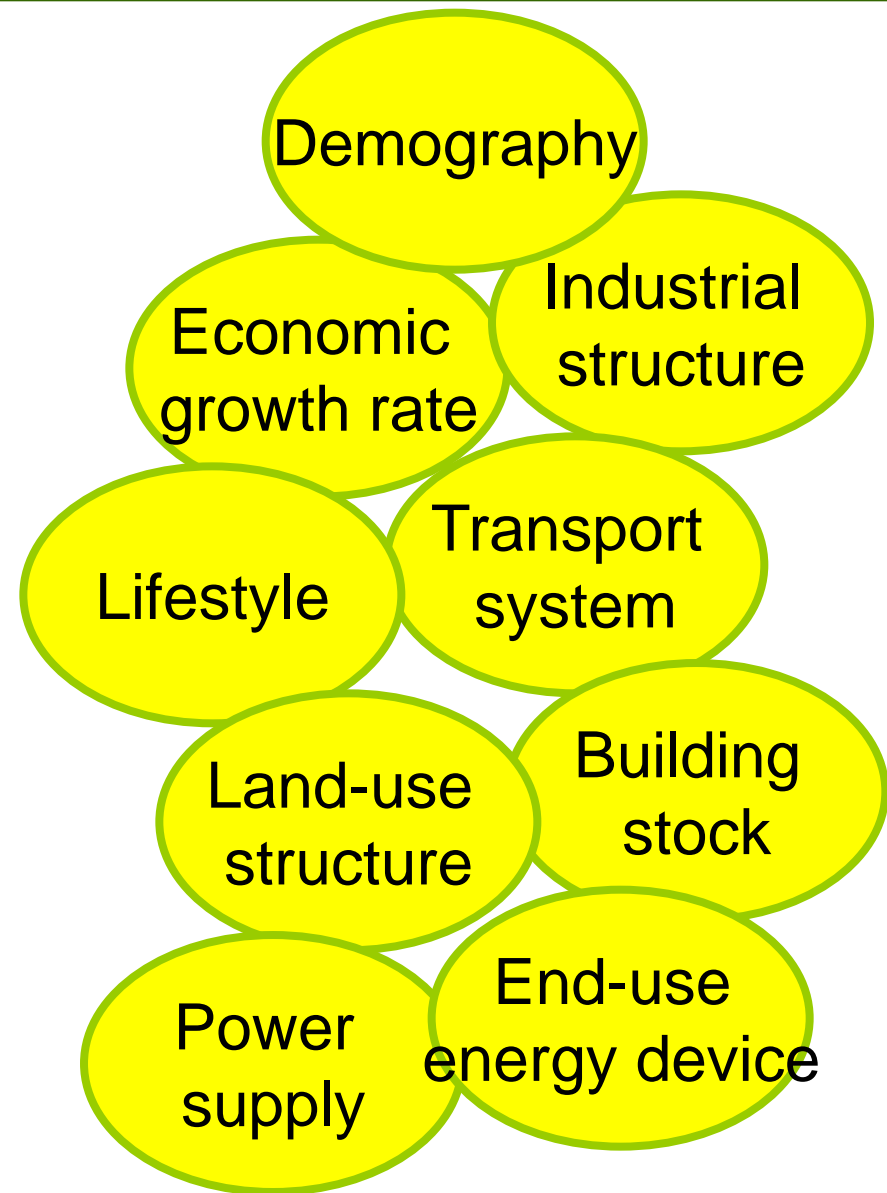
- Backcasting approach
- “Designing a future”
- Procedure of the methodology

# Backcasting approach

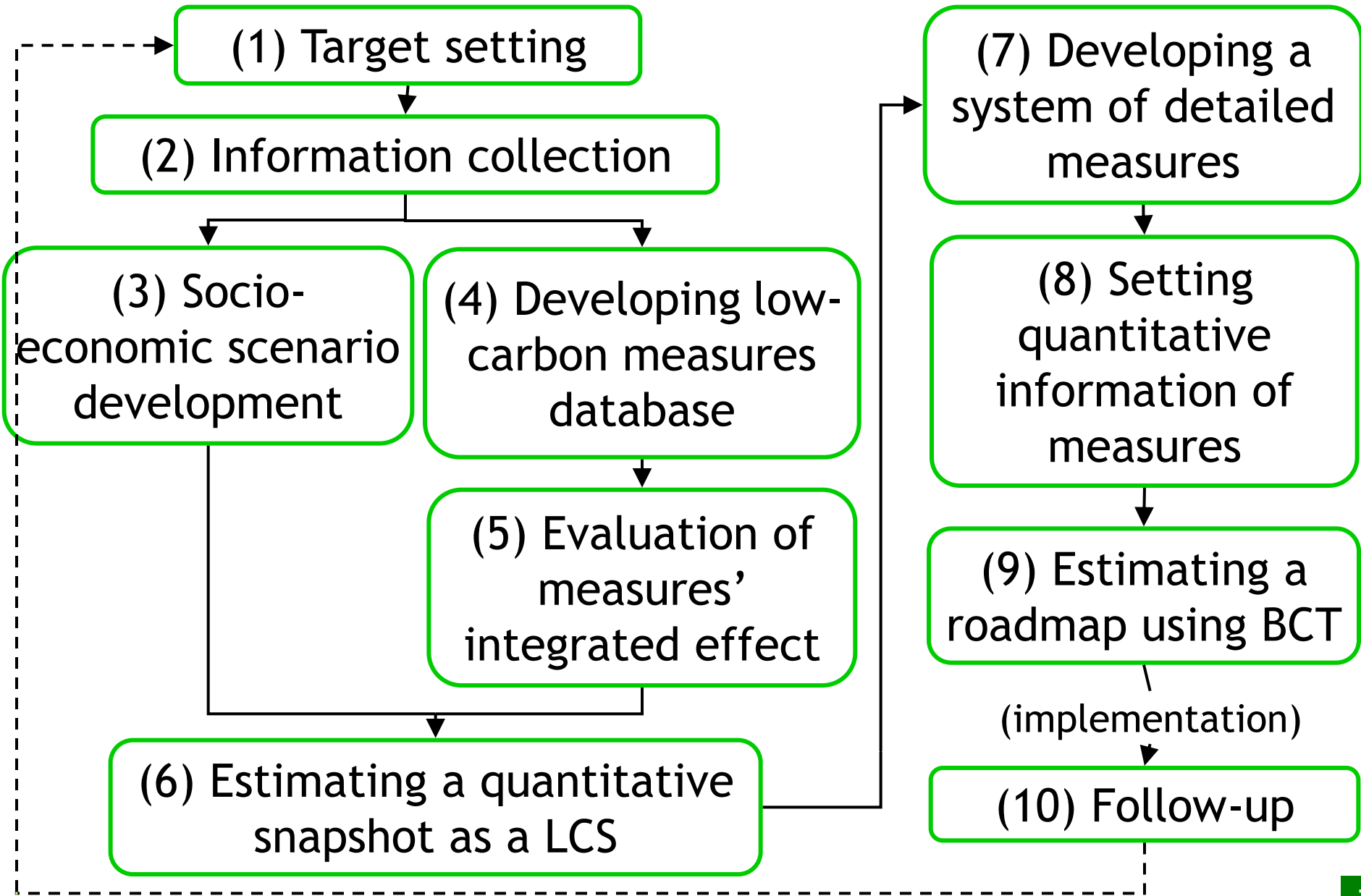


# Designing a future

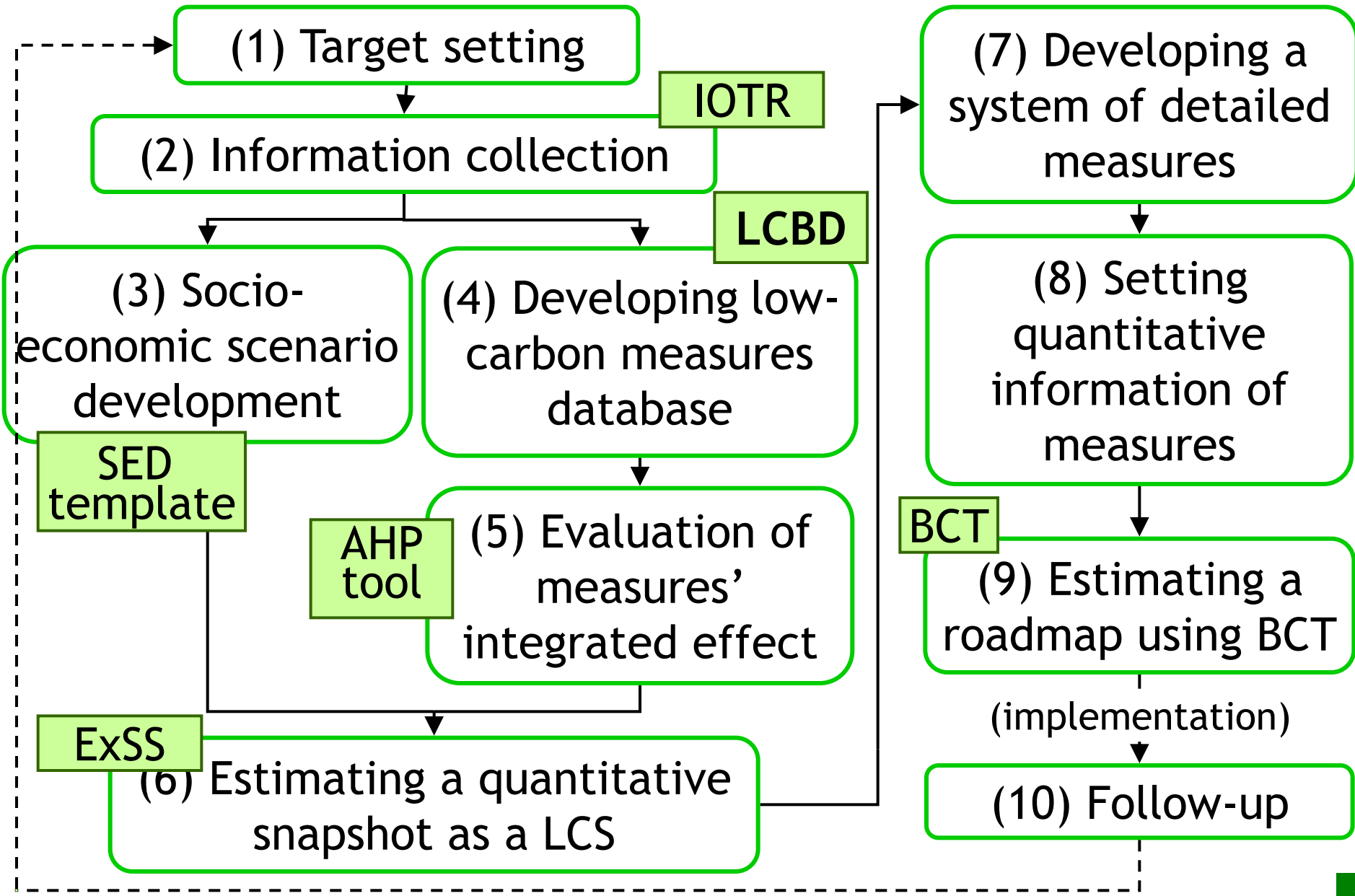
- GHG emission is related to most of the activities in the society.
- Required low-carbon measures strongly depends on the situation.
- Therefore, consider both;
  - situation of the society as a whole
  - detailed technologies used in the society.
- Follow-up (e.g. every five years)



# Procedure



# AIM tools





# Problems and tools

IO table is not available.



**IOTR**

IO table  
reconciliation tool.

How to assume future  
society?



**SED  
template**

Socio-economic  
design template.

What kind of measures  
are available?



**LCBD**

Low-carbon  
measures database

Which measure is more  
preferable than others?



**AHP  
tool**

Analytic hierarchy  
process tool.

How to calculate a  
quantitative vision?



**ExSS**

Extended  
snapshot tool.

How to calculate a  
schedule of measures?



**BCT**

Backcasting tool.

# Problems and tools

## IOTR

**IO table reconciliation tool** estimates an IO table from available information. Using cross entropy method it estimates a balanced matrix based on national IO table and local economic statistics.

## SED template

**Socio-economic design template** assumes future image and sets parameters in a Q&A style. Users answer the questions and assume direction first, and then set the volume of parameters.

## LCBD

**Low-carbon measures database** contains information of measures available in the target year. Among them are: energy-efficient technologies, renewable energy, transport structure management, etc.

## AHP tool

**Analytic hierarchy process tool** compares measures by multi-criteria and estimates integrated index. The criterion includes health, security & safety, transport convenience, cultural value, land scape, etc.

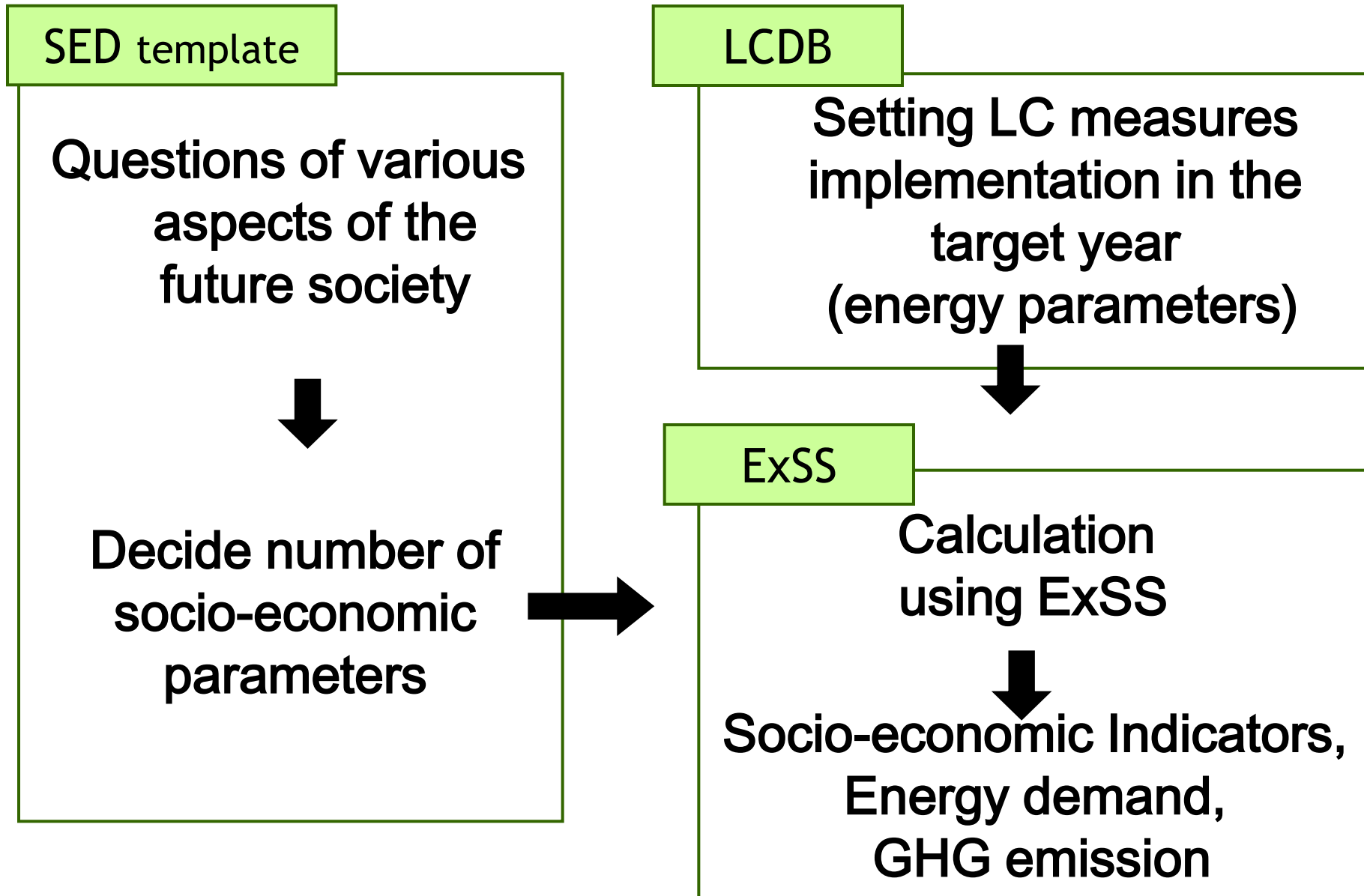
## ExSS

**Extended snapshot tool** estimates socio-economic (SE) activity, energy demand, emissions and introduction of Low-carbon measures in future. SE activity includes population, industry, transport, and land use.

## BCT

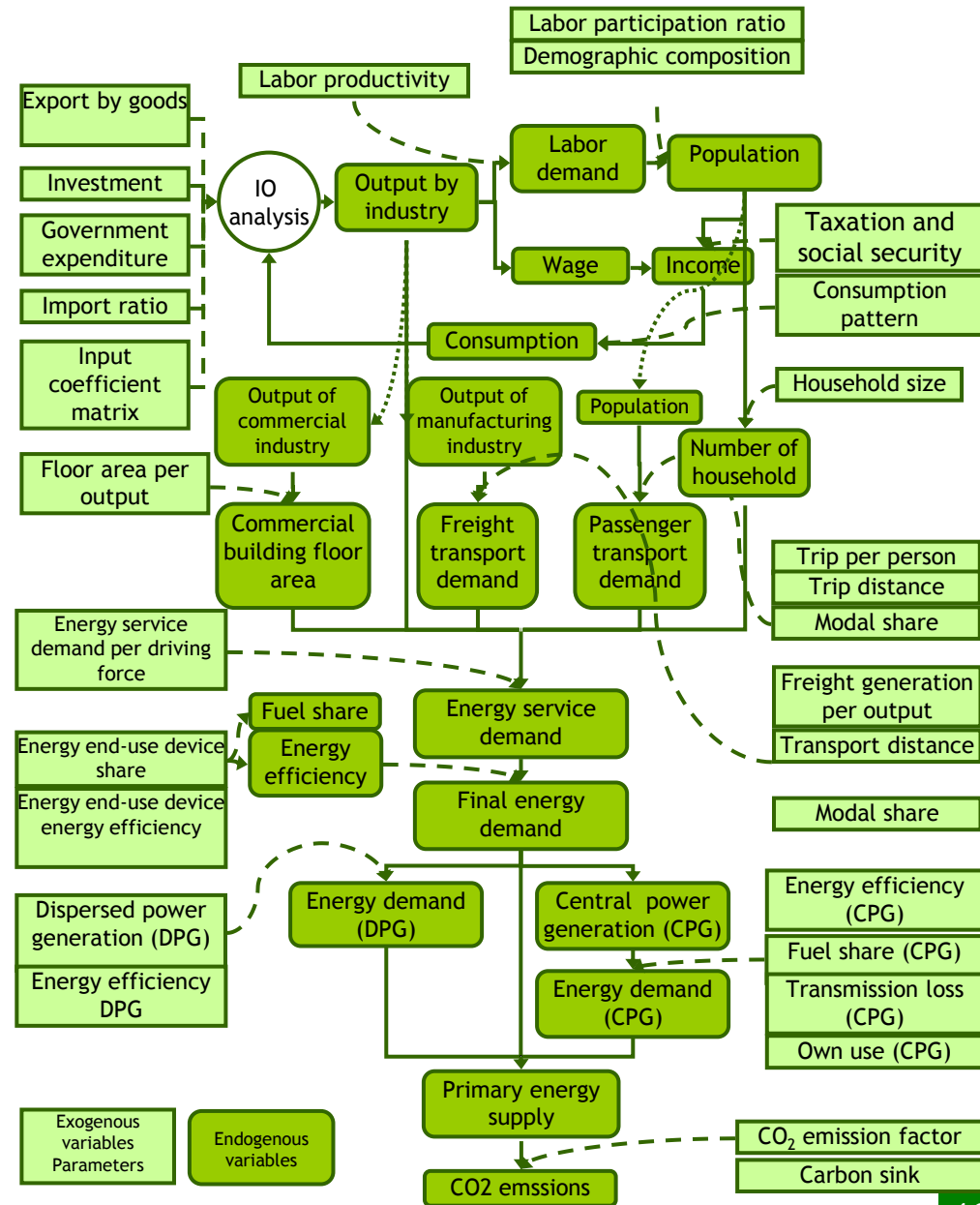
**Backcasting tool** estimates a schedule of detailed measures under resource and time constraints. It also considers integrated index estimated by AHP tool, and maximize their positive effect.

# SED template, LCDB and ExSS



# ExSS model structure

- A static model (single year) consists of simultaneous equations
- About 6000 endogenous variables
- Formulated by GAMS (general algebraic modeling system)
- Input and Output are MS Excel spread sheets.



# Backcasting tool

- Based on constraints and input information of measures, BCT estimates,
  - Schedule of measures
  - Emission reduction pass
  - Annual input resource.
- It also considers time needed for R&D, developing financial mechanism, social decision making, etc.
- Integrated effect is also considered.

# Backcasting Tool

Commercial year of technologies

Required resource input (human & financial)

Necessary years to implement

Direct GHG emission reductions

Emission reductions

Schedule

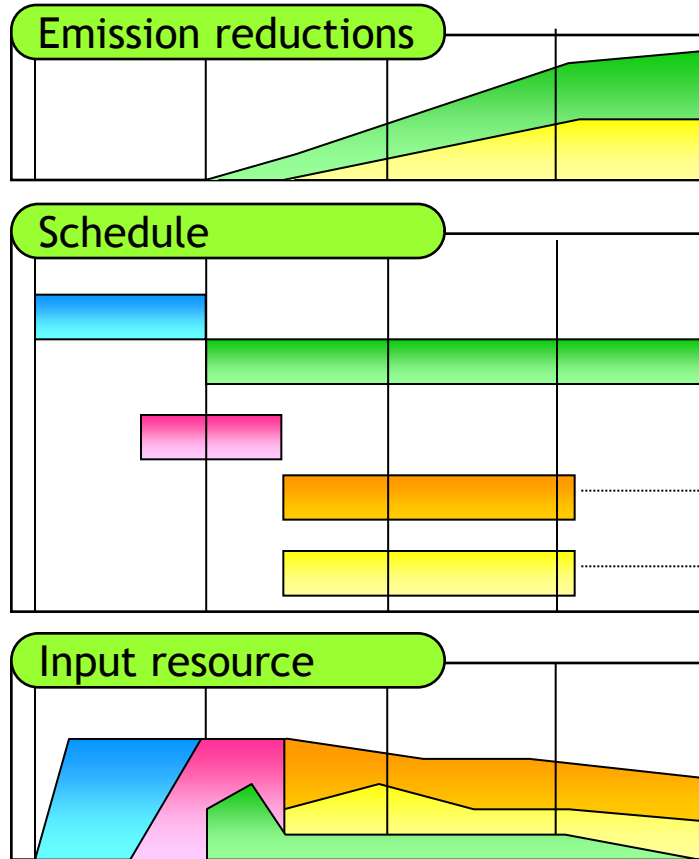
Input resource

Upper bound of annual input resource

Relations between measures

State in the starting year

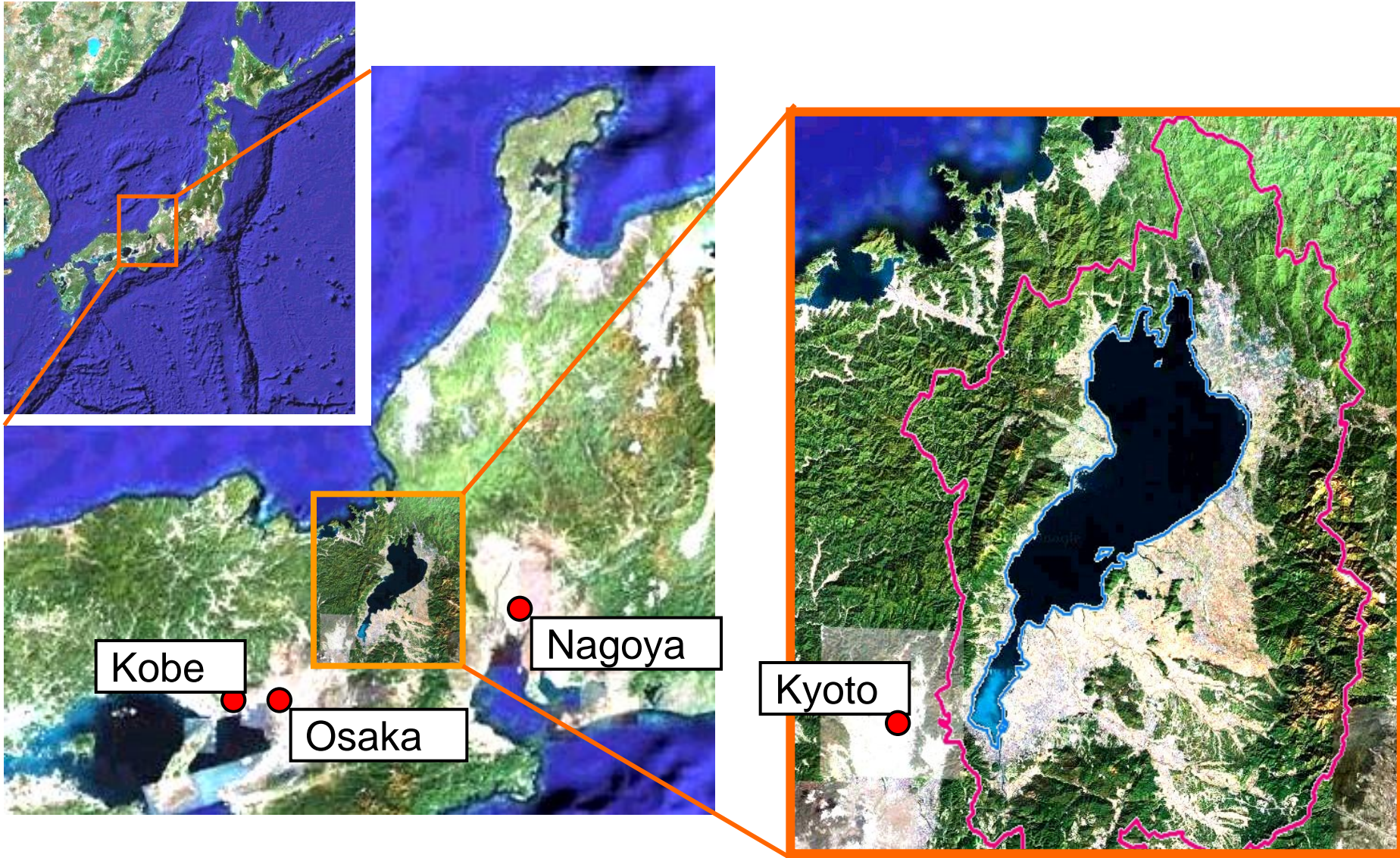
Integrated effect (ancillary and/or co-benefit)



- An application to Shiga prefecture, Japan.
  - Three environmental targets
  - Moderate economic growth
  - Industrial structure change



# About Shiga prefecture





# About Shiga Prefecture

- Population : 1.39 million
- Gross Regional Product:
  - 5935 bill.¥ ( 60bill.\$)
  - 4.25 mill.¥/capita (43000\$/capita)
- CO<sub>2</sub> emissions:
  - 12.5Mt-CO<sub>2</sub>
  - 9.0t-CO<sub>2</sub>/capita
- Industrial structure (share of gross output)
  - primary 1%
  - secondary 62%
  - tertiary 37% (in 2000)

# Target setting

- Base year 2000
- Target year 2030
- Three environmental targets
- Single socio-economic scenario
- Target activity
  - Household, Industry, Transport
  - Activity within the area of Shiga prefecture

Climate change  
mitigation

GHG emissions :  
**-50%** (related to 1990)

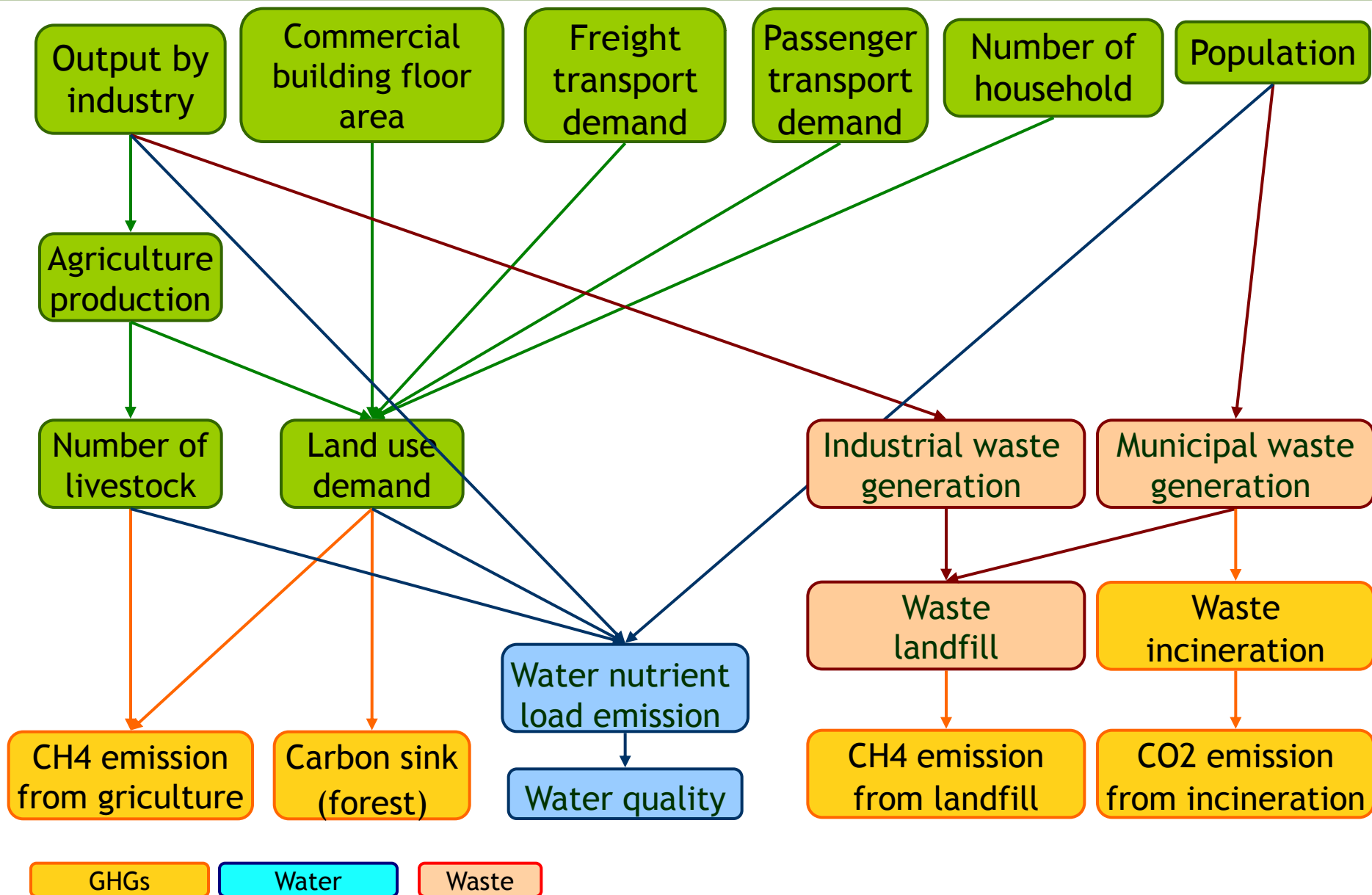
Sound eco-system:  
Revival of Lake Biwa  
environment

Nutrient load inflow :  
**-50%**

Recycling system

Landfill waste:  
**-75%**

# ExSS: further extension



# Socio-economic scenario

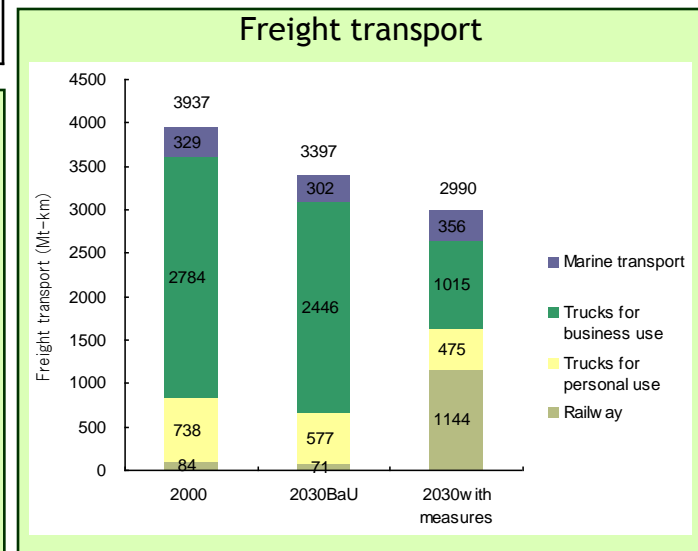
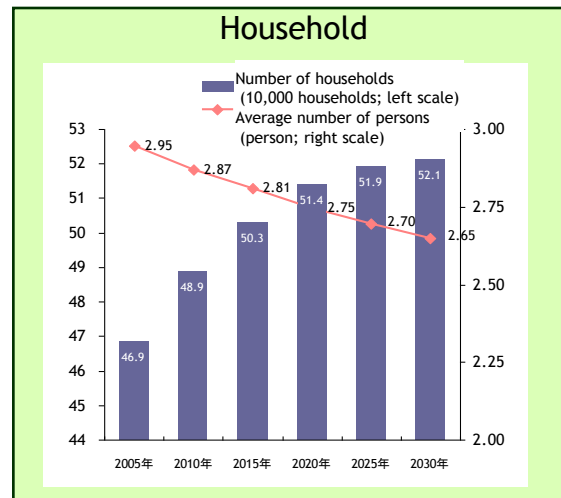
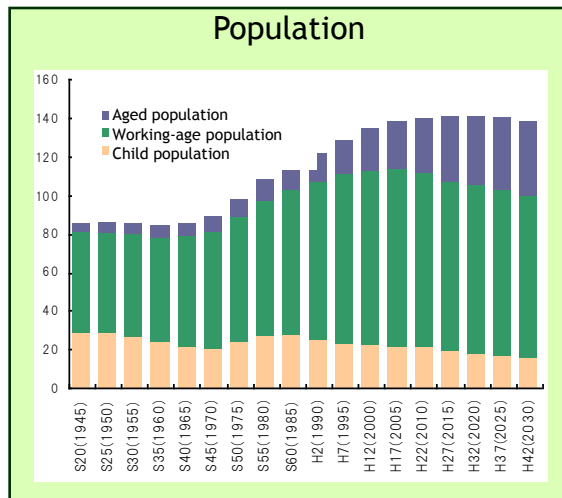
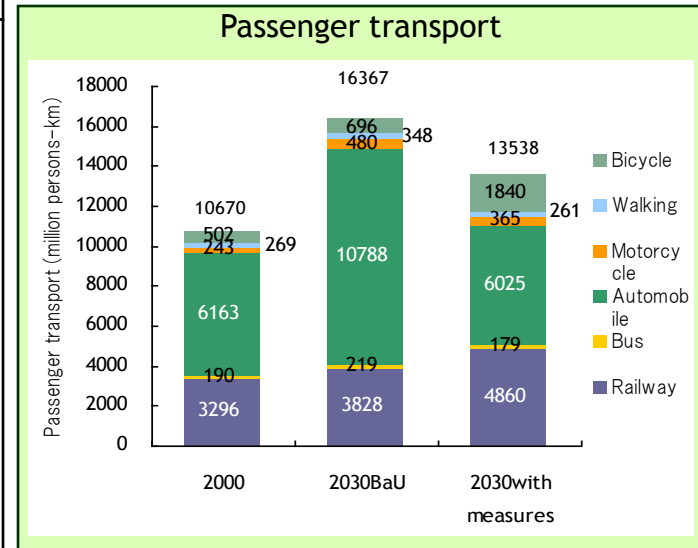
- **Dominant social trends in 2030**
  - (1) Return of the population to the current level and progress of aging;
  - (2) Mature economic growth and dramatic increase in the role of the tertiary industry; and
  - (3) Increase in the proportion of women and elderly people in employment.
- **Powerful cities and industries maintaining intra-prefectural and inter-prefectural connections**
- **Beautiful rural villages maintaining nature and landscape**

# Quantitative assumptions

Population	1.38 million in 2030 (estimated by Shiga Prefecture in 2006; similar level to the population in 2005)
No. of households	520,000 households in 2030 (same as above; 470,000 households in 2005)
National economy	Per capita GDP: approximately 0.9% of annual growth
Public fixed capital formation	Investment in infrastructure development, etc. After basic infrastructure development has been completed, new development is dramatically reduced and capital investment is placed mainly on maintenance and management. Total investment is lower than the current level.
Breakdown of private consumption expenditure	Breakdown of the goods and services consumed mainly in households. With longer-life products, the value of purchased goods remains unchanged. It is assumed that the shares of spending for the primary industry and personal services (education, healthcare and insurance, accommodation, etc.) increase.
Employment rate	Through the development of the welfare environment to facilitate the employment of elderly people and women, the employment rate of elderly males rises by 20% and the rate of women by 10 to 30%.
Time budget	The working hours of male workers are reduced by 1.5 hours per day. It is assumed that both men and women increase time for participating in social activities.
Breakdown of exports	The breakdown of goods and services delivered from Shiga to outside the prefecture. The exports of products in the manufacturing industry are assumed to remain unchanged in monetary terms.
Import ratio	The ratio of the goods and services produced outside Shiga Prefecture in the demands for goods and services in the prefecture. The import ratio of goods in the primary industry declines, but imports of other goods and services increase.
Input coefficient	The input of raw materials needed for the production of one unit in a certain industry. It is assumed that this figure declines due to paperless operations based on the use of IT, less input of metal and cement and increase of wood products in public projects, and reduced consumption of fuel and electricity as a result of energy saving.
Labor productivity	To maintain an annual economic growth of 0.9% while the population is decreasing, it is necessary to secure high labor productivity. Labor productivity per person-hour rises by 2.7% per annum in the manufacturing industry and by 1.6% in the service industry.

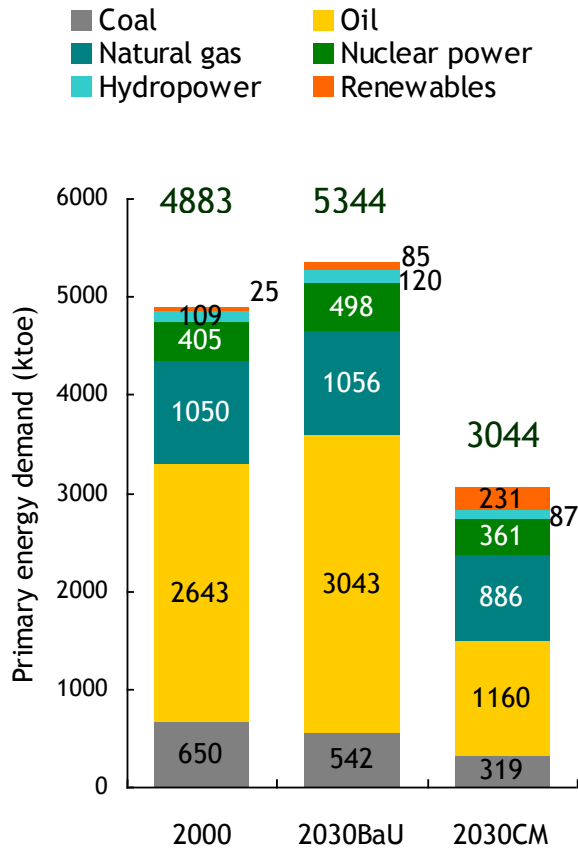
# Result: Socio-economic indicators

	2000	2030	2030/2000 (unit)	
Population	1397	1381	0.99	1000
No. of Household	439	521	1.19	1000
GDP	5935	7677	1.29	Bill.Yen
Per capita GDP	425	556	1.31	Mill.Yen
Industrial output	11584	13435	1.16	Bill.Yen
Primary industry	95	564	5.91	Bill.Yen
Secondary industry	7220	6470	0.90	Bill.Yen
Tertiary industry	4269	6401	1.50	Bill.Yen
Commercial floor area	20	23	1.13	Mill.sqm
Pass. transport demand	10670	16367	1.53	Mill p-km
Fgt. transport demand	3937	3397	0.86	Mill t-km

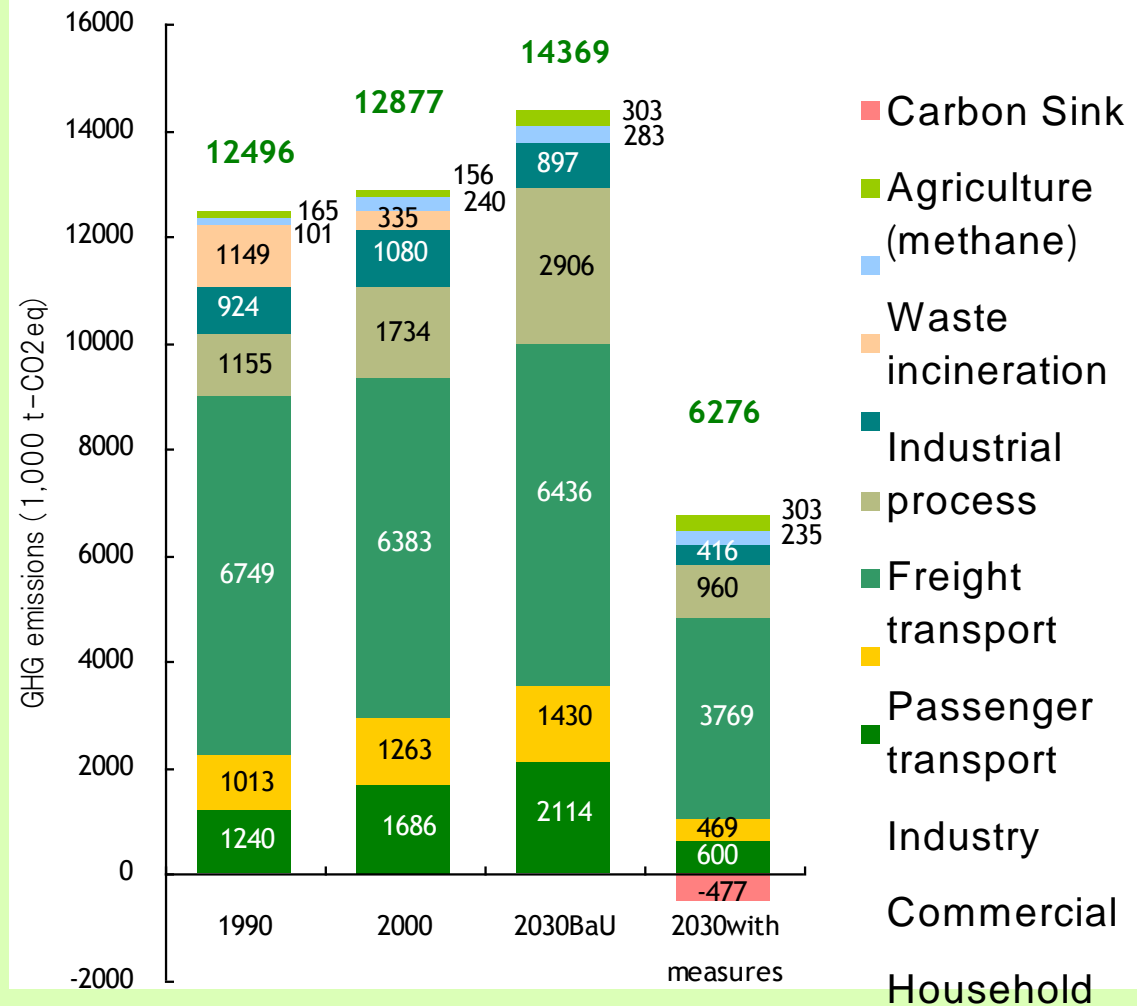


# Result: Energy and GHG

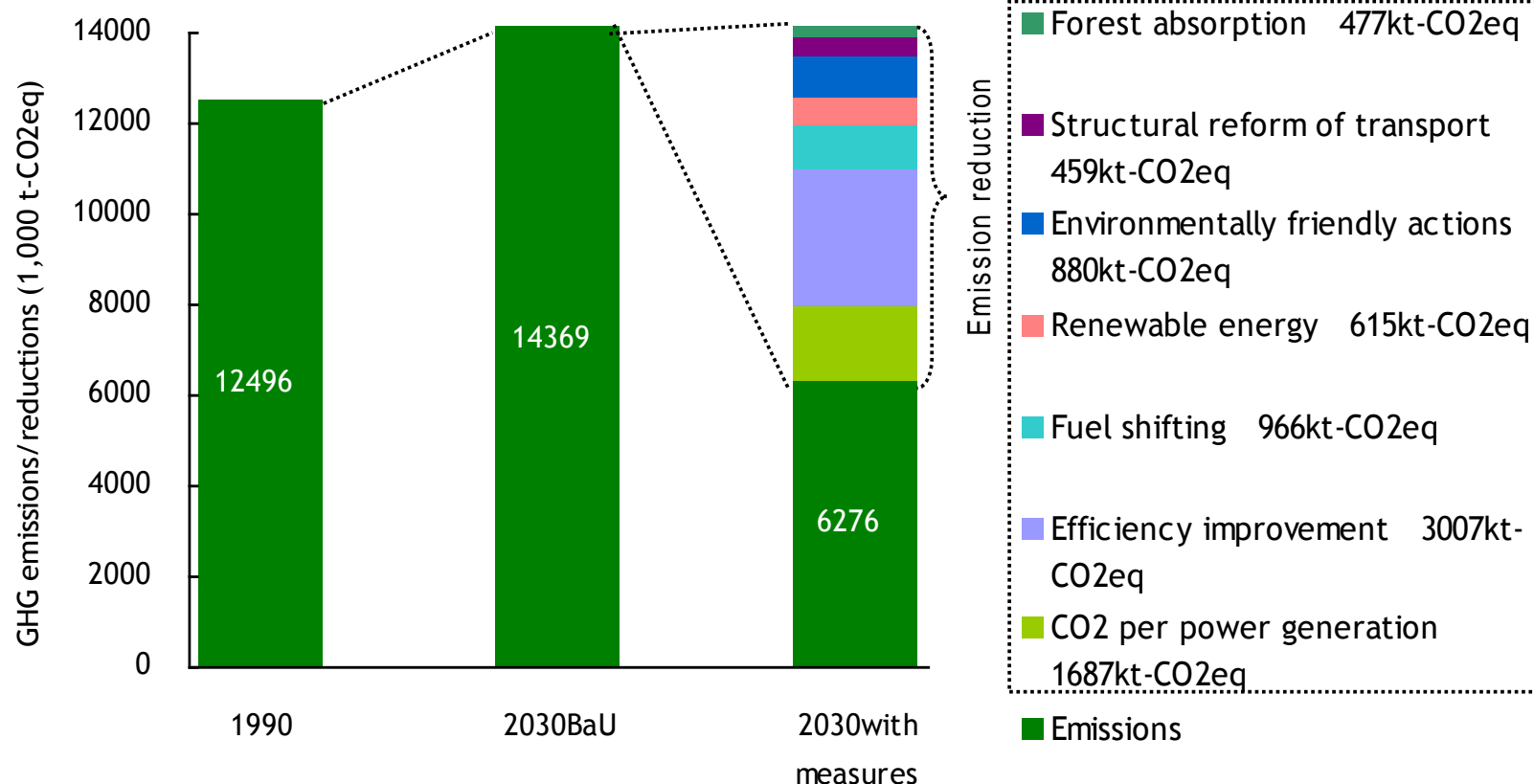
## Primary energy demand



## GHG emissions by sector

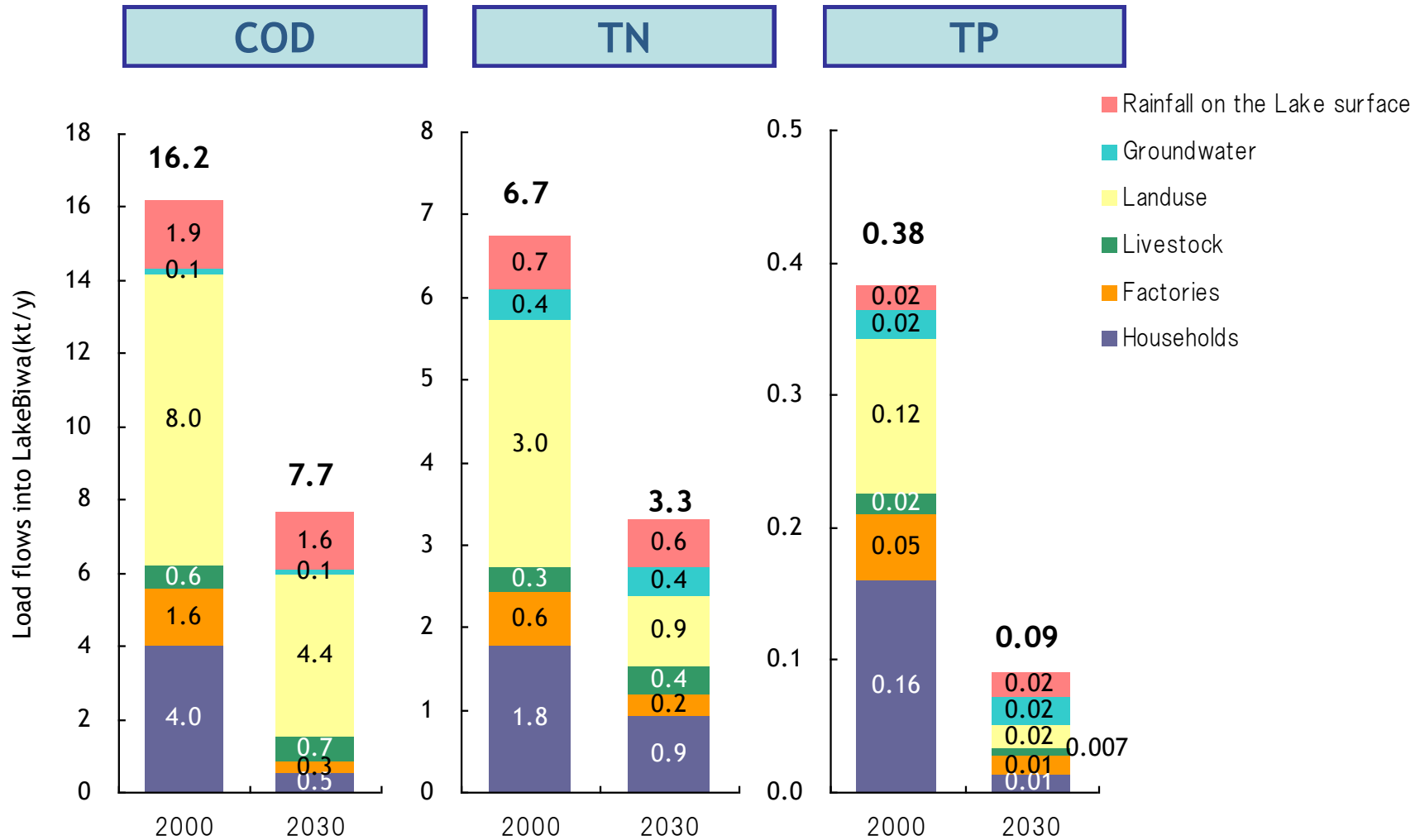


# Result: Contribution of measures



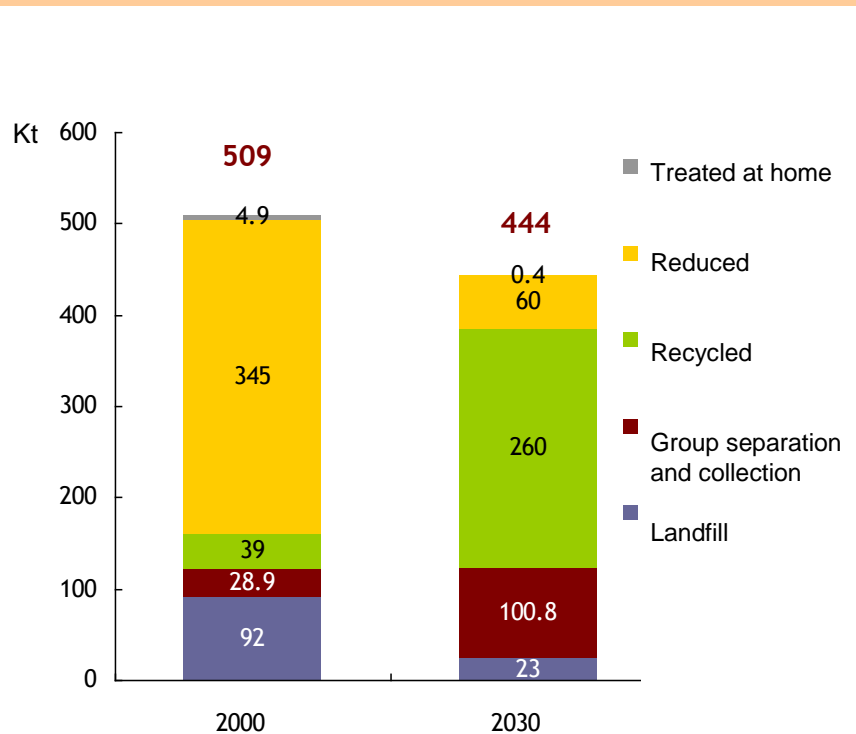


# Result: Water nutrient load

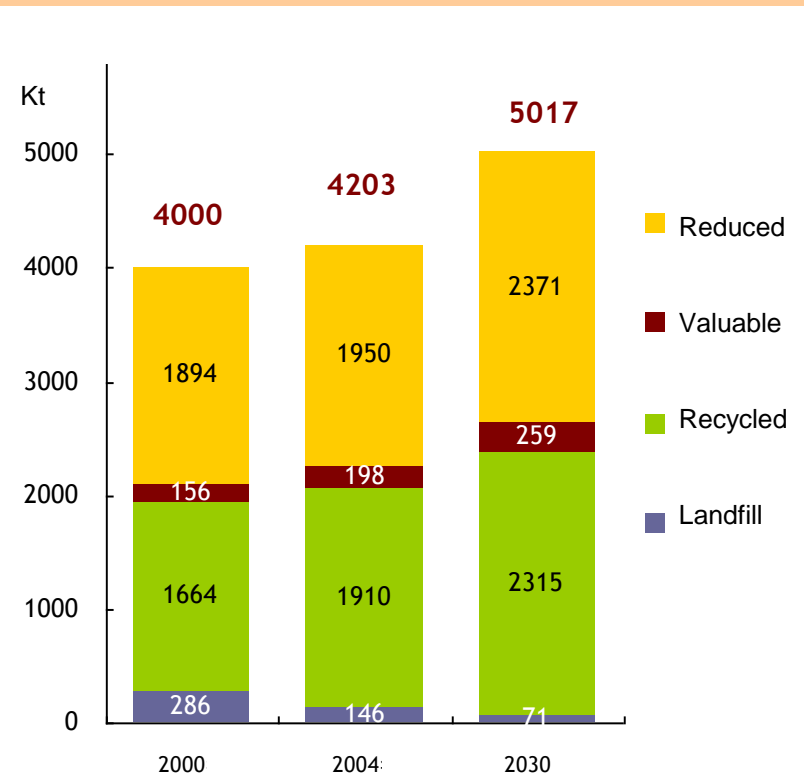


# Result: Waste landfill

## Generation and landfill of municipal waste



## Generation and landfill of industrial waste



# Counter measures

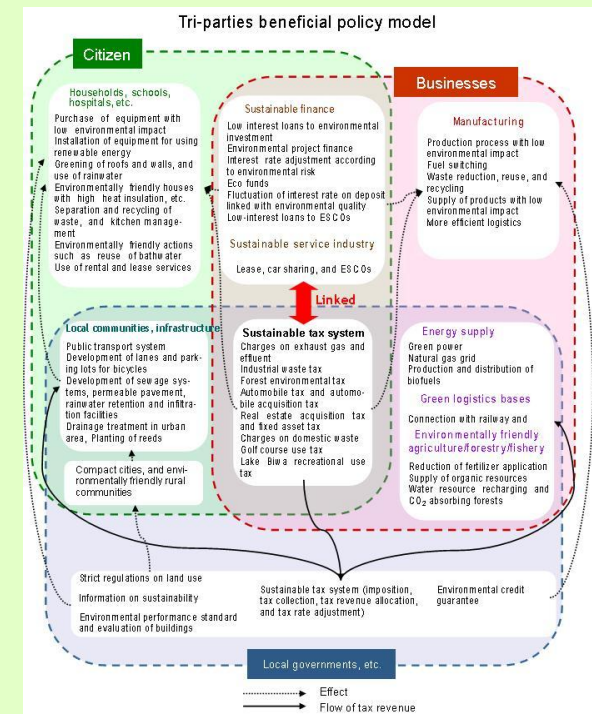
Measure	Status to be achieved by 2030	What should be done now to achieve the status	Reduction
Energy efficiency of equipment	Improvement of efficiency by 30% in total	Improvement rate of approximately 0.8% per annum; Selection of more energy efficient products at the time of replacement	551
HEMS (home energy management system)	Penetration at 90% of houses	Start of penetration	60
Heat insulation level in houses	Achievement of the next-generation heat insulation level in 90% of houses	Selection of high heat insulation level at the time of newly building, remodeling, and changing houses	55
Biomass heating	Penetration at 10% of households	Selection of biomass at the time of replacement of heating appliance	39
Passive solar heating	Penetration at 10% of households	Installation at the time of newly building and remodeling houses	39
Energy saving actions	Penetration at almost all households	Start of penetration, and education	156
Photovoltaic power	Penetration at 20% of households	Continuous expansion	54
Solar water heater	Penetration at 20% of households	Continuous expansion	99
Others			89
<b>Total in households</b>			<b>1144</b>

ktCO<sub>2</sub>eq

# Policy recommendation

## Main efforts and actions required for the respective players to achieve different environmental targets

	Realization of a low carbon economy	Rehabilitation of the environment of Lake Biwa	Establishment of a recycling system
Businesses	Introduction of high efficiency production equipment Fuel switching in manufacturing and transportation More efficient logistics and modal shift	Reduction of water pollutant loads per production value	Recycling of waste Development of efficient recycling plants
Citizen	Environmentally friendly houses Penetration of fuel-efficient passenger vehicles Energy saving actions Use of railway, bicycles, and walking	Kitchen management Reuse of bathwater and rainwater	Control of municipal waste generation through the use of rented and leased goods Separation and recycling of domestic waste
Local government s, etc.	Maintenance of forests formation of compact cities Encouragement of modal shift	Development of sewage systems and reception of industrial effluent Measures for drainage in urban Direct purification of river water and dredging Conversion to natural lakeshores	Establishment of a system for the reuse and recycling of municipal waste Establishment of efficient recycling routes

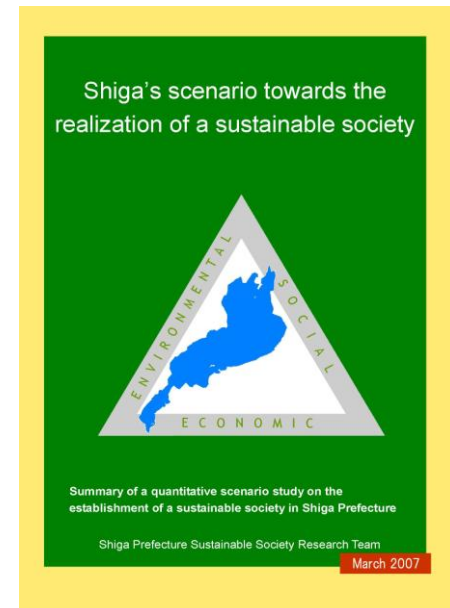


# In the REAL policy arena...

- March, 2007: Brochure of our study ----> PDF available on LBERI website.

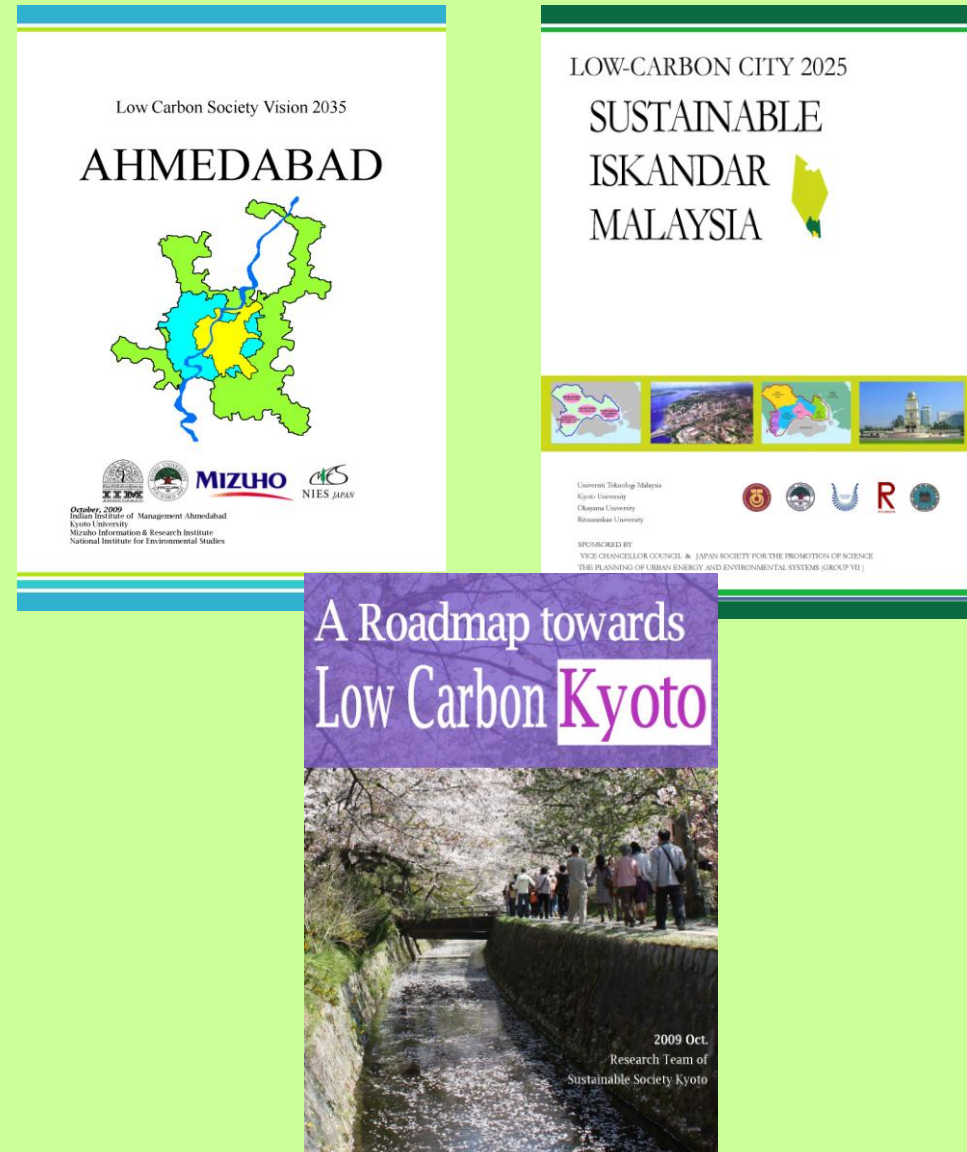
<http://www.lberi.jp/>

- December, 2007: Shiga pref. released “Shiga prefecture master plan”
- April, 2008: Shiga pref. released “Sustainable Shiga Vision”
- Currently, Shiga pref. is developing;
  - Low carbon ROADMAP towards 2030
  - Basic Environmental Ordinance
  - Basic Environmental Plan



# For other cities

- Completed
  - Kyoto city, Japan
  - Johor (Iskandar Malaysia)
  - Ahmedabad, India
- Proceeding/planning
  - Higashi-ohmi, Japan
  - Nagasaki, Japan
  - Hanoi, Vietnam
  - Dalian, China
  - Guangzhou, China
  - Bhopal, India



- Thank you.

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