



AIM modeling 2010

**~ Designing Asian scenarios towards
Low Carbon Societies ~**

Yuzuru Matsuoka

The 15th AIM International Workshop, 20, February 2010

Ohyama Memorial Hall

National Institute for Environmental Studies, 305-8506, Tsukuba, Japan

From the point of realizing global LCS, Asia is the most important region of the world.

Some groups already projected the future GHG emissions in this region, however, consistent and target oriented studies towards LCS are desperately required to realize actually Asian wise LCS.

Sorry, AIM members results are not included in this figures.

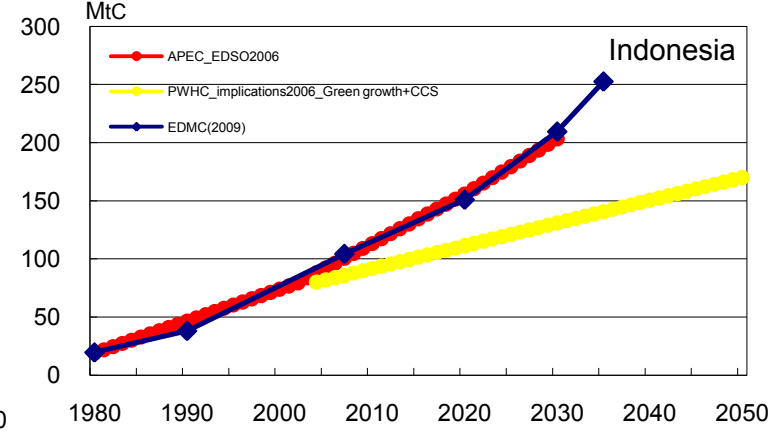
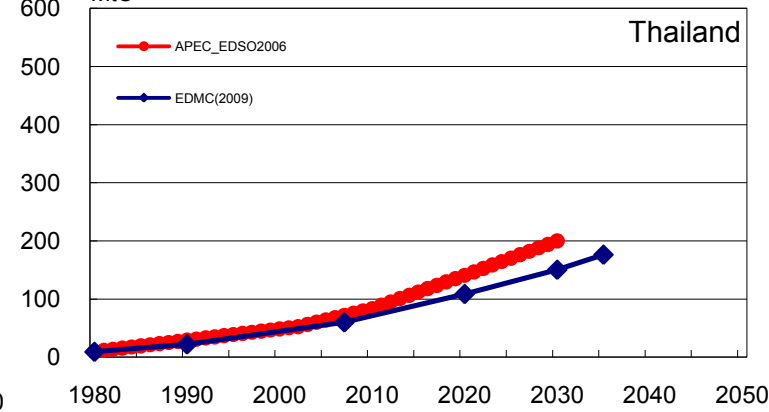
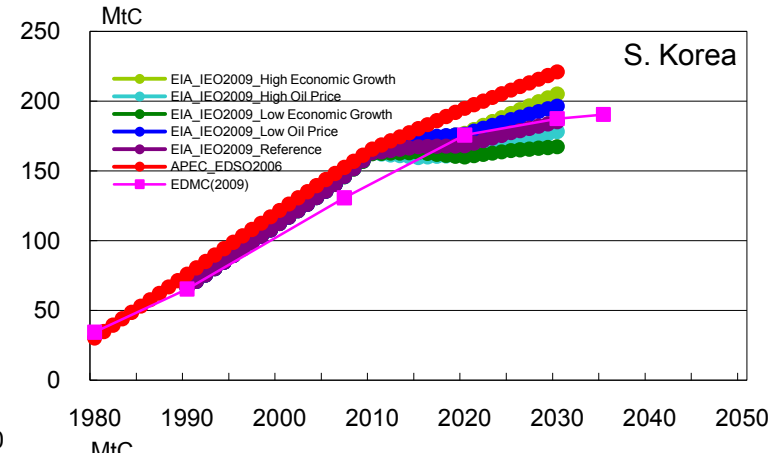
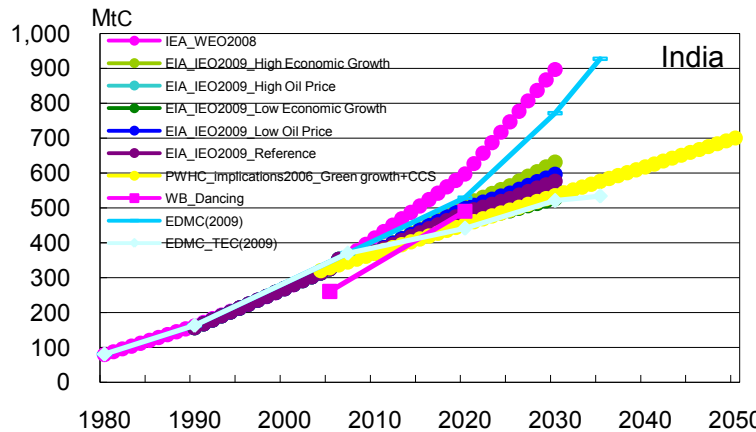
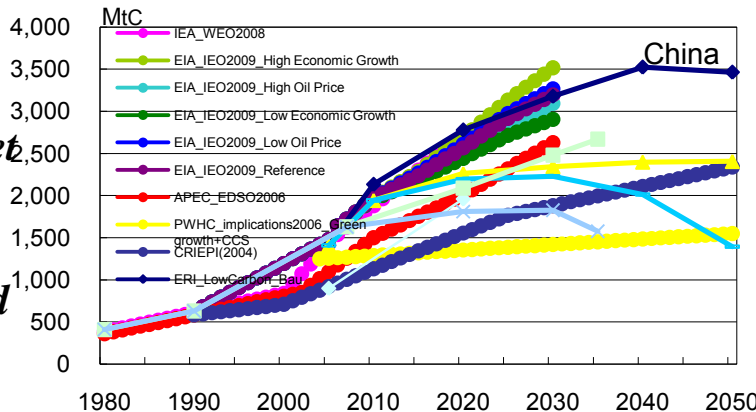
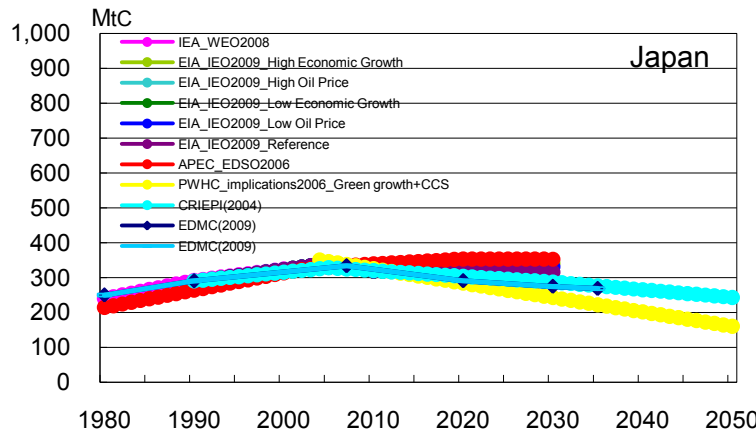


Table of Contents

- 1. Objective of the model development**
- 2. What are the Asian Low Carbon Societies we study ?**
- 3. Three regional/time scales we are concerning**
- 4. Two approaches we adopted**
- 5. Coupling the three scales and the two approaches**
 - 5.2. Regionalization for Pan Asian-Pacific approach**
 - 5.3. Flow diagram of the study**
- 6. Modeling**
 - 6.2. Element models**
 - 6.3. Integration tools**
 - 6.4. Focusing points**
- 7. Region specific studies now we are going on**
- 8. Final remarks**

1. Objective of the model development

In order to realize Asian Low Carbon Societies,

1. We focus on domestic and international factors which control the realization of LCS,
2. Describe the development, accumulation, and deepening of factors which control the realization of LCS with multi-layered, spatial, and integrated quantification models/tools,
3. Apply quantification models/tools to whole Asian area and various regions in the Asia,
4. Taking account of regional distinctive diversified characteristics,
5. Design positive Asian low carbon societies and roadmaps towards the LC societies, in each country with a back-casting methodology.

2. What are the Asian Low Carbon Societies we study ?

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

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

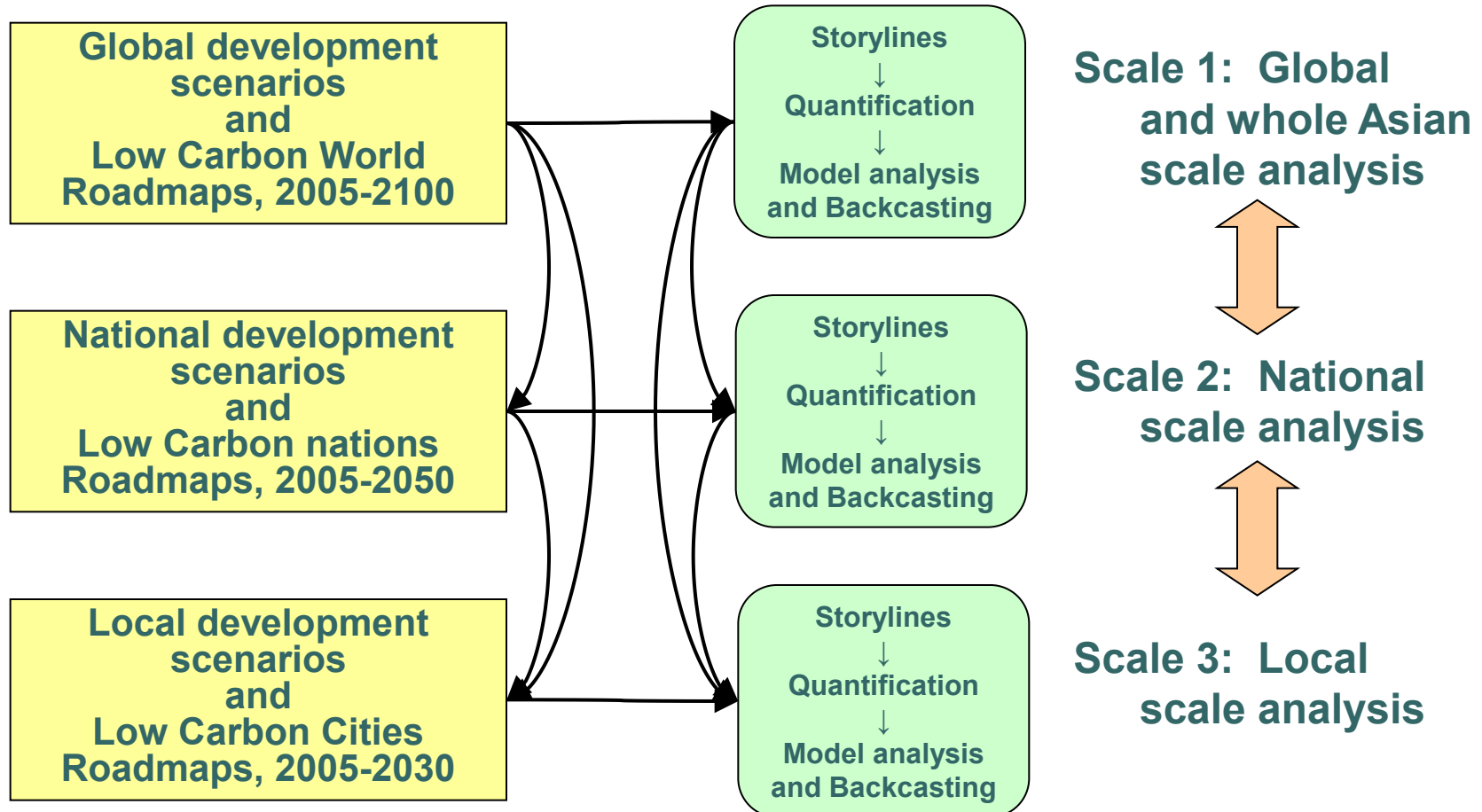
2. What are the Asian Low Carbon Societies we study?

2. (continued): Complying with each country's national reduction targets which consists with the global low carbon target, global, national and regional constraints on fossil and renewal energy resources, and land resource

1. We consider two types of national targets;
 - 1) Targets determined with some normative principle by using long-term dynamic CGE model coupled with a global climate module.
 - 2) Targets determined by political, economical and engineering arbitrament, considering reduction potentials, marginal costs, institutional inertia etc.
2. Depletion of fossil resource, domestic and international commercial biomass, competition with agricultural production..., major elements which influence the realization of Asian low carbon societies should be considered.
3. Other important issues which suffer the 21st century's Asia, such as improvement of social/human security etc. should be taken account.

3. Three regional/time scales we are concerning

To all scales, our methodology has been applied,
and they are inter-connected each other.



4. Two approaches we adopted

In order to take account of multilayered characteristics of Asian region, and not to lose perspective and reality of LCSs

1. Region specific study : Country/region specific approach collaborating with domestic research institutions, and putting more focus on regional initiative and acceptability
2. Pan Asian-Pacific approach : Put more emphasis on comprehensiveness and compatibility among global and pan Asian-Pacific regions

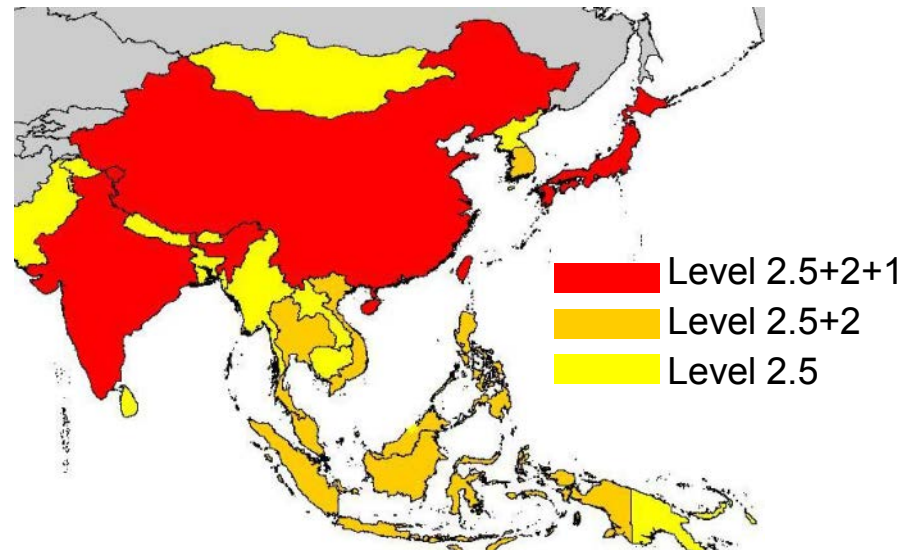
5. Coupling the three scales and the two approaches

Style	Scale/level	Spatial resolution	Time horizon	Contents	Tools
Pan Asian-Pacific approach	Level 1	JPN, CHN, IND, ASA, USA, EU, CANZ, RUS, LAM, AFR, MID	~2100	Analyse dynamically optimized economic growth and emission paths	<i>AIM/Impact[Policy]</i>
	Level 2	World 35 regions	~2100	Global LCS scenario making , especially on energy demand /supply, economic and trade changes	<i>AIM/CGE[Global] AIM/enduse[Global]</i>
		Asia 15 regions	1950~2050	National LCS scenarios and roadmap developments	<i>AIM/CGE[Country] AIM/enduse[Country] Element models BCM (Backcast model for dynamically optimized mitigation policies)</i>
	Level 2.5	Asia 28 regions	~2030	Disaggregation and localization of LCS and Roadmap designs of level 2, considering regional characteristics and development paths	<i>ExSS (Extended snapshot model) BCT (Backcast tool for managing mitigation policies)</i>
Region specific study	Country, city, local level (Level 3)	Iskandar, Ahmadabad, Guangzhou, Kyoto, Shiga pref., Hanoi	~2030	On-site localized studies collaborated with domestic research institutions. Design of qualitative, quantitative LCS scenarios and their roadmaps.	<i>Element models AIM/enduse[local] ExSS (Extended snapshot model) BCT (Backcast tool for managing mitigation policies)</i>

5.2. Regionalization for Pan Asian-Pacific approach

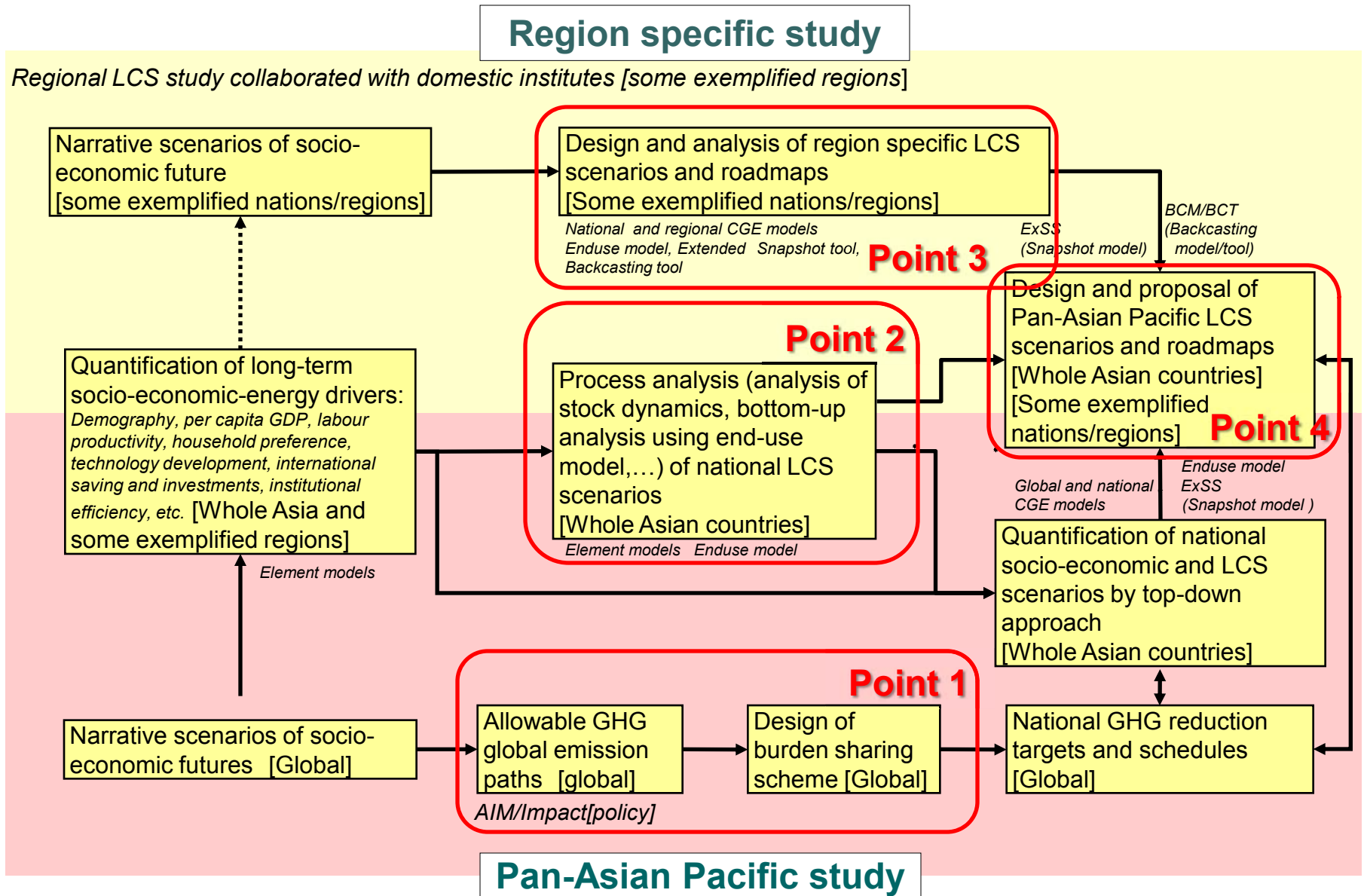
Country/Region	Level 2.5 (28 regions)	Level2 (15 regions)	Level 1 (4 regions)
Japan	JPN	JPN	JPN
China	CHN	CHN	CHN
Taiwan	TWN	TWN	
India	IND	IND	IND
Indonesia	IDN	IDN	ASIA
Malaysia	MYS	MYS	
Philippines	PHL	PHL	
Korea, Republic of	KOR	KOR	
Singapore	SGP	SGP	
Thailand	THA	THA	
Viet Nam	VNM	VNM	
Korea, DPR	PRK	XEA	
Mongolia	MNG	XSE	
Lao PDR	LAO		
Myanmar	MMR	XSA	
Brunei	BRN		
Cambodia	KHM		
Timor-Leste	TLS		
Bangladesh	BGD		
Bhutan	BTN		
Nepal	NPL		
Pakistan	PAK	XOC	
Maldives	MDV		
Sri Lanka	LKA		
Afghanistan	AFG		
Fiji	FJI		
Papua New Guinea	PNG		
Marshall Islands	MCR		
Micronesia			
Palau	XOC		
Kiribati			
Nauru			
Samoa			
Solomon Islands			
Tonga			
Tuvalu			
Vanuatu			

- East, South, Southeast Asia, Melanesia, Micronesia, and Polynesia, Based on major international statistics.
- Four regions in level 1, *i.e.* China, India, Japan and Rest of Asia
- Fifteen regions in level 2. Aggregation of small countries less than one million population and so on.
- 28 regions in level 2.5. Aggregation of small island states in Oceania region



5.3. Flow diagram of the study

How these approaches are integrated towards Asian LCS study?



6. Modeling

Development, maintenance and application of multi-layered modeling system

Two groups of models and tools have been and are being developed.

- (1) Quantification tools encompassing various spatial scales and disciplines, operated complementary, such as global, country, and local (city) scales, energy, economical, demographical, industrial, building, transportation systems, etc.
*i.e. Element models, AIM/impact,***

- (2) Integration tools which link the above models to low carbon society visions and roadmaps.
*i.e. AIM/CGE, AIM/enduse, ExSS (Extended snapshot model), BCM (Backcasting model),***

6.2. Element models

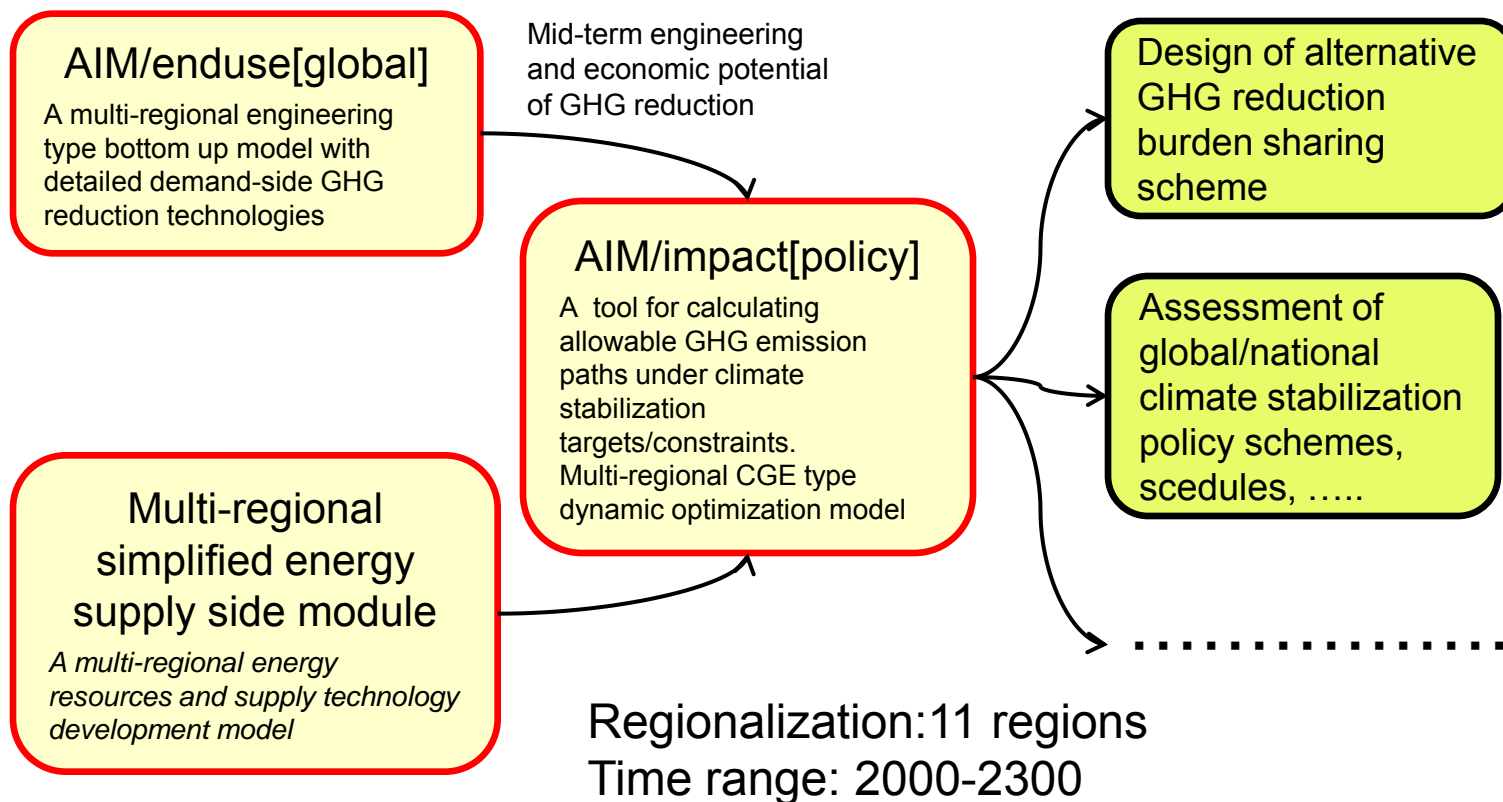
- **Macro-economy model (EME):** Supply-side type mid-term econometric model
- **Population/Household dynamics model (PHM):** to describe each country's demographic dynamics
- **House and building dynamics model (BDM):** to describe transition and renovation dynamics towards modern and highly insulated buildings.
- **Traffic demand model (TDM):** to describe passenger and freight transports coupled with economic activity and urban structure
- **Material stocks and flow model (MSFM):** to describe material metabolism towards low material societies
- **Energy supply model (ESM):** to describe scenarios of biomass production, power infrastructure development
- **Household production and lifestyle model (HPLM):** to describe the transition of household consumption, lifestyle etc.
- **AIM/enduse[air]:** an atmospheric environment model to estimate co-benefits caused by low carbon policies.

6.3. Integration tools

- **AIM/CGE:** One/multi-regional CGE model. Integration platform with which element models are soft-linked according to analytical objects. Global and National scales.
- **AIM/enduse:** One/multi-regional multi-sectoral bottom-up type energy enduse model. Integration platform of energy service's generation processes, energy technology development, and LCS policies. Global, national, and local scales.
- **Extended snapshot tool (ExSS):** A tool for integrating future economic, industrial, social and energy policies, using social accounting matrices, trade matrices, energy balance tables, energy technologies/regional energy resources information. One/multi-regional accounting type tool Multi-regional static model.
- **Back-casting model /Tool (BCM/BCT):** A model for designing roadmaps towards low carbon societies. Dynamic optimization model.

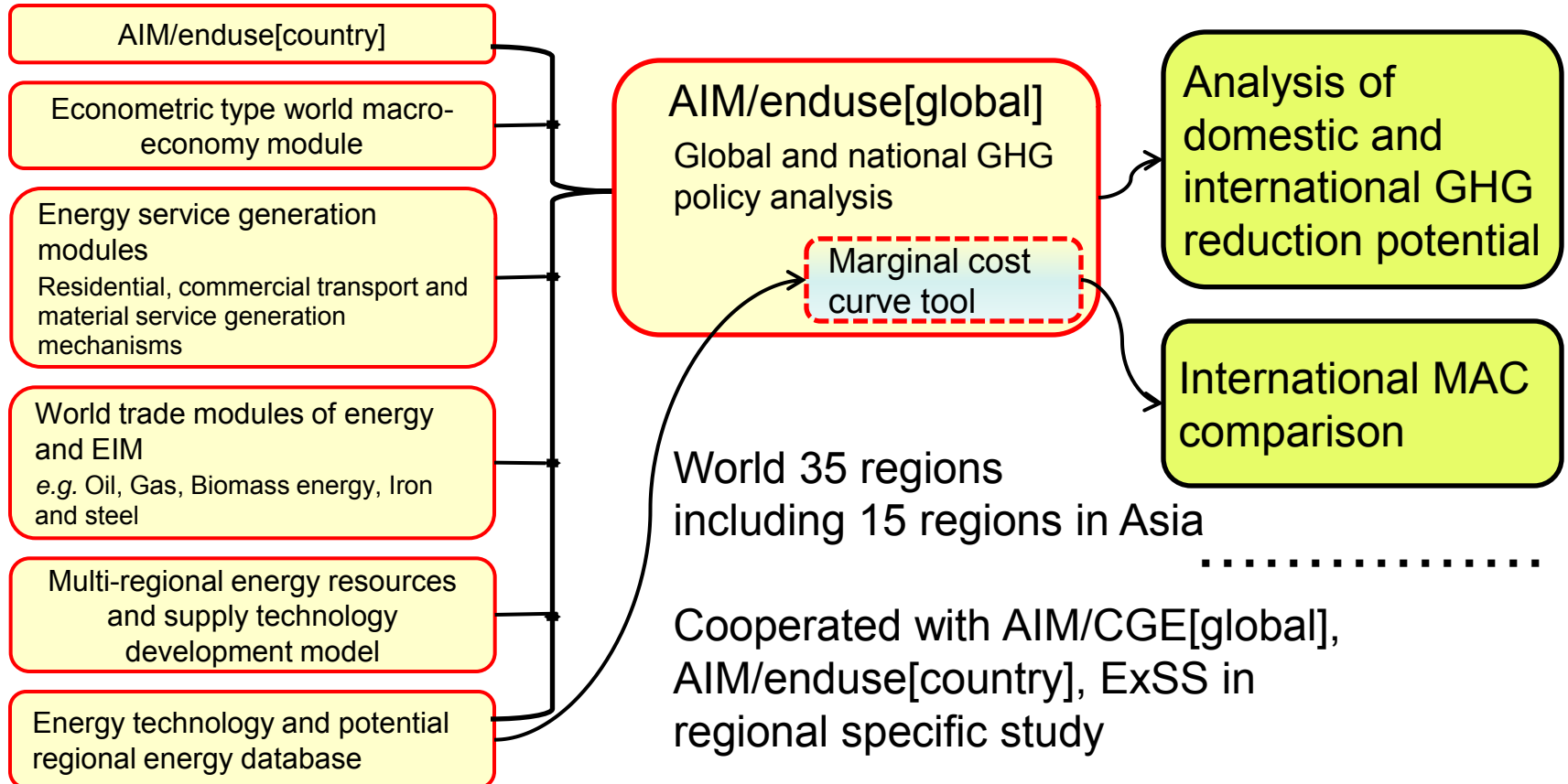
6.4. Focusing points

Point 1: Coupling of allowable GHG global emission paths with details of reduction technologies



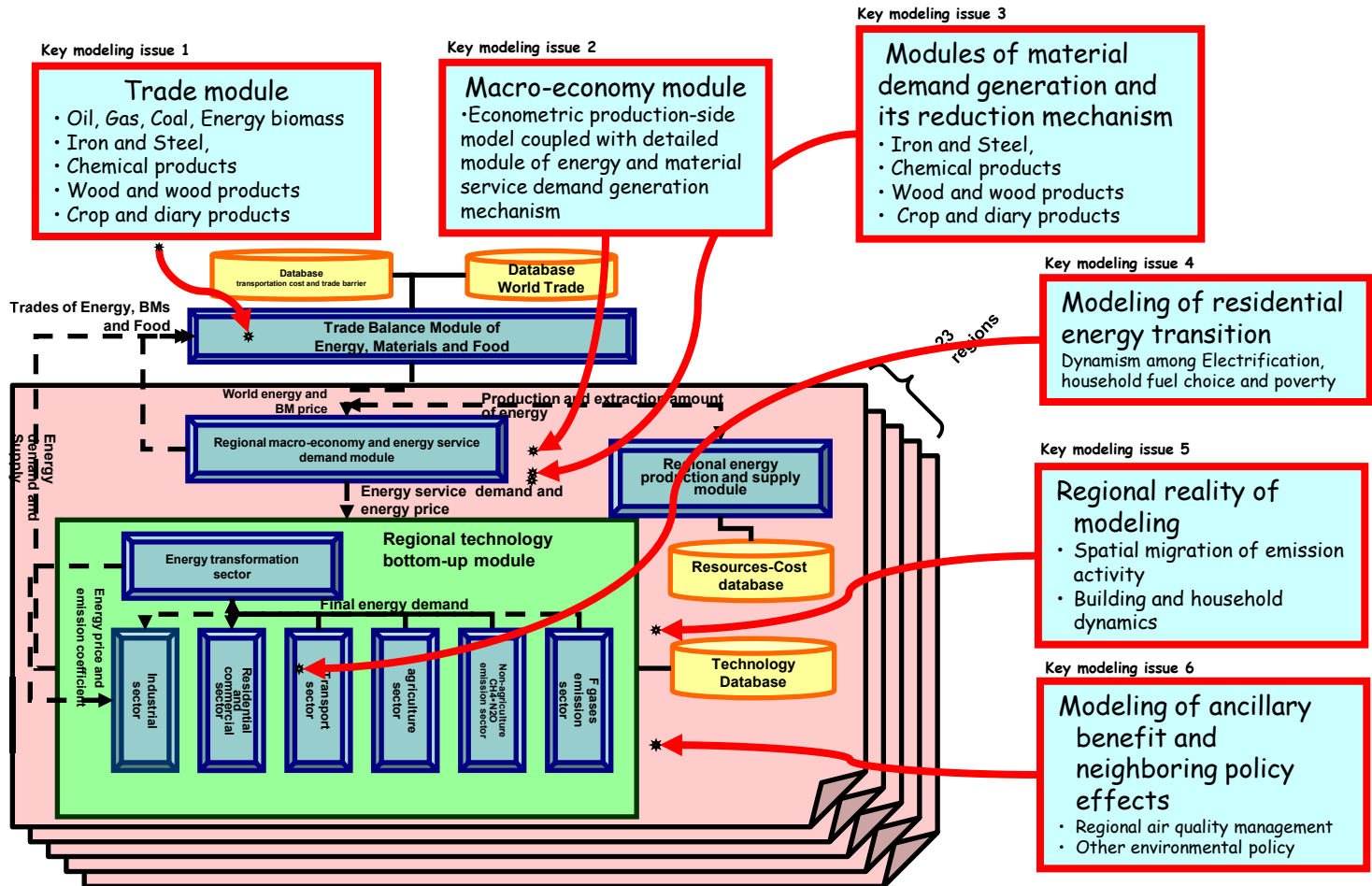
6.4 Focusing points

Point 2: Extension/reinforcement of AIM/enduse for Global/Asian LCS scenario study



6.4 Focusing points

Frame of AIM/enduse[Global] (from 2004 AIM workshop)

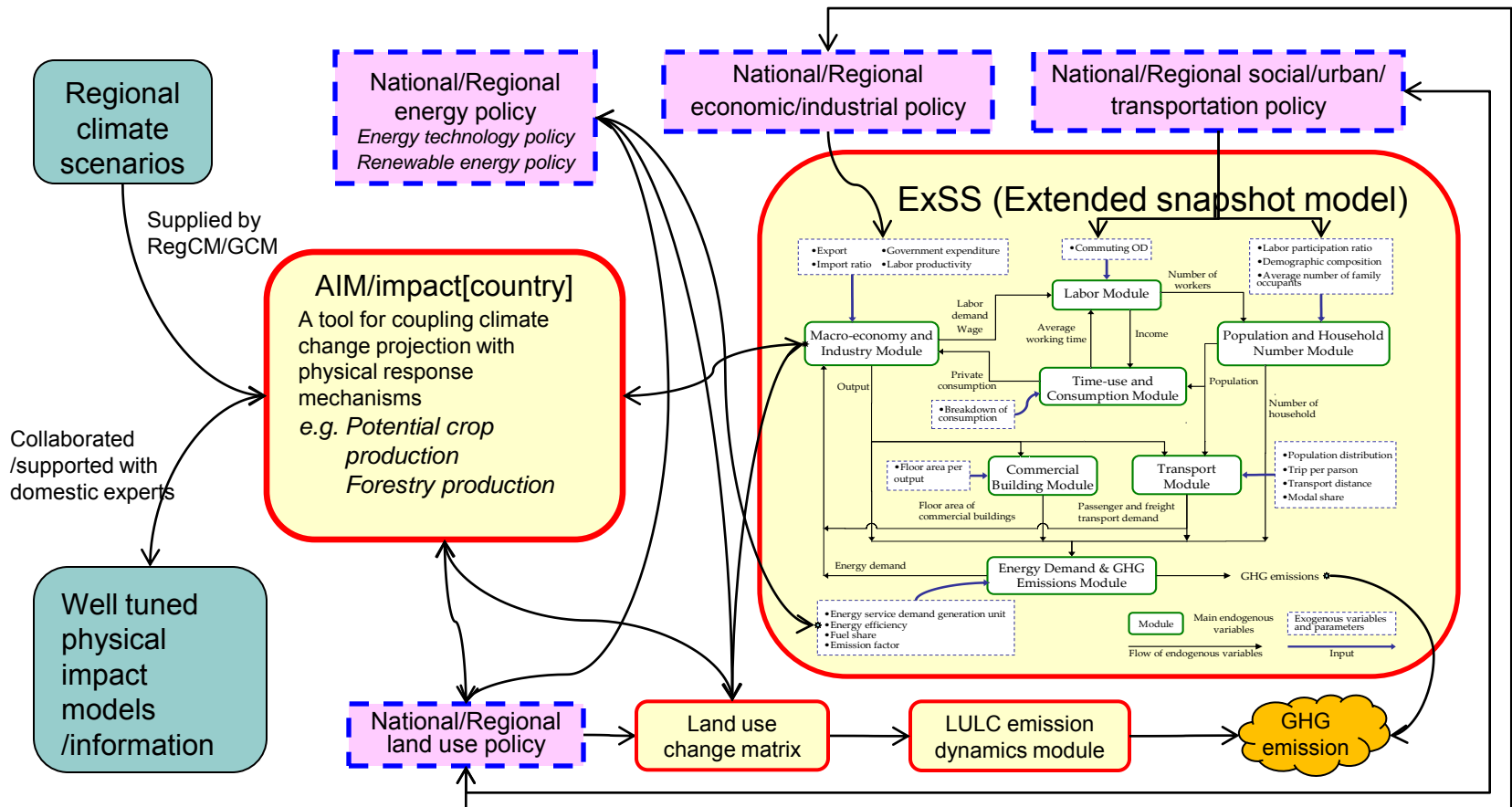


I have to admit, this Point 2 was what we have finished several years ago.

We must catch up on the delay as soon as possible, not to lose the timing

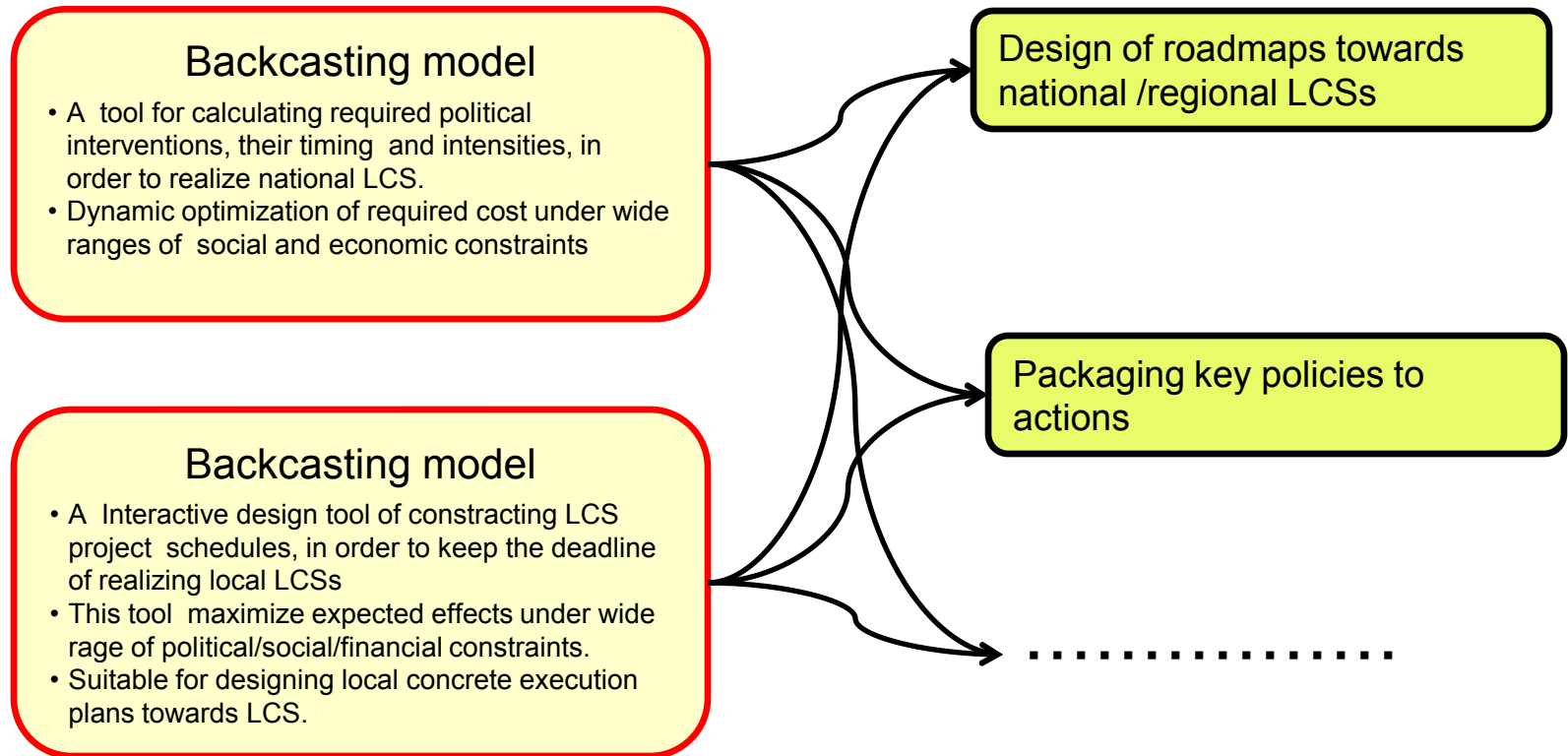
6.4 Focusing points

Point 3: Coupling of Extended Snapshot Tool (ExSS) with other important mechanisms relating with LCS, such as land use dynamics, climate impacts/adptation, etc.



6.4 Focusing points

Point 4: Establish designing methodology of LCS roadmaps; Back-Casting approach



6.4 Focusing points

Example of concrete execution plan towards Local LCS - Roadmap towards Low Carbon Kyoto study -

Action 1 Walkable City, Kyoto

The "Walkable City, Kyoto" action will reduce CO₂ emissions in 2030 by 722 kt-CO₂. These are measures for promoting urban design that prioritizes pedestrians and public transport in order to reduce CO₂ emissions in the transport sector.

In part because Kyoto City has already actively promoted this measure, we estimate that many of the measures in the roadmap can be completed by the year 2020. However, other measures such as road pricing and the introduction of light rail transit (LRT) that involve long-term construction work or more significant changes to the transport structure will take longer, so all of the measures will not be completed until 2030.

The objective of "Promotion of mobility management" is to promote the use of public transport by the general public. Implementation of transport demand management (TDM) is needed to bring about a voluntary change in the attitude of the general public. This measure will employ educational pamphlets and related maps to encourage the use of public transport, opinion surveys of transport behavior and so on.

"Construction of pedestrian transit malls" is a measure designed to bring about a shift from the use of privately owned automobiles to public transport as the means of transport used by the general public. The sidewalks along Shijo-dori in the city center will be widened to secure a comfortable pedestrian space and promote a modal shift on the part of the general public. The use of pedestrian transit malls by the general public will enable CO₂ emissions to be reduced by 32 kt-CO₂.

However, as many tourists visit Kyoto from other areas, it is important to have those tourists use public transport as well. "Attraction of tourists using public transport" is the measure that will be employed to promote the use of public transport by tourists. Publicity campaigns will be held at major train stations in the Kansai and Chubu districts to invite tourists to come by public transport. Moreover, the introduction of intelligent buses that travel between tourist spots in the city will encourage tourists to use public transport to travel within the city as well. These measures will reduce CO₂ emissions by 12 kt-CO₂.



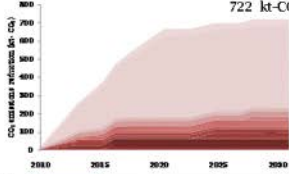
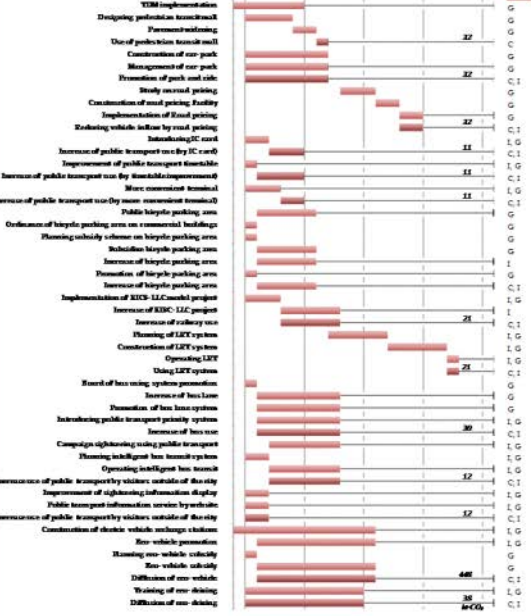

Figure 7 Passenger transport volume

In the "Recent urban levels" case, the modal share for means of transport in the same as 2010 as it was in 2005. In the "Recent measures" case, a modal shift has occurred. From private owned automobiles to other means of transport, with the result that the volume bills share has decreased and the share of public transport, bicycle and pedestrian transit has increased.

In the "Restrictive measures" case, the modal share for means of transport within the region that was targeted by restrictions has shifted. 18% for trains, 24% for buses, 2% for pedestrian transit, and 7% for bicycles. Moreover, major regional transport within the city by automobile has shifted. 18% for trains, 24% for buses, and 5% for walking, pedestrian transit and bicycles. This part is placed outside the region by automobile has shifted to 5% for trains.

Walkable City, Kyoto

722 kt-CO₂

Measure	Start Year	End Year	CO ₂ Reduction (kt-CO ₂)	Category
TDM implementation	2010	2030	30	G
Designing pedestrian transit mall	2010	2020	32	G
Promoting walking	2010	2030	32	G
Use of pedestrian transit mall	2010	2020	32	C
Construction of one-park	2010	2020	32	G
Management of one-park	2010	2020	32	G
Expansion of park and side	2010	2020	32	C, I
Steady renewal parking	2010	2020	32	G
Construction of road parking facility	2010	2020	32	G
Implementation of road parking	2010	2020	32	I, G
Enforcing vehicle inflow by road pricing	2010	2020	32	C, I
Introducing LRT road	2010	2020	32	I, G
Increase of public transport use by IC card	2010	2020	32	C, I
Improvement of public transport timetable	2010	2020	32	I, G
Increase of public transport use by timetable improvement	2010	2020	32	C, I
More convenient timetable	2010	2020	32	I, G
Increase of public transport use by more convenient timetable	2010	2020	32	C, I
Public bicycle parking area	2010	2020	32	G
Enforcement of bicycle parking area on commercial buildings	2010	2020	32	G
Flowing vehicle scheme on bicycle parking area	2010	2020	32	G
Restrictive bicycle parking area	2010	2020	32	I
Increase of bicycle parking area	2010	2020	32	C, I
Implementation of RHC-LLC road project	2010	2020	32	I, G
Increase of railway use	2010	2020	32	C, I
Flowing of LRT system	2010	2020	32	I, G
Construction of LRT system	2010	2020	32	I, G
Opening LRT	2010	2020	32	I, G
Using LRT system	2010	2020	32	C, I
Board of bus using system promotion	2010	2020	32	G
Increase of bus lane	2010	2020	32	G
Promotion of bus lane system	2010	2020	32	G
Introducing public transport priority system	2010	2020	32	I, G
Increase of bus use	2010	2020	32	C, I
Campaign enlightening using public transport	2010	2020	32	I, G
Flowing intelligent bus transit system	2010	2020	32	I, G
Opening intelligent bus transit	2010	2020	32	I, G
Increase of public transport by vehicle outside of the city	2010	2020	32	C, I
Improvement of nightingale information display	2010	2020	32	I, G
Public transport information service by website	2010	2020	32	I, G
Increase of public transport by website outside of the city	2010	2020	32	C, I
Construction of electric vehicle exchange station	2010	2020	32	I, G
New vehicle promotion	2010	2020	32	I, G
Flowing one-vehicle mobility	2010	2020	32	G
New-vehicle mobility	2010	2020	32	G
Diffusion of one-vehicle	2010	2020	32	C, I
Training of one-vehicle	2010	2020	32	I, G
Diffusion of one-vehicle	2010	2020	32	C, I

Legend: C Citizen, I Industry, G Government, O Outside of the city

6.4 Focusing points

Example of Packaging key policies to actions - Roadmap towards Low Carbon Kyoto study -

Action 1 Walkable City, Kyoto

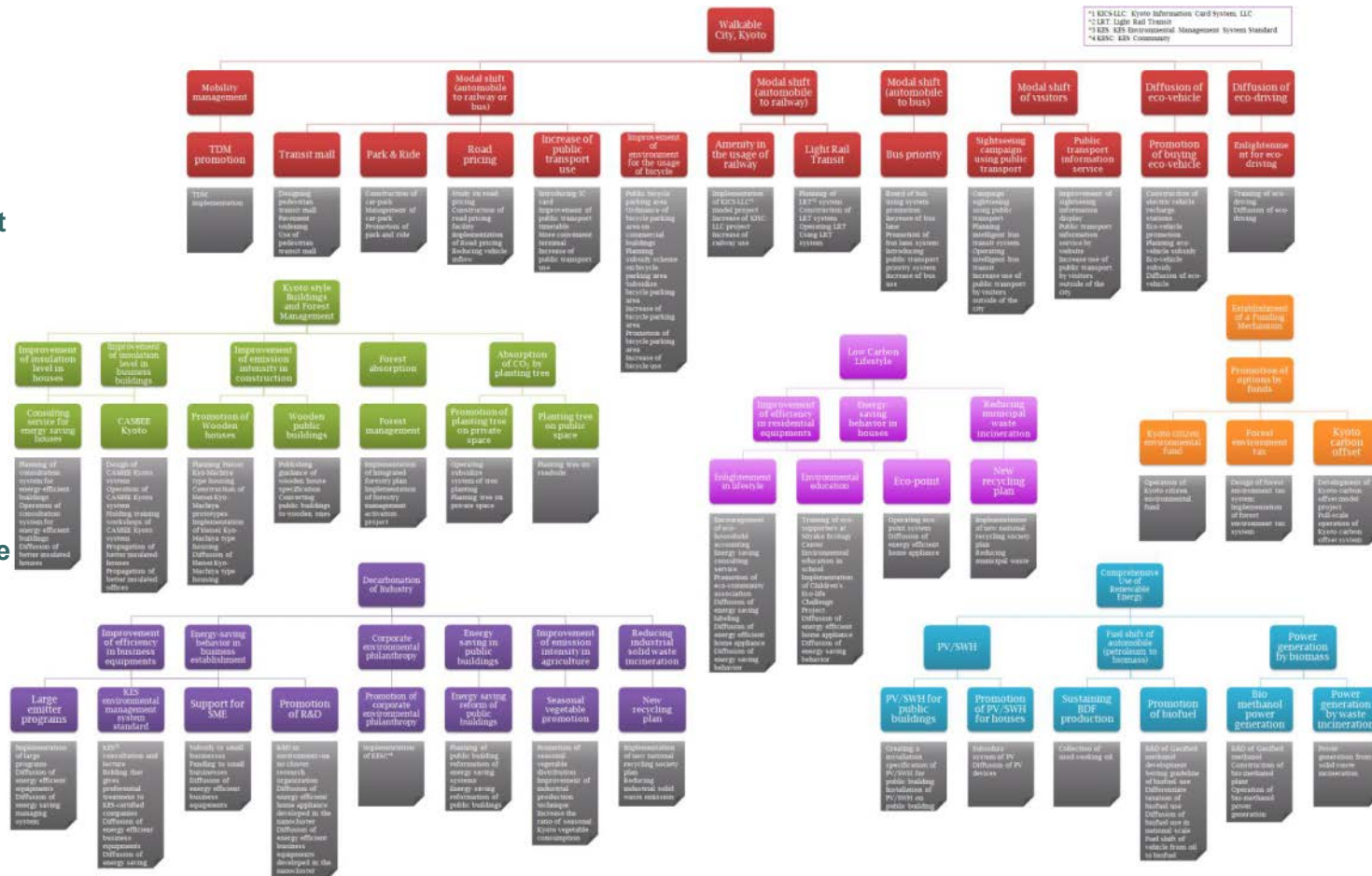
Action 2 Kyoto-style Buildings and Forest Management

Action 3 Low Carbon Lifestyle

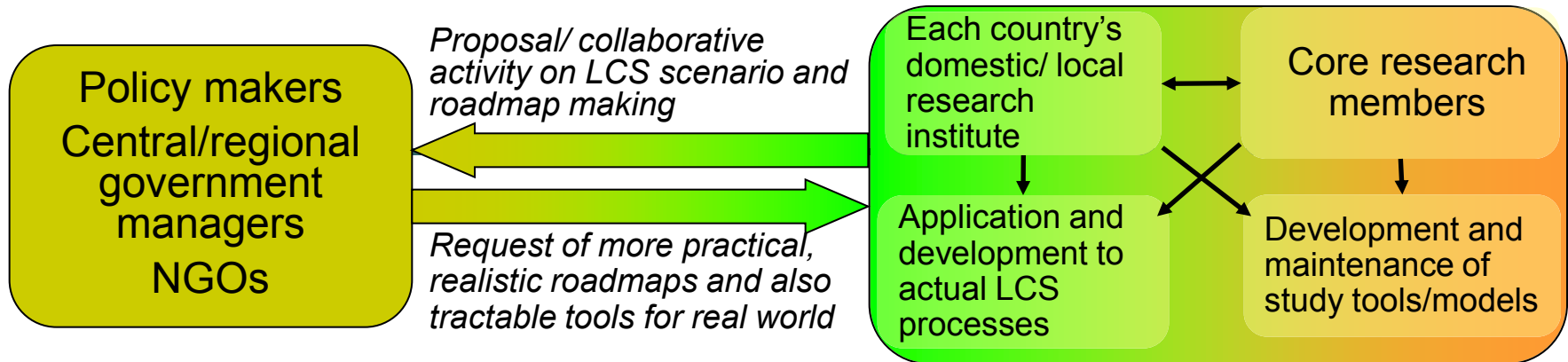
Action 4 Decarbonation of Industry

Action 5 Comprehensive Use of Renewable Energy

Action 6 Establishment of a Funding Mechanism



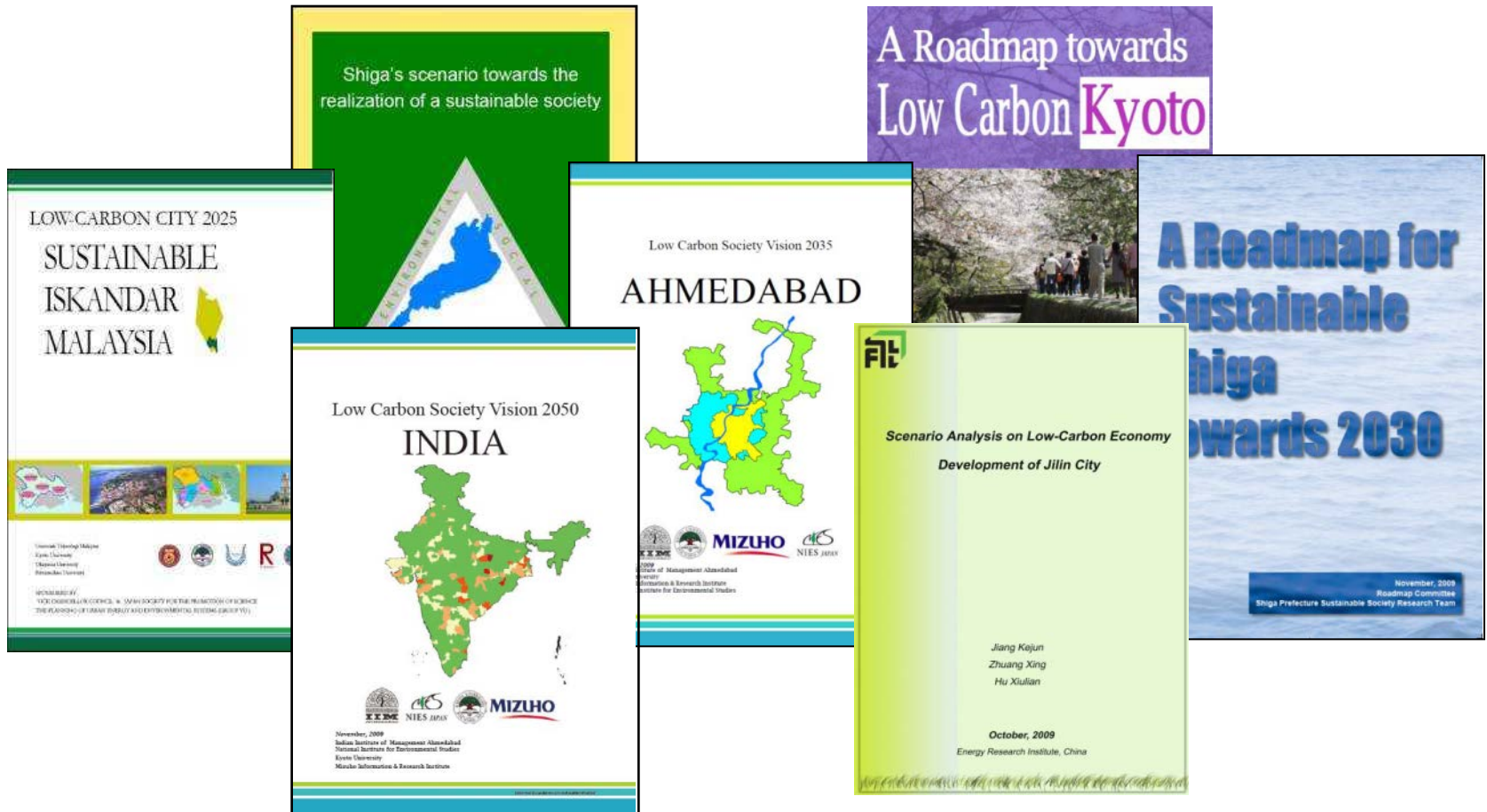
7. Region specific studies now we are going on



Region	Country	Domestic counterpart institutions	Stage
Japan	Japan	NIES, Kyoto Univ. and 23 institutions in Japan	Preliminary stage finished and implementing to policy making stage
Iskandar development region	Malaysia	University Technology Malaysia, Iskandar Regional Development Authority, Federal Department of Town and Country Planning Malaysia, Malaysia Energy Centre	Preliminary stage finished
India	India	Indian Institute of Management, Ahmedabad	Preliminary stage finished
Ahmedabad city	India	Indian Institute of Management, Ahmedabad	Preliminary stage finished
Guangzhou city	China	Guangzhou Institute of Energy Conversion, CAS	Just started
Shiga prefecture	Japan	Lake Biwa Environmental Research Institute	Implementation stage
Kyoto city	Japan	Kyoto city government	Preliminary stage finished
Kyoto prefecture	Japan	Kyoto prefectural government	Just started

7. Region specific studies now we started collaborated with Asian colleagues

Communication and feedbacks of LCS study to real world



8. Final remarks

AIM model family introduced in 2008 AIM/WS is not still obsolete.

We will continue enforcing the AIM model family and intensify internal collaborations among them.

Especially, we must devote urgent and most efforts to the red parts in order not being left behind

From 2008 AIM/Workshop AIM model family

Category	Name	Category	Objective	Model type
Top-down models	Ecosystem	Conservation of ecosystem/ water stress/ landuse/ pollution in developing countries	Modeling of relationship among economic activities, land use and ecosystem	Multi-regional CGE + various environmental process models
	Global/CGE	Energy, GHG Control	Projection of long-term GHGs emission	Multi-regional CGE model
	Material	CO2 reduction, energy consumption, waste management, environmental industry	Economic and material flow impact by climate and other environmental policy	One regional national CGE model
	Econometric	Forecasting macro-economic frame	Quantification and analysis of macroeconomic and energy variables	Country-level econometric model
Models /Tools for scenario making	Backcasting	GHG, Energy, Low carbon society	Establishing scenarios toward sustainable society from view points of environment and economy	Country-level dynamic optimization model
	Population/Household	Population, household	Establishing scenarios toward sustainable society from view points of environment and economy	Cohort-component model, household transition matrix model
	Building	Residential, non-residential building	Estimation of building demands related to household change, economic change and so on	Stock dynamics model
	Transport	Passenger and Freight transport demand	Estimation of transport demand related to national/regional/urban land planning	Trip generation, modal share modeling
	Stocks	Infrastructure, capital, buildings	Estimation of raw material needs, waste generation related to recycling and economic activity	Stock dynamics model
End-use, Energy, Technology Bottom-up	Extended Snapshot	Integrating tool of element models	Comprehension of economic activity and environmental loadings with Social Accounting Matrix and energy balancing approach	Accounting tool
	Energy supply and demand regulation	Temporal and spatial regulation of electricity, heat and hydrogen	Adjustment among temporal and spatial fluctuation of energy demand and supply	Simulation and optimization type model
	Enduse[global]	GHG,SO2,NOx,PM abatement technology	Technology selection for global warming, regional air pollution	Country-level or regional-level bottom-up model
	Enduse[country]	GHG,SO2,NOx,PM abatement technology	Technology selection for global warming, regional air pollution	Country-level or regional-level bottom-up model
Impact Assessment	Enduse[local]	GHG,SO2,NOx,PM abatement technology	Technology selection for global warming, regional air pollution	Country-level or regional-level bottom-up model
	Impact	Impact assessment of climate change	Impact assessment at global scale	Process model based on raster GIS data
	Impact[Country]	Impact assessment of climate change	Impact assessment at country scale	Process model based on raster GIS data
	Impact[policy]	Integration of mitigation policy evaluation and impact assessment	Investigation of stabilization level and mitigation policy with considering consequent impacts	Calculating global GHGs paths