Future AIM modeling

~Focused on mid-term national integrated assessment models~

Yuzuru Matsuoka

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Focusing points

- AIM project(B52)
- APEIS
- Low Carbon Society toward 2050 Project(S3)
- Climate Impact Top-down project(S4)
- Others

- Reinforcement of national/regional integrated assessment processes coupled with global assessment processes.
- Expansion of global warming specific issues to more comprehensive integration of environmental issues, such as low material society, WEHAB problems, and so on.

AIM model family, FY2003

	Top-down/CGE			End-use, Energy, Technology Bottom-up				Impact Assessment						Constructing Institution	Work-support-type tool		Others
	AIM/Ecosystem	AIM/Material	AIM/CGE	AIM/Trend	AIM/Enduse[local]	AIM/Enduse[country]	AIM/Enduse[global]	AIM/Impact	AIM/Impact[Country]	AIM/Impact[policy] (tentative name)	AIM/DVM-LU (tentative name)	AIM/Water	AIM/Air	AIM/Institution (tentative name)	AIM/Common Database	A-GIS	APEIS/Strategy Database
Category	Conservation of ecosystem/ water stress/ landuse/ pollution in developing countries	CO2 reduction, energy consumption, waste management. environmental industry, and recycling-based society	Energy, GHG Control	Evaluate country-wise environmental problems	GHG,SO2,NOX,PM abatement technology	GHG,SO2,NOX,PM abatement technology	GHG,SO2,NOX,PM abatement technology	Impact assessment of climate change	Impact assessment of climate change	Integration of mitigation policy evaluation and impact assessment	Impact assessment of climate change and land-use change	Impact assessment	Environmental Assesment	International egotiation, international relations	Sharing of data	Data visualization	analysis of counterm easure
Objective	Modeling of relationship among economic activities, land use and ecosystem	Economic and material flow impact by waste management and climate policy	Long-term global warming	Quantification and analysis of energy and environmental variables	Technology selection for global warming, regional air pollution	Technology selection for global warming, regional air pollution	Technology selection for global warming, regional air pollution	Impact assessment at global scale	Impact assessment at country scale	Investigation of stabilization level and mitigation policy with considering consequent impacts	Integrated assessment of the interaction among climate, vegetation and land-use	Integrated assessment of water supply and demand focusing on urban area	Regional and country scale atmospheric environmental analysis	Supporting constructing international institution	Sharing of input and output of AIM family's models in unified format	Addition of geographic information to output of AIM family's model	analysis for effect innovation al counterm easure against environme ntal problem
Model type	Global economic model + various process models sucha as water	Country economic model	Global economic top-down model	Country-level econometric model	Country-level or regional-level bottom-up model	Country-level or regional-level bottom-up model	Country-level or regional-level bottom-up model	Process model based on raster GIS data	Process model based on raster GIS data	Tool for synthesizing current knowledges	Integrated model (process model + global economic model)	City model (coupling process and statistical model)	Atmospheric quality model + GIS	Incorporating knowledge base and information of international institutions with AIM models, and assessing institutions	Database	Interface between AIM family's model and GIS	Bottom-up model
Target year	～2100	～2030-2050	～2100-2150	～2032	～2030	～2050	～2050	～2100	～2100	～2050 (Mitigation policy) ～2100 (Impact)	～2150	～2050	-	～2100	-	-	-2050
Destination	MA (millennium ecosystem assessment)/ APEIS/ General environmental analysis	Carbon tax/ APEIS/BKP/ Coming top-down fund	EMF21 (Energy Modeling Forum) APEIS IPCC UNEP/GEO4	ACROPOLIS	Tool for country and local level policy making by AIM team in each country, Estimation of future GHG inventories	Tool for country and local level policy making by AIM team in each country	ACROPOLIS EMF21 APEIS BKP IPCC	APEIS AIACC GEF	APEIS AIACC GEF	BKP,IPCC,Initiative	Next generation of AIM model	APEIS	Regional Environmental Planning, Auxiliary benefit analysis	BKP, IPCC	Sharing of statistical data Data transfer among AIM family's models Provision of interface for output of AIM family's model	Data visualization of AIM model's output Data transfer among AIM models with consistency in spatial scale	APEIS
Content	Ecosytem and landuse in global env. problems	Assess reduction of environmental loads by promoting recycle, environmental industry and investment	Main model for top-down energy model	Simple environmental burden estimation model that can be operated by policymakers in each country	Characteristics of regional detailed resolution, Interface between regional air pollution and energy management	Assess country-level energy and GHG reduction policy, Main tool to achieve reduction target for AIM team in each country	Bottom-up model covering world region and supplemented by AIM/CGE	Flagship model of AIM/Impact study	Distribution package for collaborative research teams of AIM	Communication tool for policymakers	Full couple model of land-use and land-cover changes	Urbanization, water use management, coupling water quantity and quality problem	Coupled with AIM/Enduse[local], analysis of regional atmospheric environment	To assess efficiency and equity of UNFCCC and the Kyoto Protocol etc.	Supplement tool of AIM family's model Interface of stakeholders for output of AIM family's model	Supplement tool of AIM family's model	Interface of policy makers
Work time schedule	Middle for MA/ Middle for APEIS	Short for cabon tax in Japan and BKP/ long for application to Asian countries	Short-term: EMF21, middle-term: APEIS, GEO4, long-term: IPCC	Operational	Operational	Operational	short-term: ACROPOLIS, EMF21, middle-term: APEIS, BKP, long-term:IPCC	Operational	Short/Mid term	Mid term	Mid/Long term	Short/Mid term	Soon	Short/Mid term	Short -Medium	Short -Medium	Short -Medium
1:MoE		○ carbob tax / BKP / recycling-based society				○BKP	○BKP				○BKP			○BKP			
2:APEIS	○		○					○	○			○	○				○
3:MA	○											△					
4:EMF21			○				○										
5:ACROPOLIS				○			○										
5:IPCC			○				○			○BKP	○			△			
6:GEO, etc		△Asian countries	○GEO4	○GEO4	○	○	○		○AIACC,GEF	○Initiative			○				
Audience	Global	MoE/National gov.	Outside	Outside	each country, local government, outside	MoE, each country government, outside	MoE, each country government, outside	Outside	Outside	MoE/outside	Outside	Outside	Local government	Outside	Inside of AIM team, Policy makers	Inside of AIM team	MOE, Asian foreign-governments
Task	Completion of model	Link with enduse model	Completion	To include more environmental indices	Link with AIM/AIR(air pollution model and GIS, revision of data	Revision of data	Link with the country models	Additional modules Manual writing	Additional modules and Manual writing	Fix specification and development schedule in detail	Make a linkage between land-use model and global dynamic vegetation model	Linkage of water resource assessment model	Link with A-GIS	Incorporating with other AIM models	Linkage with AIM family's model Reinforcement of database	Development of user interface and various command for interpolation	Reinforcement of database
Main modeller	Masui & Hijioka	Masui	Fujino	Fujino	Kainuma	Kainuma	Kainuma	Takahashi, Hijioka	Takahashi, Hijioka	Takahashi, Hijioka	Takahashi	Hijioka	Fujiwara	Kameyama	Hibino of FRIC	Ishii of FRIC	Hibino of FRIC

AIM model family, FY2006

Kind	Name	Category	Objective	Model type	Target year	FY 2006 activity
Top-down/CGE	Ecosystem	Conservation of ecosystem/ water stress/ landuse/ pollution in developing countries	Modeling of relationship among economic activities, land use and ecosystem	Global economic model + various process models such as water	~2100	Use common Economic module → Specialized in specific environmental change processes
	CGE	Energy, GHG Control	Long-term global warming	Global economic top-down model	~2100-2150	Specialized in energy supply and demand mechanism
	Material	CO2 reduction, energy consumption, waste management. environmental industry, and recycling-based society	Economic and material flow impact by waste management and climate policy	Country economic model	~2030-2050	Connecting with stock models, houshold models, transport models and so on.
	Trend	Evaluate country-wise environmental problems	Quantification and analysis of energy and environmental variables	Country-level econometric model	~2032	Extention to simultanious equation models, more firm caliblation
	Backcasting	GHG, Energy, Recycled society	Establishing scenarios toward saustainable society from view points of environment and economy	Country-level dynamic optimization model	~2050	Merging and aggregation of AIM/material and AIM/Trend
Models for scenario making	Population	Population, household	Establishing scenarios toward saustainable society from view points of environment and economy	Cohort-component model, houshold transition matrix model	~2050	Quantitative shinario making tools for mid-term national/regional integrated assessment
	Building	Residential, non-residential building	Estimation of building demands related to houshold change, economic change and so on	Stock dynamics model	~2050	
	Transport	Passenger and Freight transport demand	Estimation of transport demand related to national/regional/urban land planning	Trip generation, modal share modeling	~2050	
	Stocks	Infrastracture, capital, buildings	Estimation of raw material needs, waste generation related to recycling and economic activity		~2050	
End-use, Energy, Technology Bottom-up	Energy supply and demand regulation	Temporal and spatial regulation of electlicity, heat and hydrogen	Adjustment among temporal and spatial fluctuation of energy demand and supply	Simulation and optimization type model	~2050	
	Enduse[global]	GHG,SO2,NOX,PM abatement technology	Technology selection for global warming, regional air pollution	Country-level or regional-level bottom-up model	~2050	Still developing. Estimation of feasibility and economic burdens of low carbon world
	Enduse[country]	GHG,SO2,NOX,PM abatement technology	Technology selection for global warming, regional air pollution	Country-level or regional-level bottom-up model	~2050	Keep maintainance
	Enduse[local]	GHG,SO2,NOX,PM abatement technology	Technology selection for global warming, regional air pollution	Country-level or regional-level bottom-up model	~2030	
Impact Assessment	Impact	Impact assessment of climate change	Impact assessment at global scale	Process model based on raster GIS data	~2100	Keeping maintainance and reinforcement ? Anyway, it is necessary to reconfirm the developing policy, to review and to reorganize it.
	Impact[Country]	Impact assessment of climate change	Impact assessment at country scale	Process model based on raster GIS data	~2100	
	Impact[policy]	Integration of mitigation policy evaluation and impact assessment	Investigation of stabilization level and mitigation policy with considering consequent impacts	Tool for synthesizing current knowledges	~2100	
	Water	Impact assessment	Integrated assessment of water supply and demand focusing on urban area	City model(coupling process and statistical model)	~2050	Coupling with AIM/GBDB(Global basin database), and reinforce for more specific issues, such as MDG and so on
	Air	Environmental Assesment	Regional and country scale atmospheric environmental analysis	Atmospheric quality model + GIS	~2050	Coupling with AIM/Enduse[local], and estabilsh firm and sound platform for assessing long-range and urban air pollution issues.

AIM model family, FY2006 –topdown/CGE-

Kind	Name	FY 2006 activity
Top-down/CGE	Ecosystem	Use common Economic module { Specialized in specific environmental change processes
	CGE	Specialized in energy supply and demand mechanism
	Material	Connecting with stock models, houshold models, transport models and so on.
	Trend	Extention to simultanious equation models, more firm caliblation
	Backcasting	Merging and aggregation of AIM/material and AIM/Trend

AIM model family, FY2006 –scenario making-

Kind	Name	Category	Objective	Model type	Target year	FY 2006 activity
Top-down/CGE	Material	CO2 reduction, energy consumption, waste management. environmental industry, and recycling-based society	Economic and material flow impact by waste management and climate policy	Country economic model	~2030-2050	Connecting with stock models, houshold models, transport models and so on.
	Trend	Evaluate country-wise environmental problems	Quantification and analysis of energy and environmental variables	Country-level econometric model	~2032	Extention to simultanious equation models, more firm caliblation
	Backcasting	GHG, Energy, Recycled society	Establishing scenarios toward saustainable society from view points of environment and economy	Country-level dynamic optimization model	~2050	Merging and aggregation of AIM/material and AIM/Trend
Models for scenario making	Population	Population, household	Establishing scenarios toward saustainable society from view points	Cohort-component model, household transition matrix	~2050	
	Building	Residential building	Estimation of residential building related to houshold change,	Stock dynamics model	~2050	
	Transport	Passenger and Freight transport demand	Estimation of transport demand related to national/regional/urban land planning	Trip generation/modal share modeling	~2050	
	Stocks	Infrastracture, capital, buildings	Estimation of raw material needs, waste generation related to recycling and economic activity		~2050	
	Energy supply and demand regulation	Temporal and spatial regulation of electlicity, heat and hydrogen	Adjustment among temporal and spatial fluctuation of energy demand and supply	Simulation and optimization type model	~2050	
End-use, Energy, Technology Bottom-up	Enduse[global]	GHG,SO2,NOX,PM abatement technology	Technology selection for global warming, regional air pollution	Country-level or regional-level bottom-up model	~2050	Still developing. Estimation of feasibility and economic burdens of low carbon world
	Enduse[country]	GHG,SO2,NOX,PM abatement technology	Technology selection for global warming, regional air pollution	Country-level or regional-level bottom-up model	~2050	Keep maintainance
	Enduse[local]	GHG,SO2,NOX,PM abatement technology	Technology selection for global warming, regional air pollution	Country-level or regional-level bottom-up model	~2030	

Hard link with AIM/Material or AIM/Backcasting

accounting tool

AIM model family, FY2006 –Enduse and impact-

Kind	Name	FY 2006 activity
End-use, Energy, Technology Bottom-up	Enduse[global]	Still developing. Estimation of feasibility and economic burdens of low carbon world
	Enduse[country]	Keep maintainance
	Enduse[local]	
Impact Assessment	Impact	Keeping maintainance and reinforcement ? Anyway, it is necessary to reconfirm the developing policy, to review and to reorganize it.
	Impact[Country]	
	Impact[policy]	
	Water	Coupling with AIM/GBDB(Global basin database), and reinforce for more specific issues, such as MDG and so on
	Air	Coupling with AIM/Enduse[local], and estabilsh firm and sound platform for assessing long-range and urban air pollution issues.

Integrated Assessment Model for national/regional scenario making

The objects of national/regional scenario making with IAM are;

1. To support designing future societies, which satisfy prescribed environmental, economical and social targets.
2. To show feasible, concrete and plausible pathways that will reach the future societies.

The design is consistent, quantitative, feasible and plausible from the view points of technology, economy and sociality.

Often the designed societies are not on the BaU pathway (current trend), and in order to reach them, we need many trend breaking interventions.

Integrated Assessment Model for national/regional scenario making (Snapshot model)

First of all, to design future quantitatively , we must describe concrete pictures of desired societies, which are feasible , and consistent with physical, economical, technological laws. To keep the consistency and feasibility, we are developing a group of models, called "Snapshot models". Example of snapshot models are;

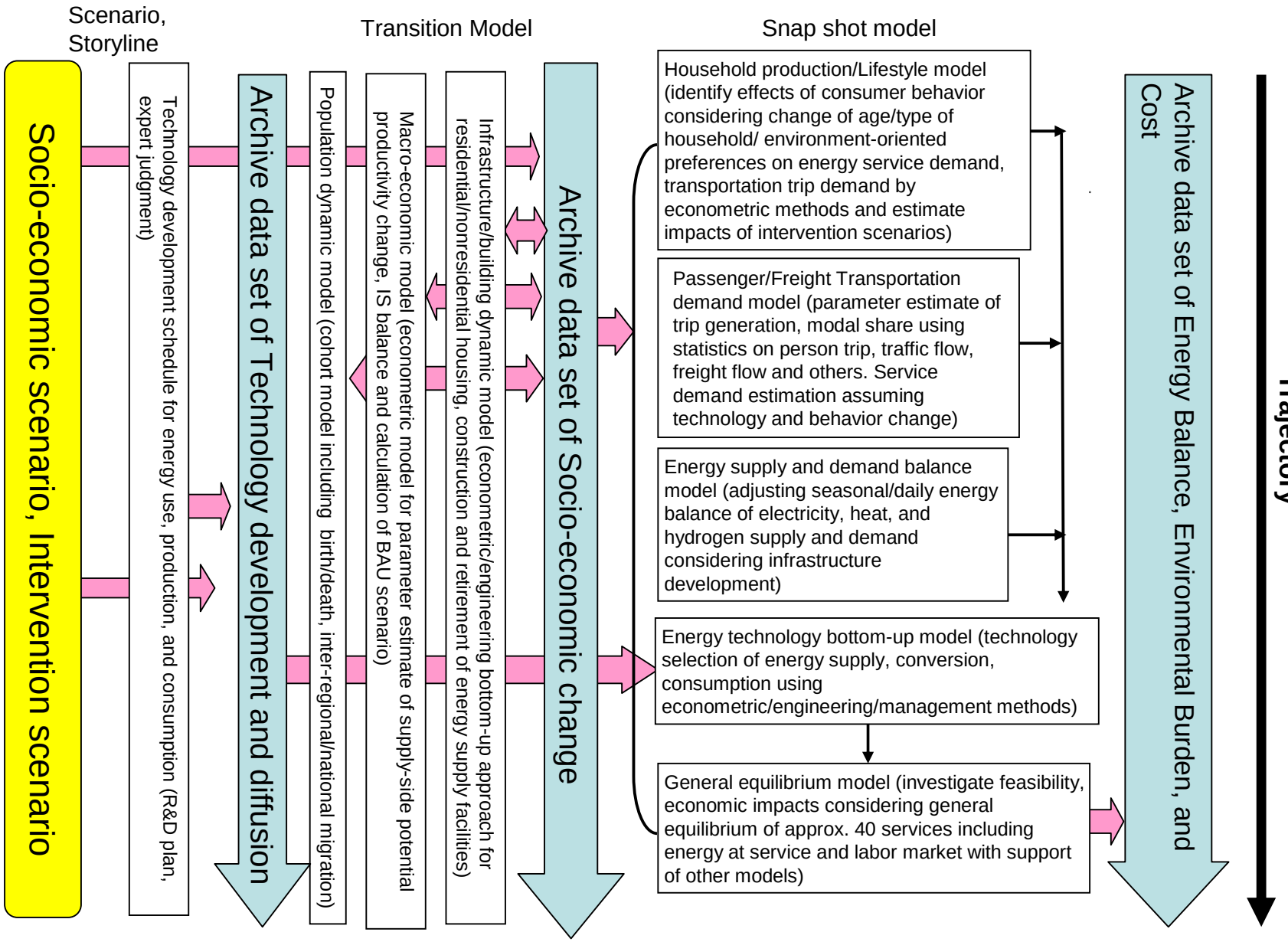
- Household production/Lifestyle model
- Passenger/Freight transportation demand model
- Energy supply and demand balance model
- Energy technology bottom-up model
- General equilibrium model

Integrated Assessment Model for national/regional scenario making (Transition model)

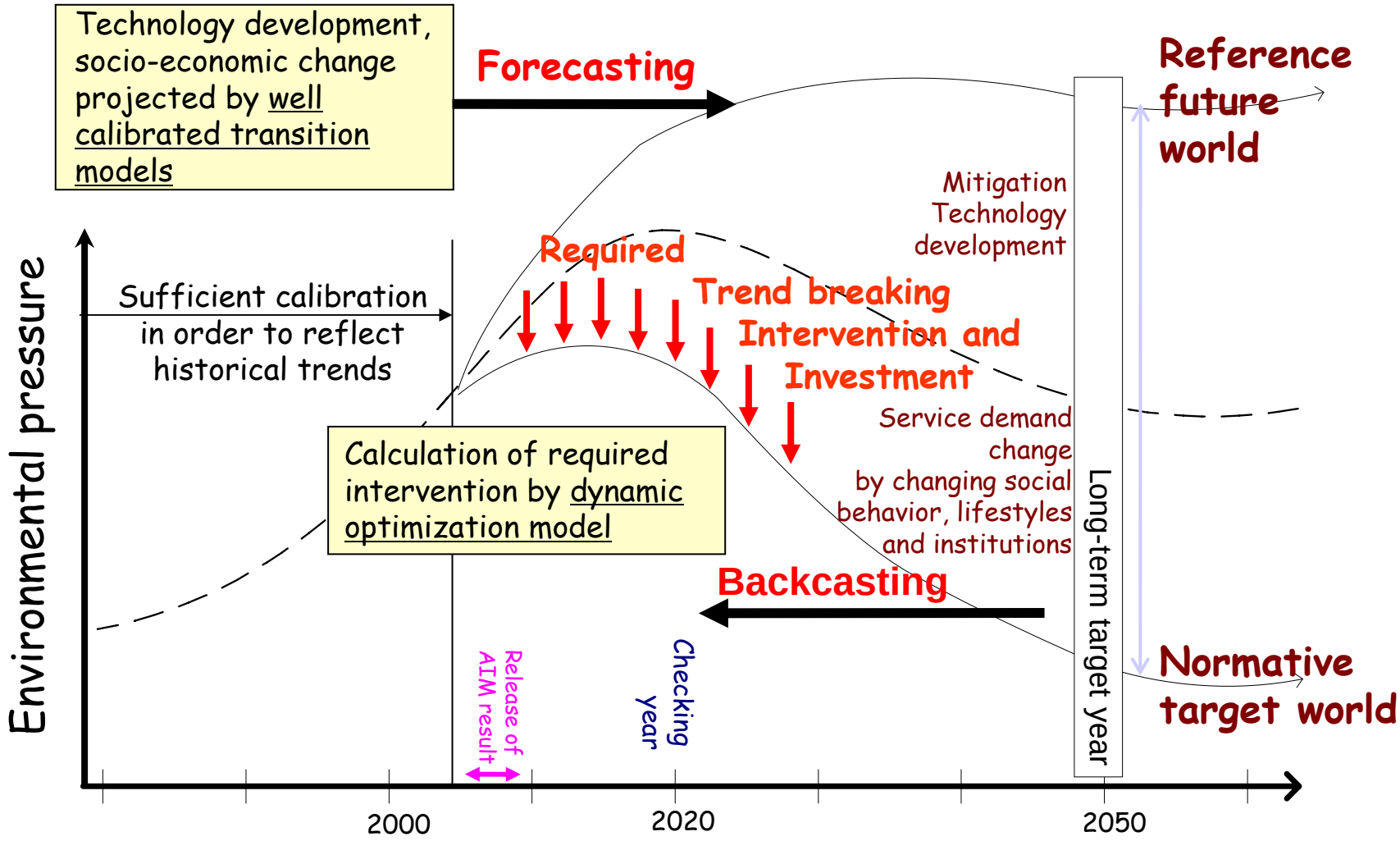
Secondly, to design pathways which leads us to future prescribed normative societies, we must design concrete schedules of trend breaking innovation processes of technology, social and economic systems and infrastructure development with some rationale. To design these schedules, we are developing a group of models, called "Transition models". Example of transition models are;

- Infrastructure/building dynamic model
- Dynamic macro-economy model
- Population and household transition model

Coupling of storylines, transition models and snapshot models



Forecasting from now and Backcasting from future prescribed/normative world by the transition models

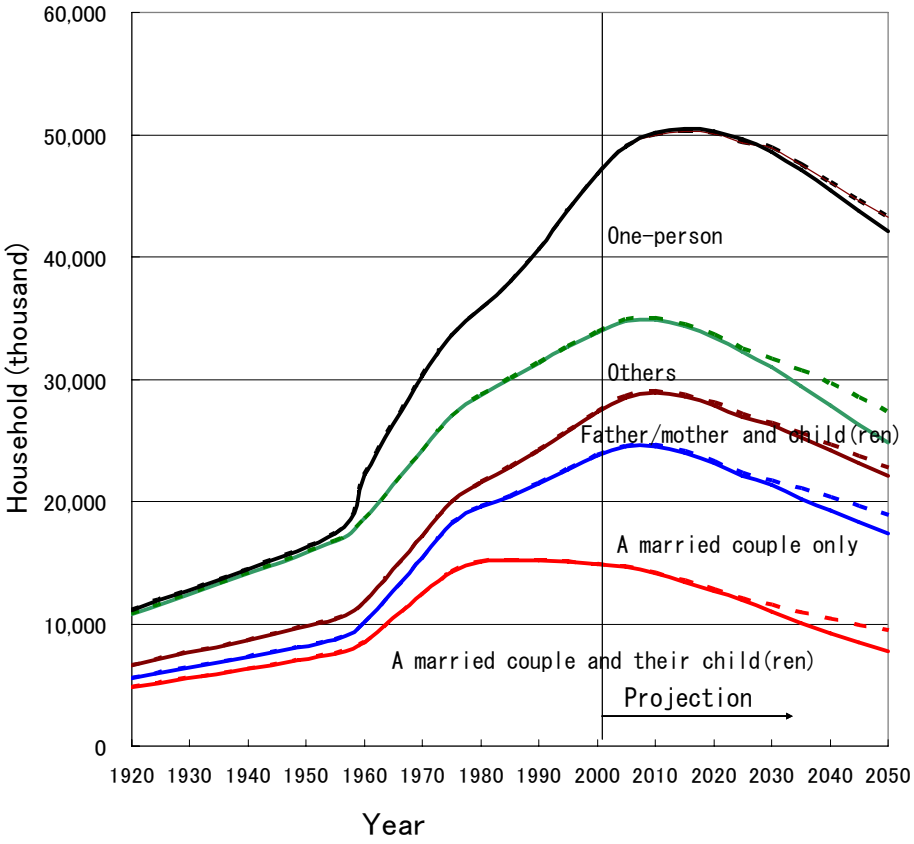


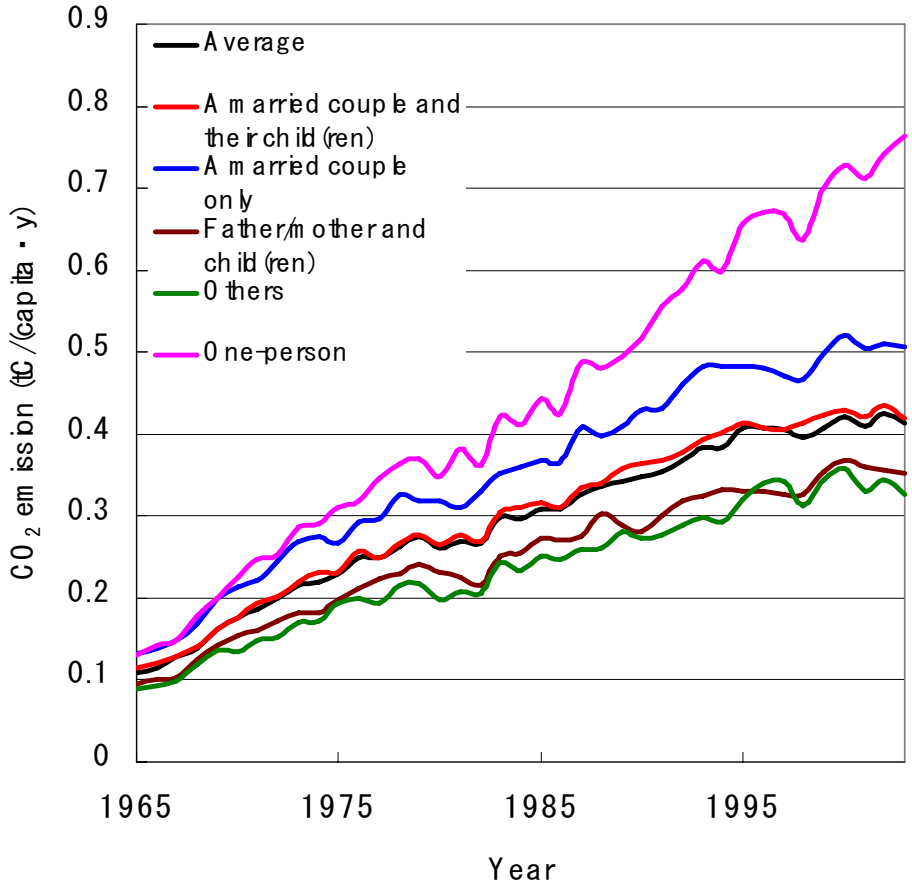
Concerns and Keywords of the Future Society

Besides technology development, the models should describe the following future trends and their impacts on environment.

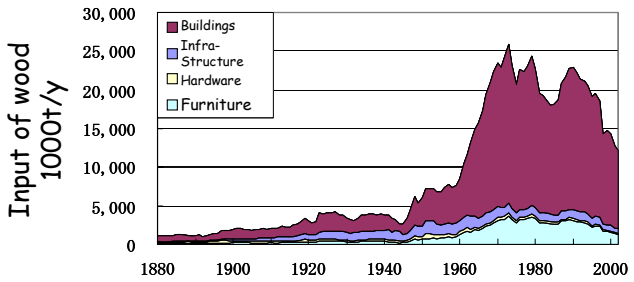
- Demographic transition: Low fertility, Aging society
- Lifestyle change: Household type changes, Empowerment of women, Affluence, Flexibility, Insecurity, Social capital loosing, Pension problem
- Transportation change: Urbanization, Modal change
- Industrial change: Weightless society, hyper-IT, globalization
- Other severe environmental constraints, such as an orientation toward recycle-oriented society

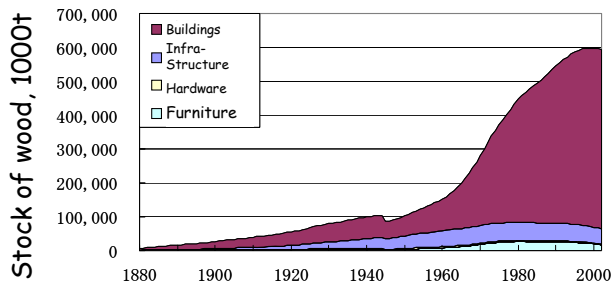
Change of types of household and its impact on CO_2 emission Experience of Japan, 1965-2000

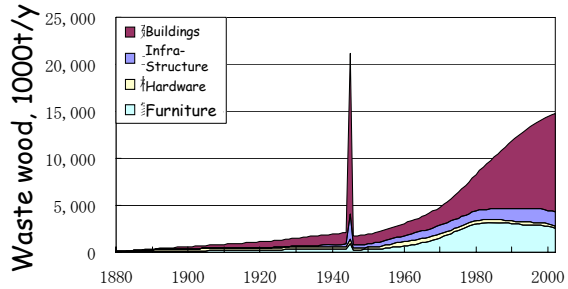


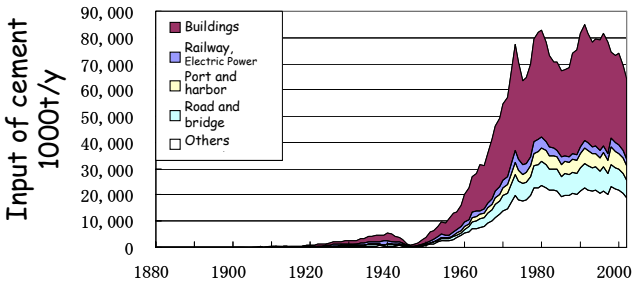


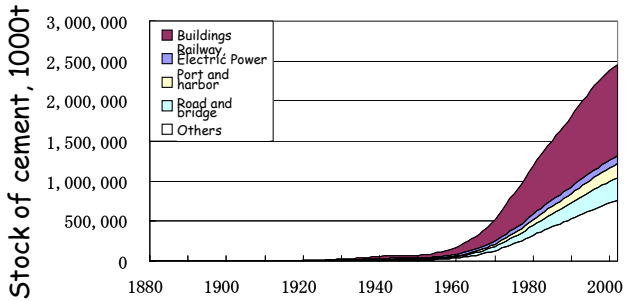
Stock dynamics - Material stock balances in Japan's society -

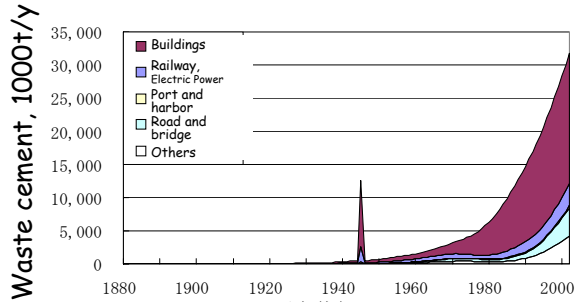


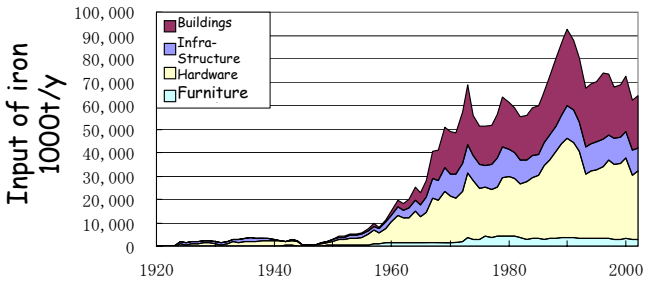


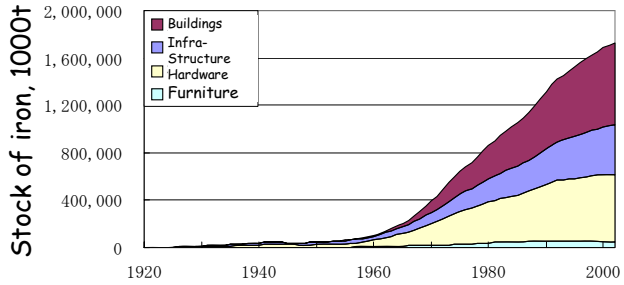


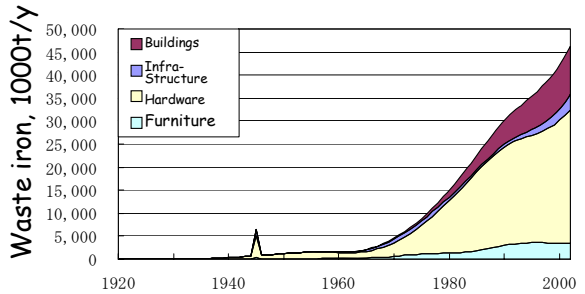




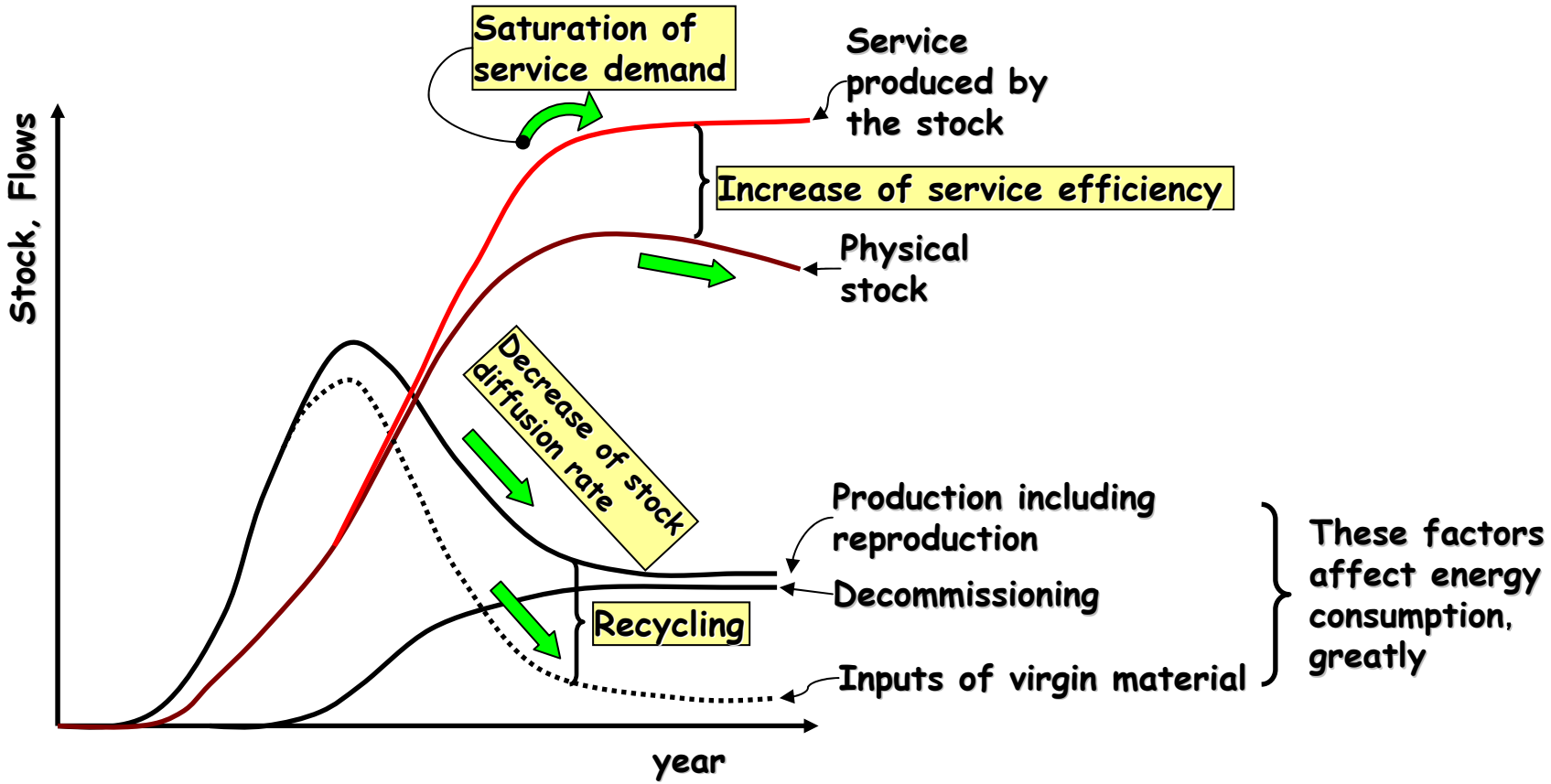








Stock dynamics greatly affects social energy/material efficiency



In order to design pathways which lead us to prescribed world,

The Backcasting Model

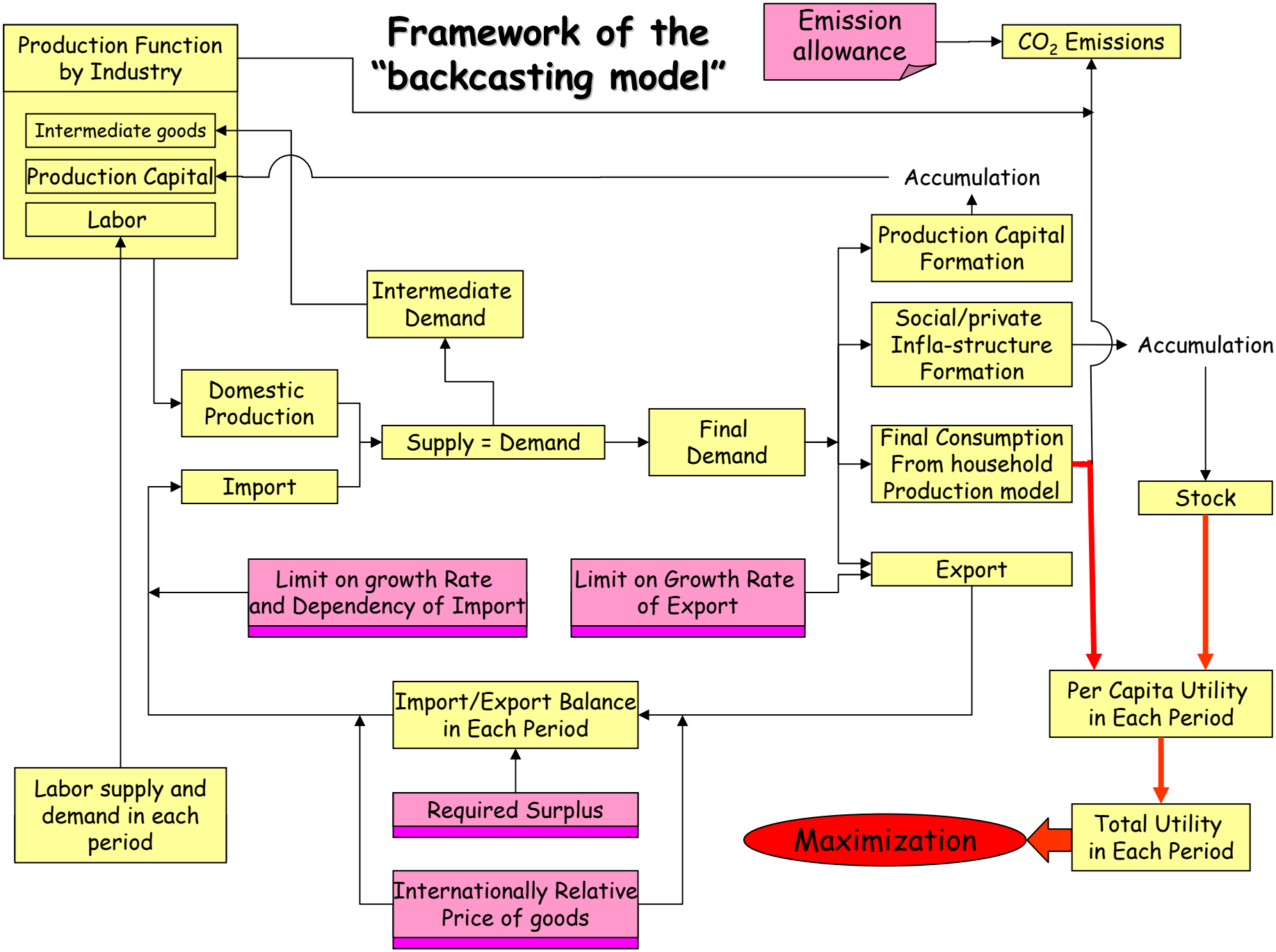
will be developed

- Objective of the model is to identify required political intervention and public/private investment schedule with backcasting from future prescribed world.

- The model is one country multi-sector (＜20 sectors) econometric model coupled with
  1) Intervention/investment optimization module,
  2) Stock dynamics (infrastructure/buildings/capital) modules
  3) Aggregated environmental load emission modules

- And has interfaces for
  1) The changing of input-output coefficients by technology development,
  2) Final consumption changes projected by the household life-style model
- The model should be well calibrated with historical dynamics, and can differentiate current trends and required tread breaking intervention.

Framework of the "backcasting model"

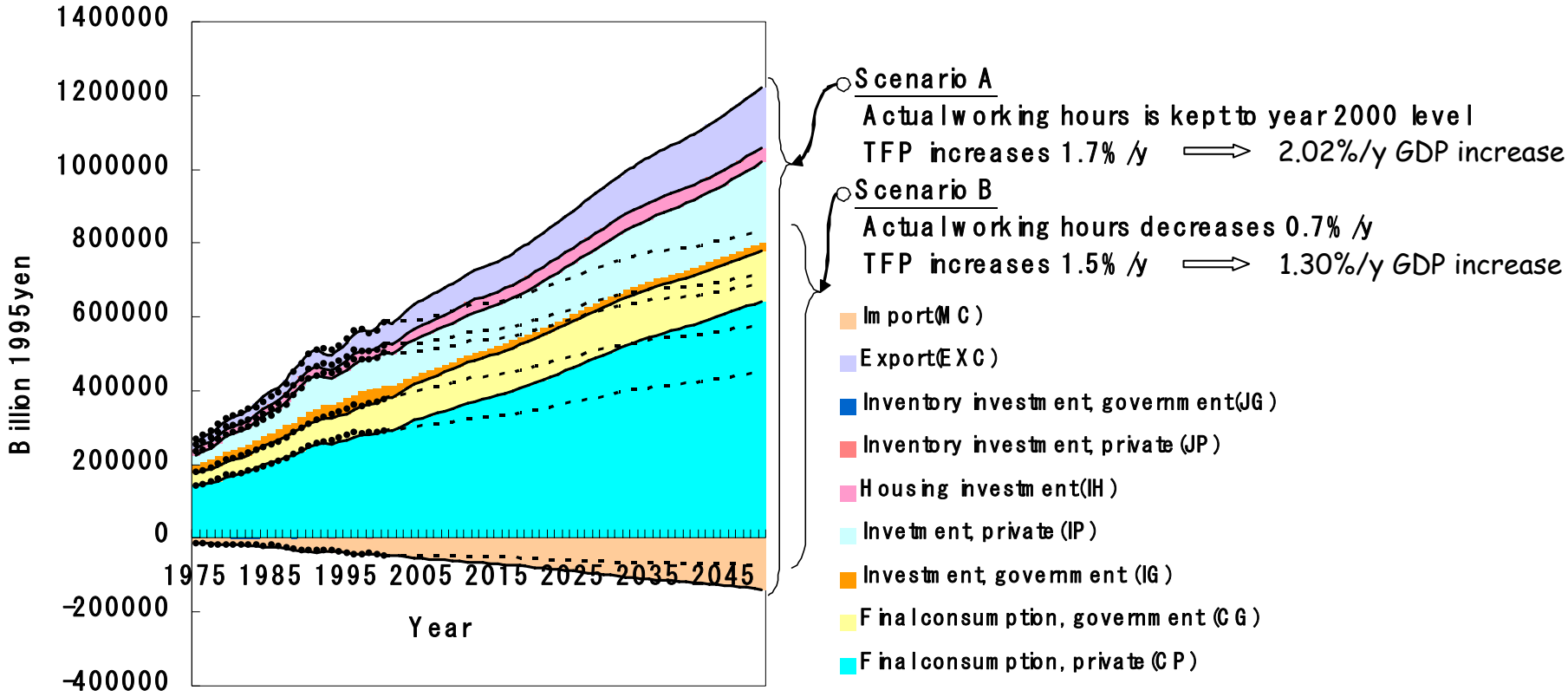


AIM model family, FY2006 –topdown/CGE-

Kind	Name	FY 2006 activity	
Top-down/CGE	Ecosystem	Use common Economic module	Specialized in specific environmental change processes
	CGE		Specialized in energy supply and demand mechanism
	Material	Connecting with stock models, houshold models, transport models and so on.	
	Trend	Extention to simultanious equation models, more firm caliblation	
	Backcasting		Merging and aggregation of AIM/material and AIM/Trend

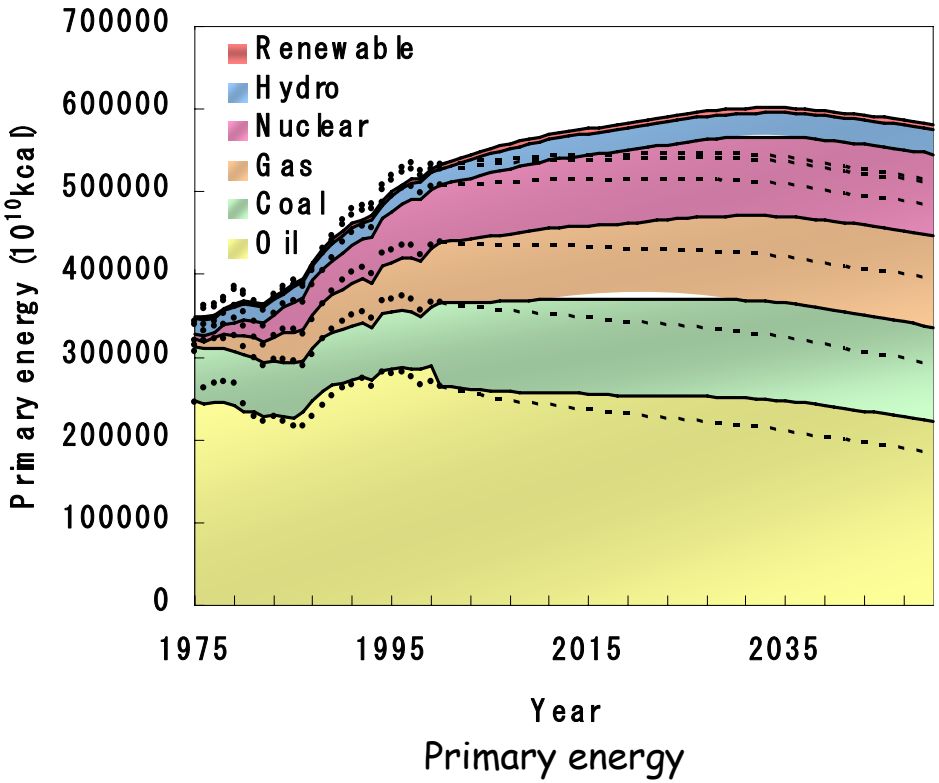
Calibration and forecasting using the macroeconomic module of the"Backcasting model"

Japan, 1975-2000 (calibration), 2001-2050 (forecasting)
No. of equations: 375 (Statistical: 155, definitional: 220)

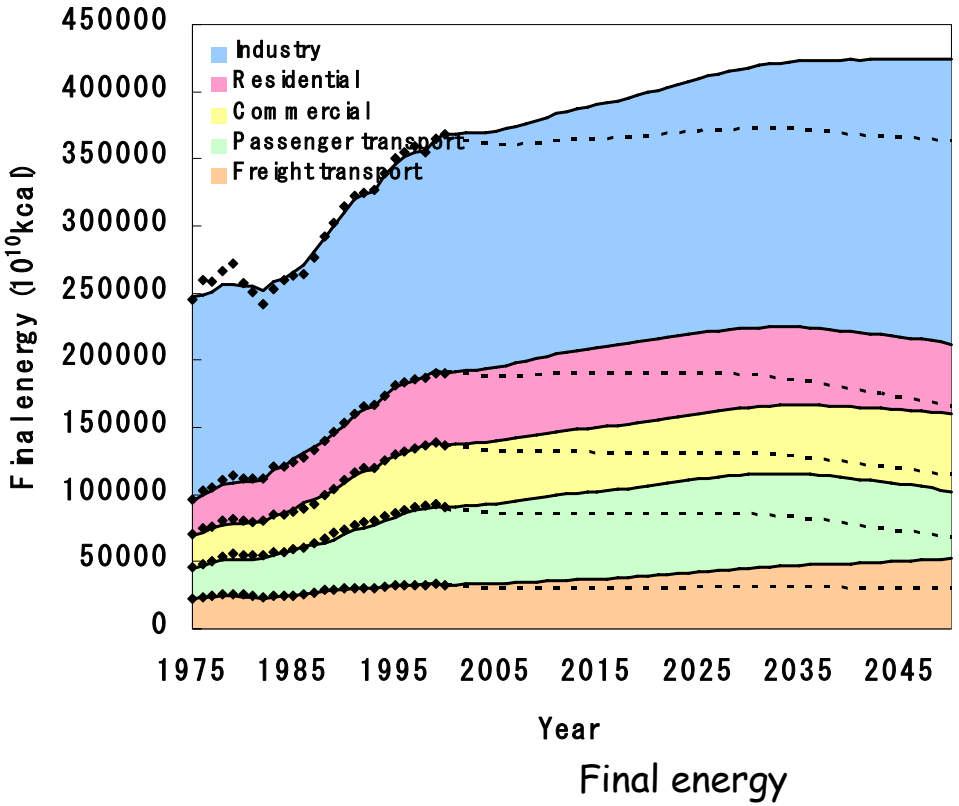


Calibration and forecasting using the macroeconomic module of the"Backcasting model"

Japan, 1975-2000 (calibration), 2001-2050 (forecasting)



Primary energy



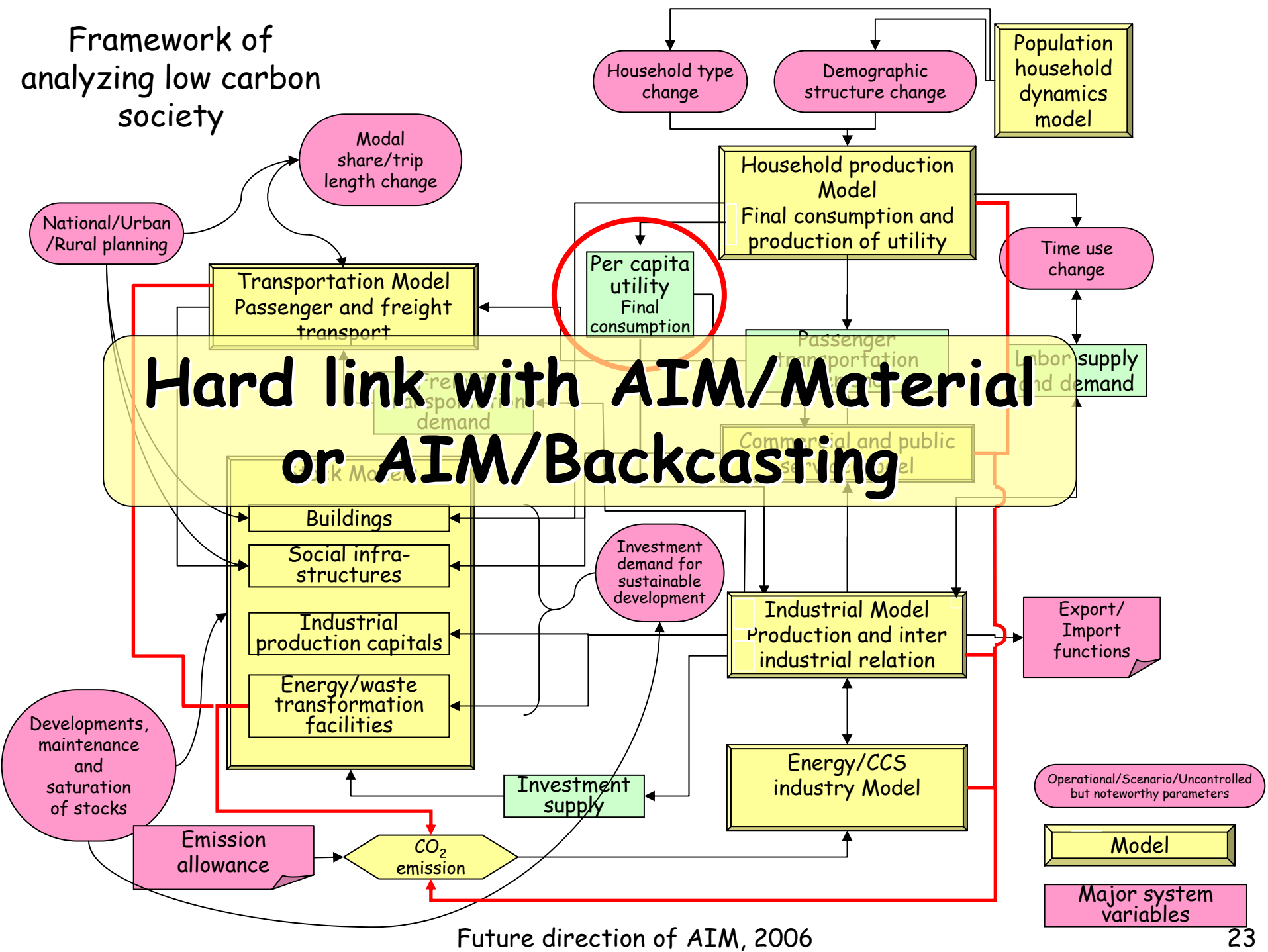
Final energy

Concerns and Keywords of the Future Society

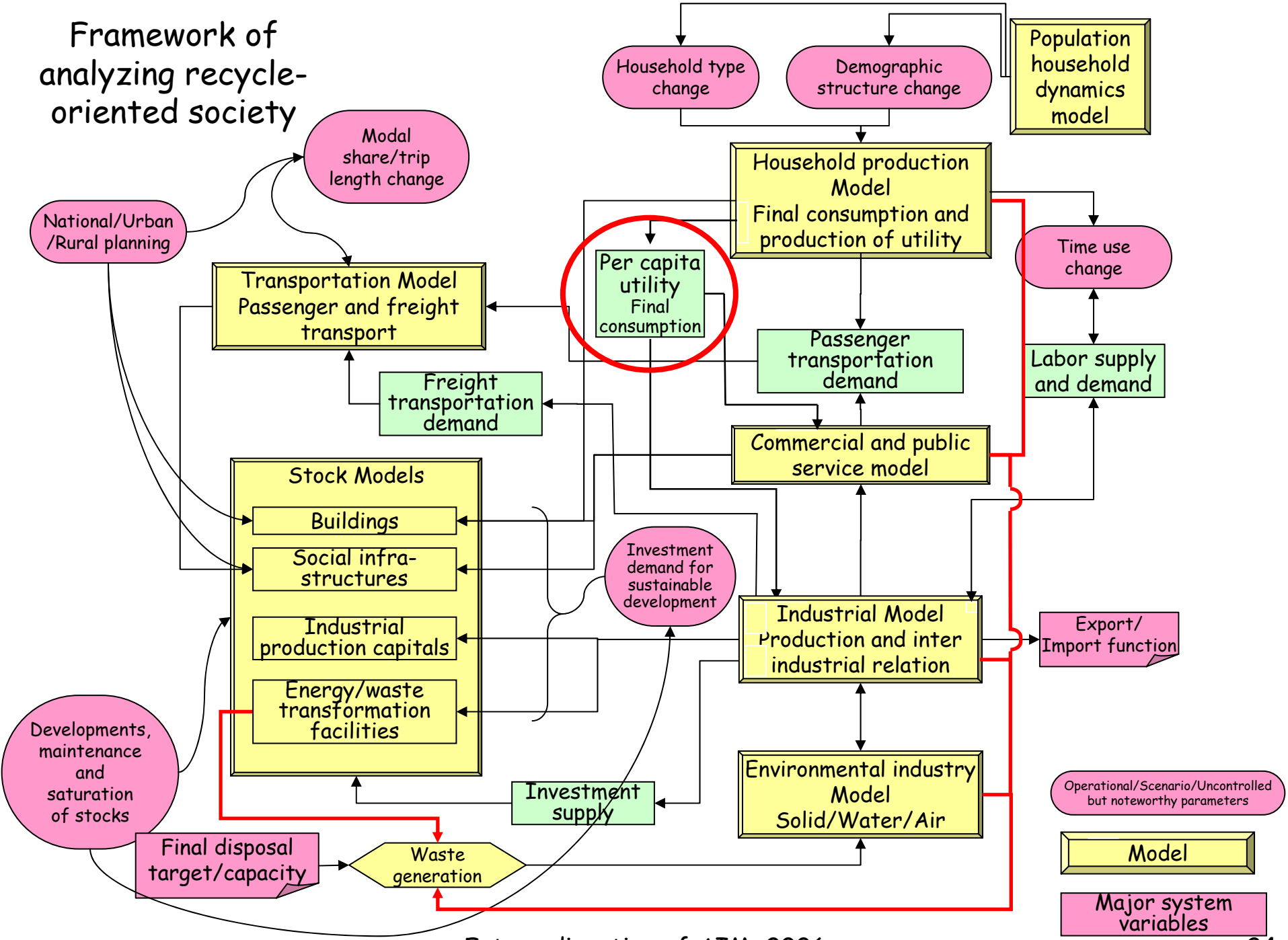
Besides economic and technology development, the models should explicitly describe the relationships between following social changes and environmental consequences.

- Changes of Demographic structure, family type
- Changes of Income, Consumption propensity, Time use
- Changes of Transportation demand; Urbanization, Modal share, trip length
- World trade environment
- Developments and saturation of social stocks, such as infrastructures and capitals and so on

Framework of analyzing low carbon society



Framework of analyzing recycle-oriented society



The 6 steps for the mid-term national IAM development

1. Examine feasibility and suitability of the research from the view points of
   1) problem definition (for example, toward low carbon society, material recycled society, coupling of these two, target index of future society, etc.),
   2) data availability,
   3) human recourses of the research team

2. Become familiar with the component models, collect and organize related information for the analysis

3. Establish/calibrate models thoroughly with the last 20-50 years, and project (forecast) the latest trend with no intervention to the next 50 years

4. Using SDB (engineering/institutional innovation's database), projected socio-economic future calculated by the above models, and a simple and transparent calculator (such as Menoco) which connects the both, we can examine relationship among socio-economic transitions and necessary innovations to keep the targets with try and error .

5. Aggregate/combine the above calculation processes within a model (i.e. Backcasting model)

6. Using the interactive version of the above tools (models), hold a series of PIA (Participatory Integrated Assessment) workshops with stakeholders to support the trend breaking movement.

Modeling activities in FY2006

From the view point of international and national establishment of environmentally sustainable development in the Asian-Pacific region;

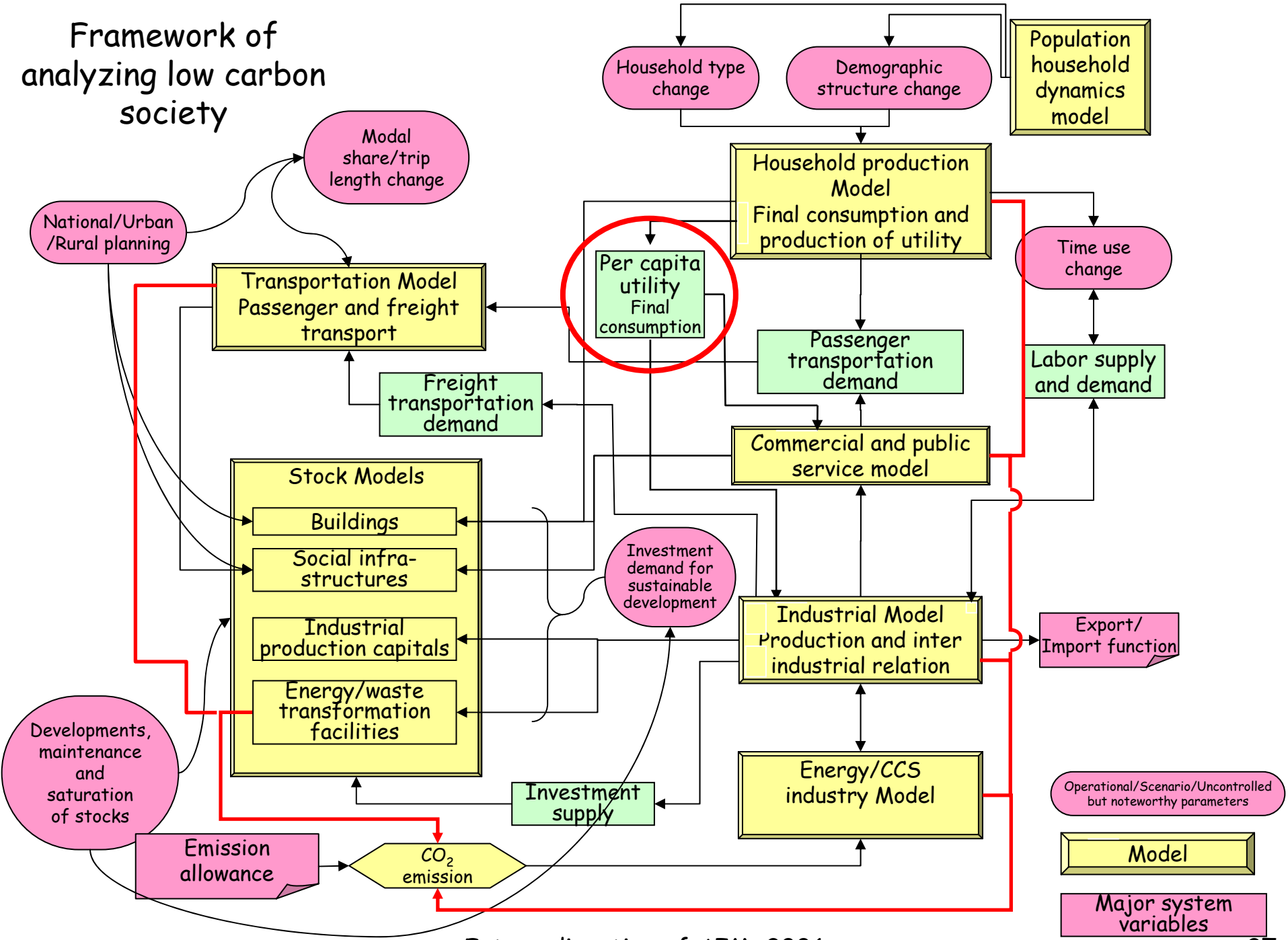
1. Focusing on the following three spatial scales and three temporal scale;
   1) International/National/Regional,
   2) 2020(2030) /2050/after 2100

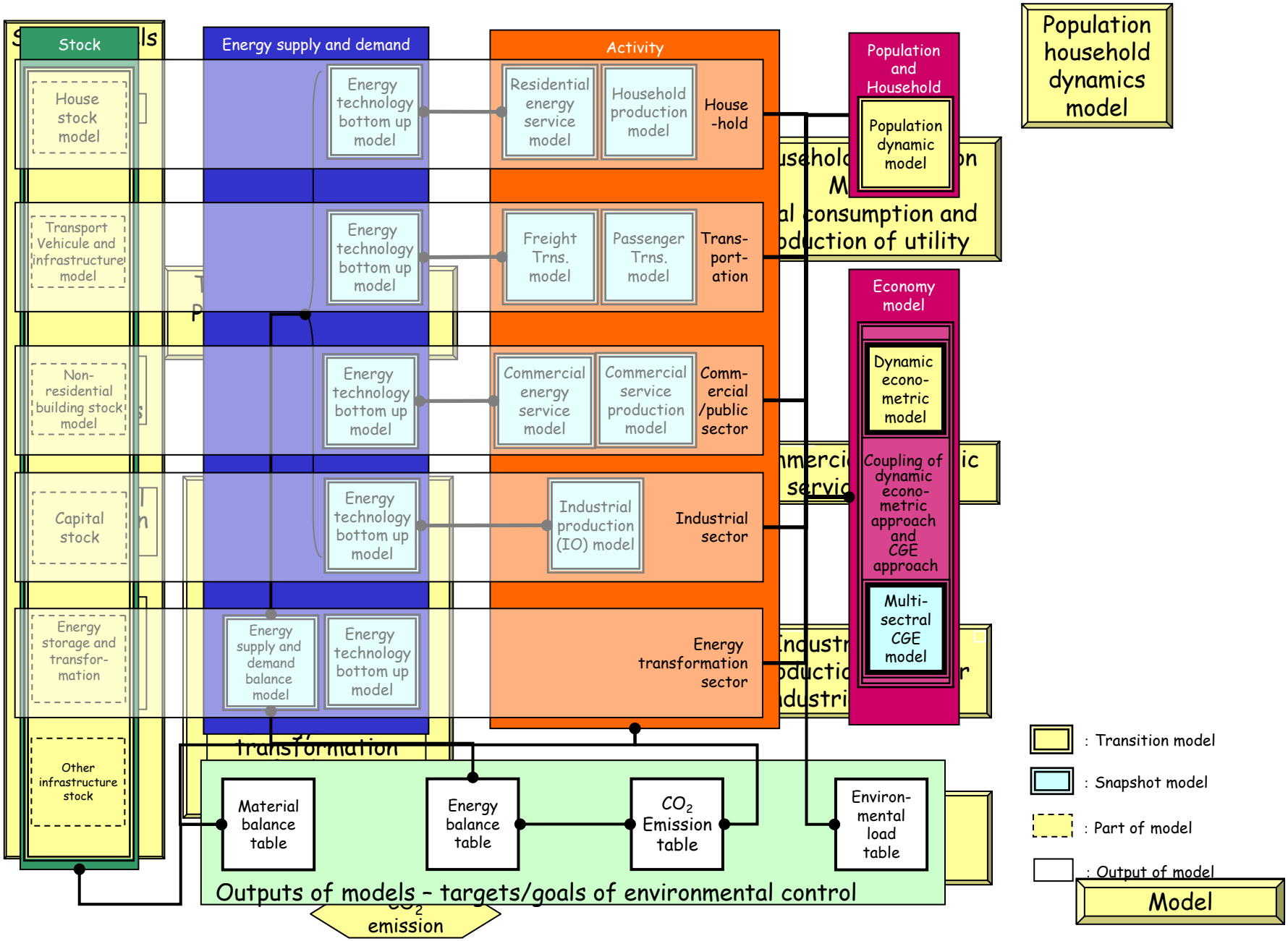
2. As for national/regional scales, we put focuses on creating;
   1) Low carbon society,
   2) Eco-efficient society.

3. For mid-term national/regional scale integrated assessment, we use models separately and combining;
   - Energy end-use model,
   - One/Multi-regional CGE/econometric models for macro-economic and industrial dynamics,
   - Demography and household model,
   - Consumption and Lifestyle model,
   - Transport demand dynamics model,
   - Stock and infra-structure model,
   - SDB (Strategic Database).

4. Also, for global long-term integrated assessment, we will keep developing AIM/Enduse[global], AIM/Ecosystem(CGE), AIM/Impact[Process], AIM/Impact[Policy].

Framework of analyzing low carbon society




Stock
Energy supply and demand
Activity
Population and Household
Population household dynamics model
House stock model
Energy technology bottom up model
Residential energy service model
Household production model
House -hold
Population dynamic model
Transport Vehicule and infrastructure model
Freight Trns. model
Passenger Trns. model
Trans-port-ation
Non-residential building stock model
Commercial energy service model
Commercial service production model
Comm-ercial /public sector
Economy model
Dynamic econo-metric model
Capital stock
Industrial production (IO) model
Industrial sector
Coupling of dynamic econo-metric approach and CGE approach
Energy storage and transfor-mation
Energy supply and demand balance model
Energy transformation sector
Multi-sectral CGE model
Other infrastructure stock
Material balance table
Energy balance table
CO_2 Emission table
Environ-mental load table
Outputs of models – targets/goals of environmental control
CO_2 emission
: Transition model
: Snapshot model
: Part of model
: Output of model
Model

Models for analyzing one country Sustainable Development