Session IX, Special lectures No4.

Back-casting approach

AIM Training Workshop 2006
October 16-20, 2006
At Ohyama Memorial Hall
National Institute for Environmental Studies,
16-2 Onogawa, Tsukuba, Ibaraki, 305-8506, Japan

Yuzuru Matsuoka
Department of Urban and Environmental Engineering
Graduate School of Engineering, Kyoto University

A long-term perspective is needed in order to overcome global environmental crises

We are facing serious environmental crises.

These are all long-term issues, ranging from several decades to centuries. Delayed policies result in very high costs or the loosing of mitigation feasibility. Long-term viewpoint and long-term policy are quite important in these cases.

Forecasting future or extrapolation of today's trends, pointing out the critical issues, and estimating the future impact are the first things. But, they should be followed by explicit manifestation of future target goals, deduction of required policies in order to reach there.

The examples are;

- U.N. Millennium Development Goals (MGD)
- Realization of a low carbon society
- Sustainable society

What is back-casting approach?
-Three stages of back-casting-

Objective: Looking for and identify the near-term actions necessary to attain long-term future goals.

The first stage : Preparing some well-laid plans in order to attain the goal.

The second stage: Survey and searching alternative plans to attain the goal, required breakthroughs, sacrificed opportunities for adopting a specified paths, and put priorities to the plans.

The third stage: “Higher order learning”

Back-casting approach as a tool for transition management

- ***Trend*** is a gradual change in a particular observed variable, which originates from other, interrelated, and persists for a long time and covers a certain domain. Trend considers only a specific domain of the society.

- ***Transition*** covers a long-term, gradual continuous process of structural societal change. It takes place through mutually reinforcing and counteracting developments in technological, economic, ecological and socio-cultural domains.

- ***Transition management*** is an approach designed to deliver an active contribution to the shaping of transitions.

- And an objective of back-casting is to design and analyze this ***transition management***.

A brief history of back-casting methodology (1)

Lovins' proposal (1976): "***backwards-looking analysis***" as a long-term planning technique for electricity supply and demand.

Robinson's back-casting (1982): the purpose of back-casting is not to produce blueprints, but to indicate relative feasibility and implications of different energy futures, including social, environmental and political implications on the assumption of a clear relationship between goal setting and policy planning.

Examples: Sweden's energy planning (1980), Transportation system (2000), Strategic planning (2000), Regional planning(1999).

A brief history of back-casting methodology (2)

From early 1990s, "***participatory back-casting***" was started. They are;

- Sustainable Technology Development (STD,1993-2000)
- Strategies towards the Sustainable Household (SusHouse,1998-2000)
- Georgia basin future project (GBFP, 2002)
- The involvement of stakeholders to develop and implement tools for sustainable households in the city of tomorrow (ToolSust, 1998-2002)

Tools for quantitative back-casting

Visions of future society may be drastically different from today's one, and it is difficult to design them as an extrapolation of today's system.

Fundamental and basic relations governed the systems must be used to check the physical, economical, and technological feasibilities of these future societies. They are;

Equations of intra-temporal mechanisms

Snap-shot models

1. Equilibrium of demands and supply
2. Balancing of energy, law materials, time budget, and monetary budget

→Quasi steady Computable General Equilibrium (CGE) model,

3. Production functions of goods and service based on feasible technology

→Technology bottom-up models, energy supply model , water demand and management model

4. Demand generation functions of people's needs

→Household production/lifestyle model, transportation demand models

Equations of inter-temporal mechanisms

Transition models

1. Dynamics of population and household

→Population and household model

2. Dynamics of production capitals, and social infrastructures

→Building dynamics model, material stock and flow model

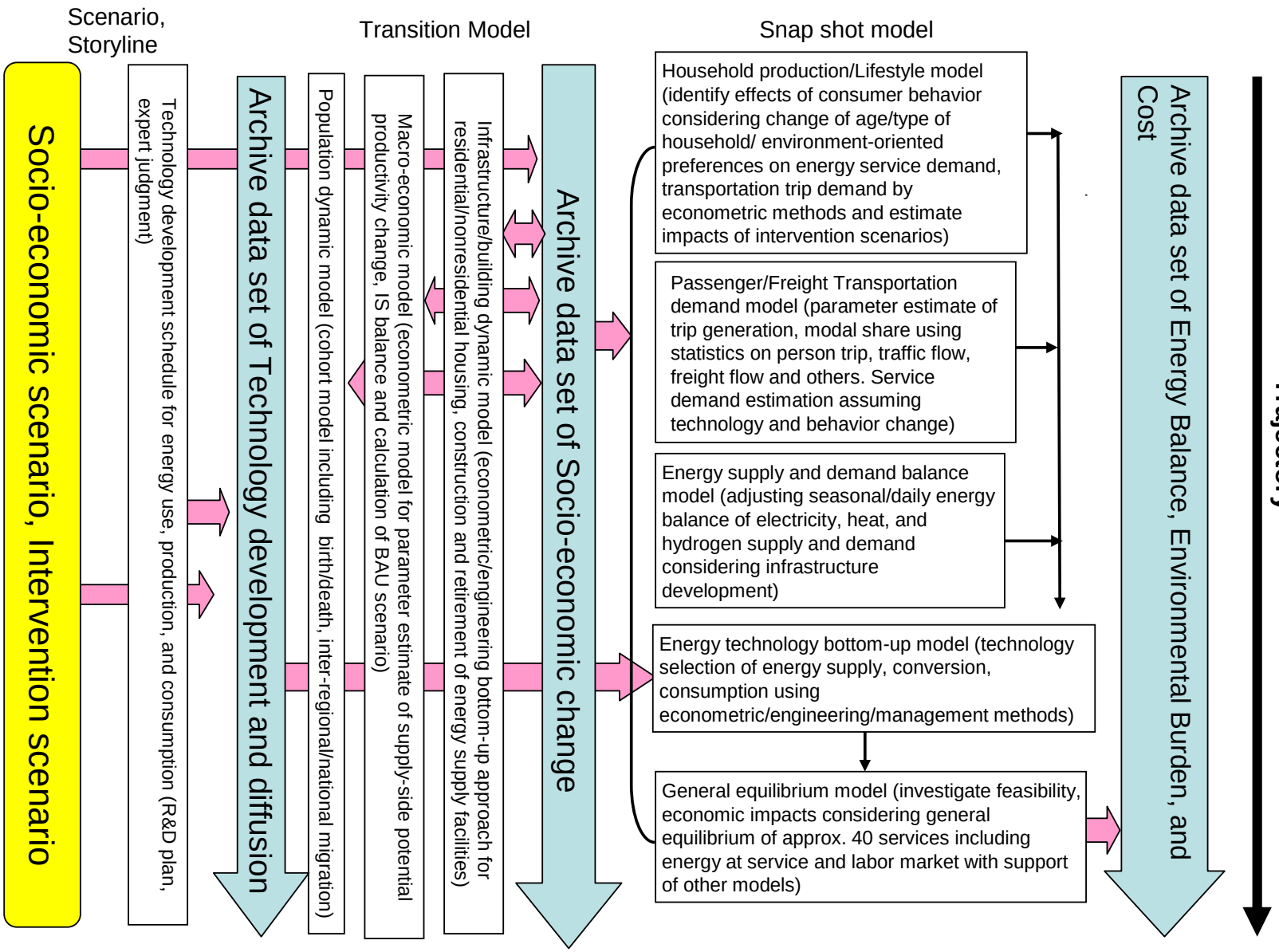
3. Cultivation, exploitation and depletion dynamics of natural capitals

→Natural capital dynamics model

4. Transition dynamics of economic institutions and instruments

→Econometric type macro-economic model

Element models for Japan low carbon society project



An example of back-casting model for Japan low carbon society project

Element models

Description and quantification of dynamic characteristics and changing mechanism of social / energy services with a bottom-up approach

Road maps of Energy technologies, and production / consumption technology progress

Transition models
- Population / household dynamic model
- Macro-economic model
- Infrastructure / building dynamic model

Snap shot models
- Household production / lifestyle model
- Passenger / freight transportation demand model
- Energy supply and demand balance model
- Energy technology bottom-up model

Back-casting model

(multi-sector dynamic optimization model)

Identification of the optimization path of infrastructure and capital investment in order to maximize cumulative social utility (present discounted value, final consumption level and social service level) from 2005 to 2050 under the following balancing equations:

- ✓Demand-and-supply balance of goods and services
- ✓Balance of energy services and energy demand-and-supply
- ✓Demand-and-supply balance of labor
- ✓Balance of international payment
- ✓Balance of infrastructure, buildings, and production capital stock

Aggregated transition dynamics of social/technological factors

Supported with the element models, we parameterize the following dynamic characteristics as a pertinent investment year, marginal abatement cost or indices of difficulty, and use them as control variables for feasibility analysis.

Energy supply sector
- Distributed energy potential and acceptance level
- CCS potential and acceptance level
- Speed of technology progress
- Speed of supply-infrastructure development

Goods/service production sectors
- Structure changing speed of production sector
- Changing speed of input-output coefficient
- Changing speed of labor-input coefficient
- Speed of energy technology efficiency improvement

Residential/commercial sector
- Change of consumption propensity
- Speed of household production efficiency improvement
- Speed of energy technology efficiency improvement

Transportation sector
- Speed of transport service efficiency improvement
- Speed of trip generation and modal change
- Speed of technology efficiency improvement
- Speed of infrastructure development

Quantify specific measures for required transition control to achieve low carbon society

Analyze required conditions for trend breaks in each sector, to identify the feasibility of achieving the CO_2 reduction target

Back-casting model for quantitative, transparent discussion toward a sustainable society

Aggregating the principles and parameters described in the element models, as constraints of the system, and formulating the system's behavior with an inter-temporal multi-sector optimum problem.

With the model, we can discuss on the schedules of investment, necessary technology development, required cost in order to reach the target world, and also, trade-off between the today's effort, feasibility and the future burdens to attain target societies.