The outline of Macroeconomic Model and Material Stock/flow Model

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Contents

Material stock / flow model

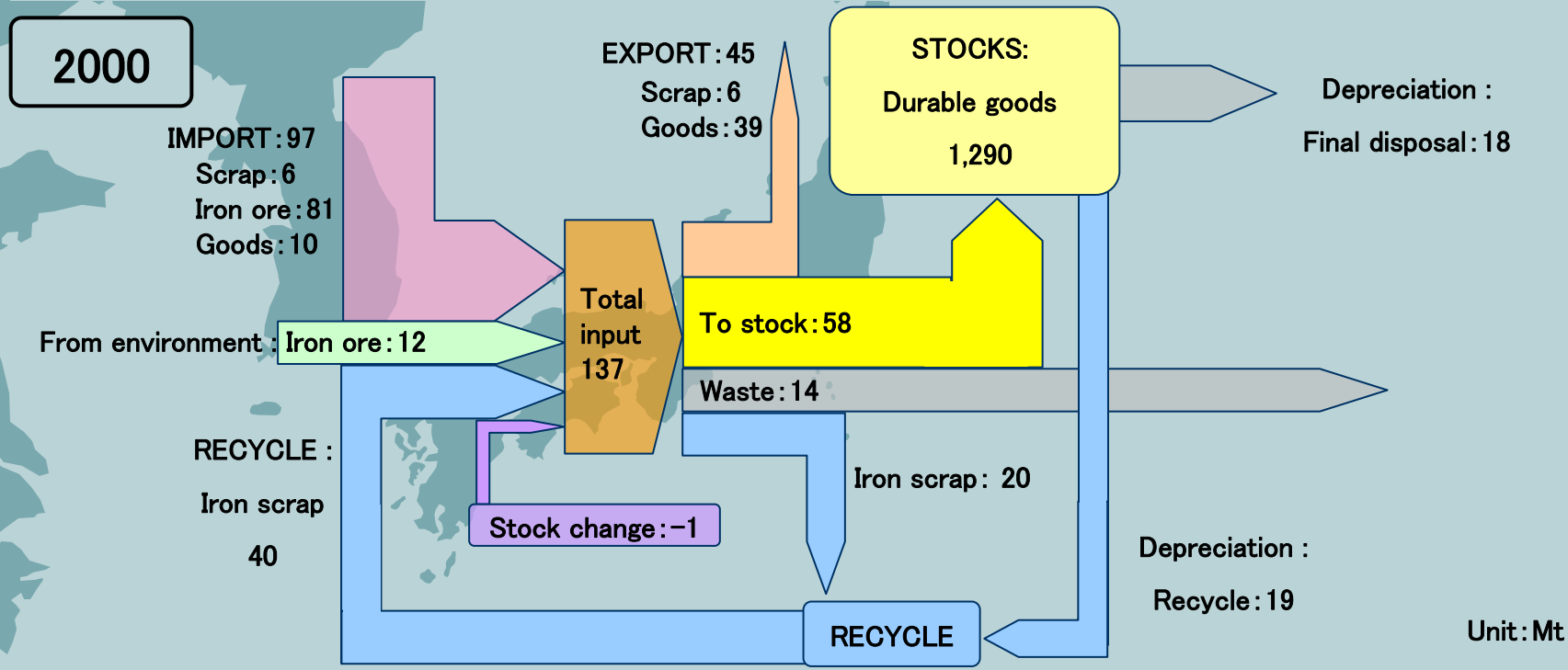
1) Estimate material stocks accumulated as durable goods
2) Estimate a) material flows among economic sectors
   b) flows between economic activities and the environment

Macroeconomic model

1) Clarify the relationship between changes in socioeconomic structure (e.g., economic growth, industrial structure, life style changes, etc.) and the energy supply-demand structure
2) Estimate CO_2 emissions with econometric method

Objective of Material Stock/flow Model

With an increase of demands for goods, a lot of materials have been accumulated as durable goods in the society.



How will these stocks change in the future?

How will these stocks affect the society?

→ 3 Viewpoints; Demand, Waste generation, Resource

Importance of Estimation of Stock

1.Estimation of Demand

Stocks affect the demand for goods. In the future, demand is given as a function of stock.

$$Demand = f(Stock)$$

2.Waste Generation

A large amount of materials accumulated in a society as durable goods are expected to generate a large amount of wastes when these goods reach the end of their lifetimes.

3.Resource

The materials contained in stocks can be treated as resources.

Considering resource constraints, following points are important,

a) what quantities of what materials will be needed in both stocks and flows in order to fulfill final demand in the future?

b) how should these resources be most effectively used?

Material Stock / flow Model

Model description

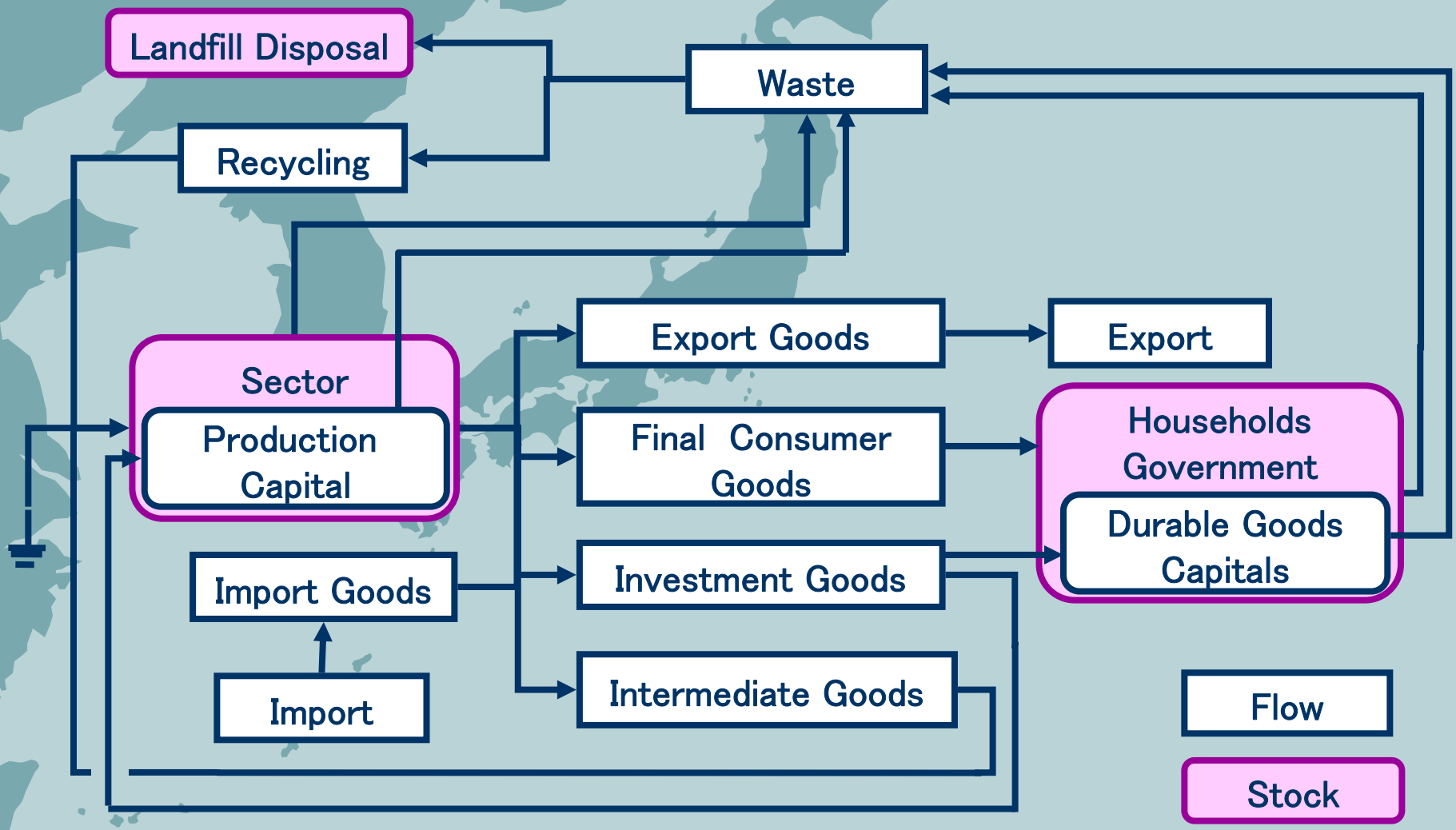
- Target Material

  iron, wood, cement, aluminum
- Time Horizon

  2000-2050
- Sector and Goods

  37 sectors and 37 goods (tentative)

Material Flow



Basic Equations

$$FD("INV",i,m,t) = VFD("INV",i,t) \cdot d(i,m,t)$$

VFD(u,i,t): quantity of material *m* in good *i* for FD sector u in year *t*

d(i,m,t): material density of material *m* in good *i*

$$\sum_{ju \in S} STCK(ju,i,m,t) =$$

$$\sum_{u,\, ju \in S} \left\{ STCK(ju,i,m,t-1) - DEP(ju,i,m,t) + INV(ju,i,m,t) + FC(u,i,m,t) \right\}$$

$$DEP(ju,i,m,t) = \sum_{\tau \le t-1} (INV(ju,i,m,\tau) + FC(u,i,m,\tau)) * pdf(i,T)$$

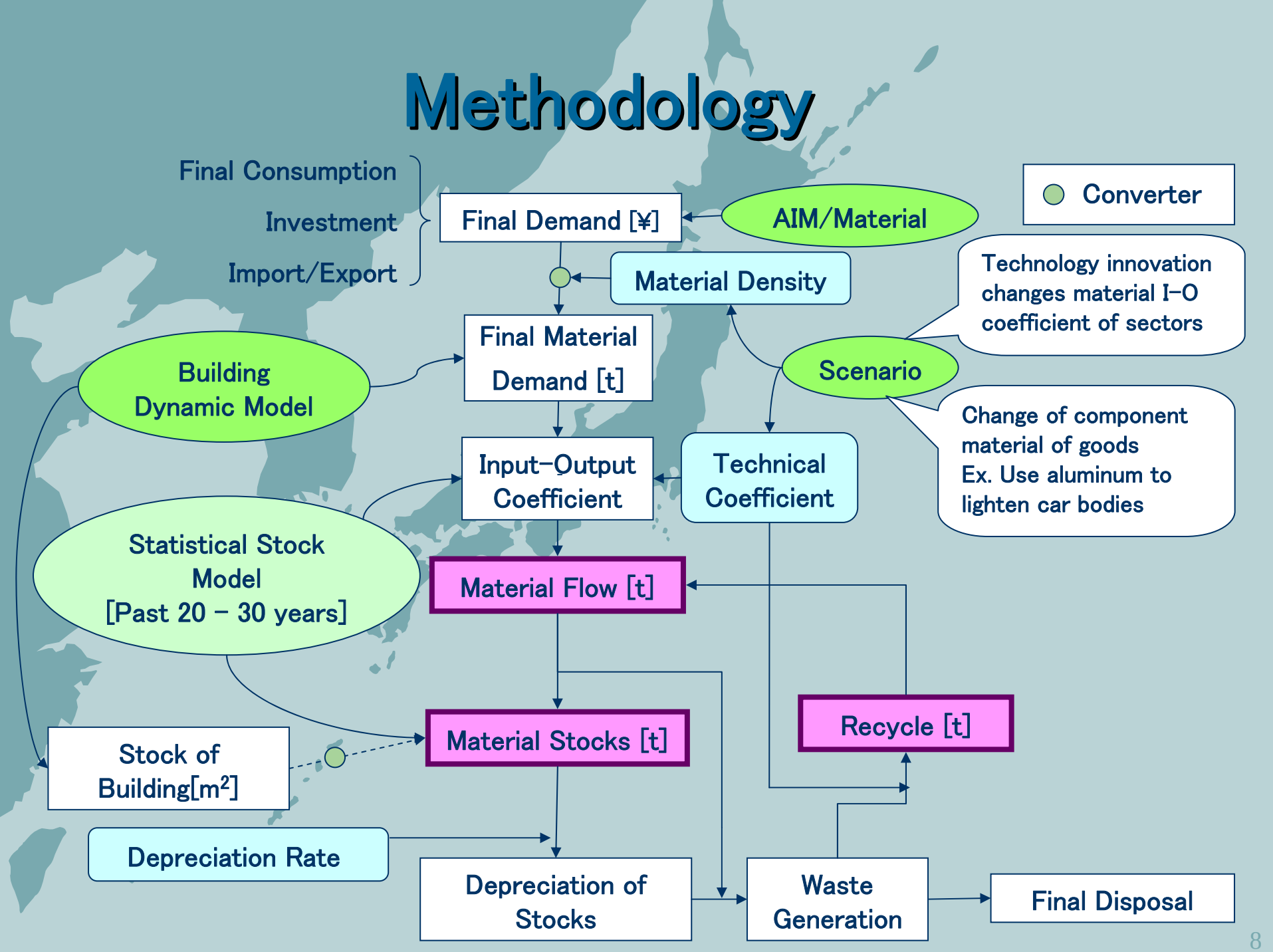
$$probability\ density\ \ function(i,T) = \frac{1}{\sqrt{2\pi}\sigma T} \exp\left\{ \frac{-(\log(T) - lt(i))^2}{2\sigma^2} \right\}$$

pdf(i,T): depreciation ratio of good *i* of age *T* [a log-normal distribution]

lt(i): life time of of good *i*

T: t− τ

Methodology



Main Data for Material Stock/flow Model

In this model, the concept of "material density" which is defined as material per unit monetary amount is important.

Bench mark year:

* Input-Output table [monetary term]
* Physical Input-Output date of each sector

Historical data:

[for estimation of stock in a bench mark year]

* Production statistic of each good

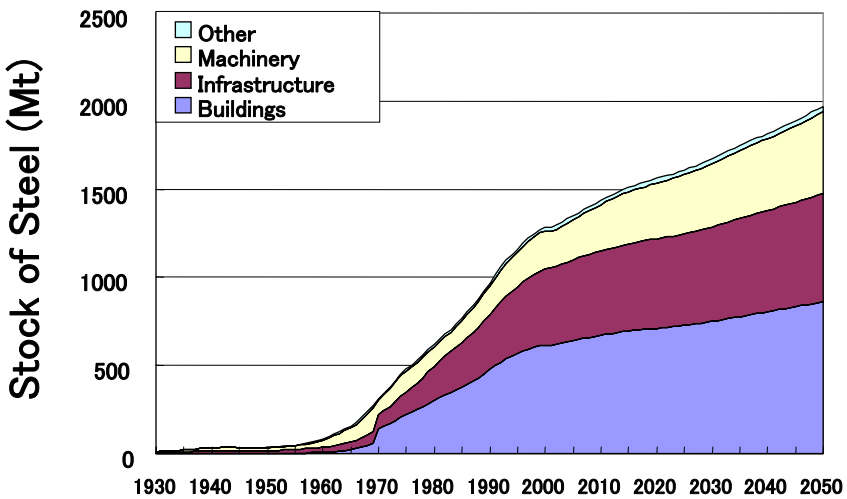
or * Investment of each good

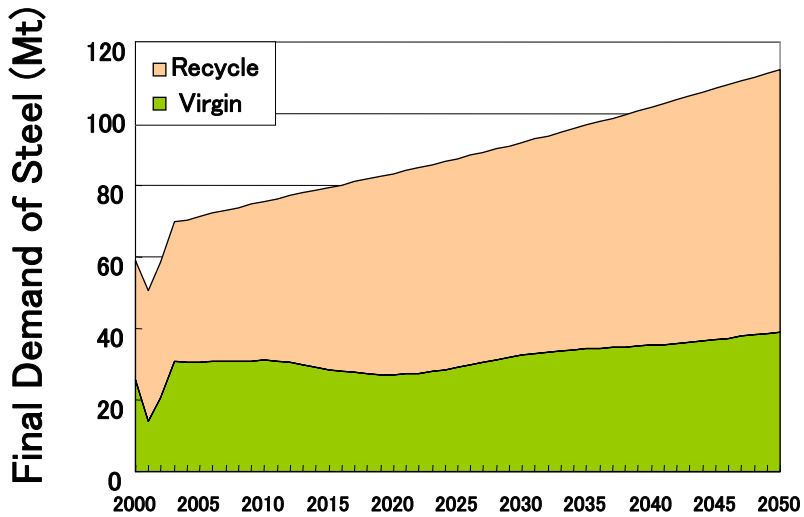
Example of Results(Steel)

<Condition : try run>

*Demand : (Output of AIM/Material)*material density

*75% of waste of iron is recycled.





Note :

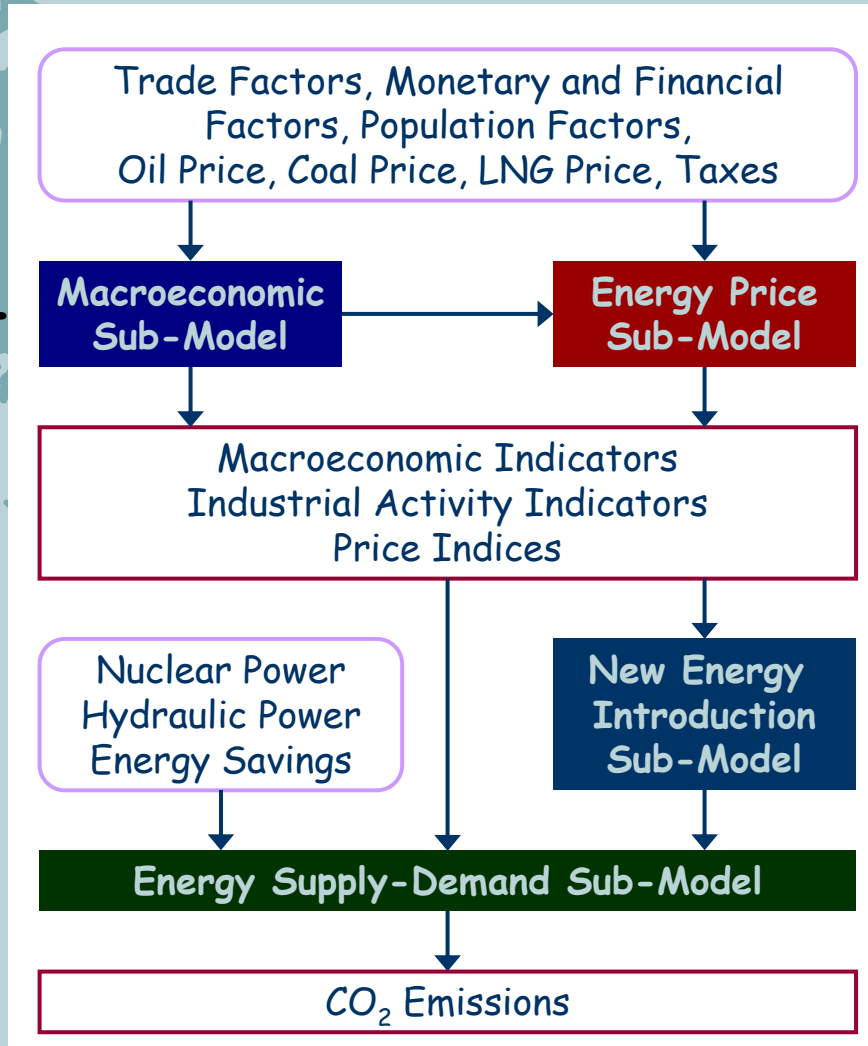
The relationship between demand and stocks are not considered.

Overview of Macroeconomic Model

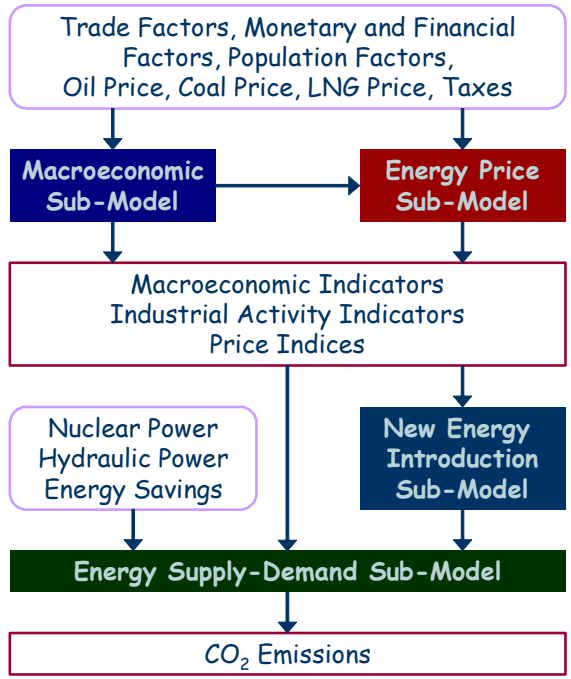
- Estimating CO2 Emissions with Econometric Method

Significance

1) Reproduce changes in socio-economic structure and the energy supply-demand structure in the past and explain the relationship among variables
2) Supplement the CGE model



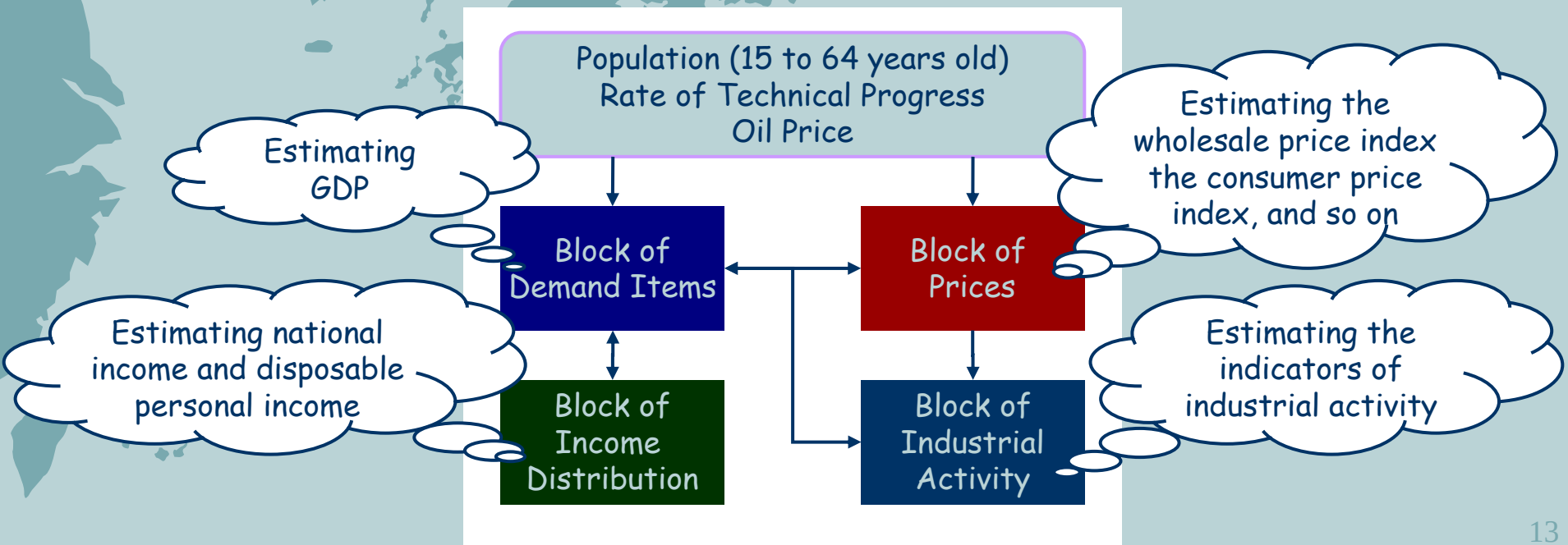
Sub-Models



- **Macro Economy Sub-Model**
  - Generate a macro frame in which income distribution, production markets, labor markets general prices, and other such elements are consistently balanced.
- **Energy Price Sub-Model**
  - Estimate secondary energy prices using import prices for crude oil, LNG, and other energy as well as domestic general price indices and other indicators.
- **New Energy Introduction Sub-Model**
  - Estimate the diffusion scale of new energy, such as solar power and wind power from such factors as the past record, new energy generation costs, competing energy prices, and so on.
- **Energy Supply-Demand Sub-Model**
  - Use the indicators of economic activity, price indices, and other such indicators obtained from the various models and estimate the final demand, primary energy supply, and CO2 emissions.

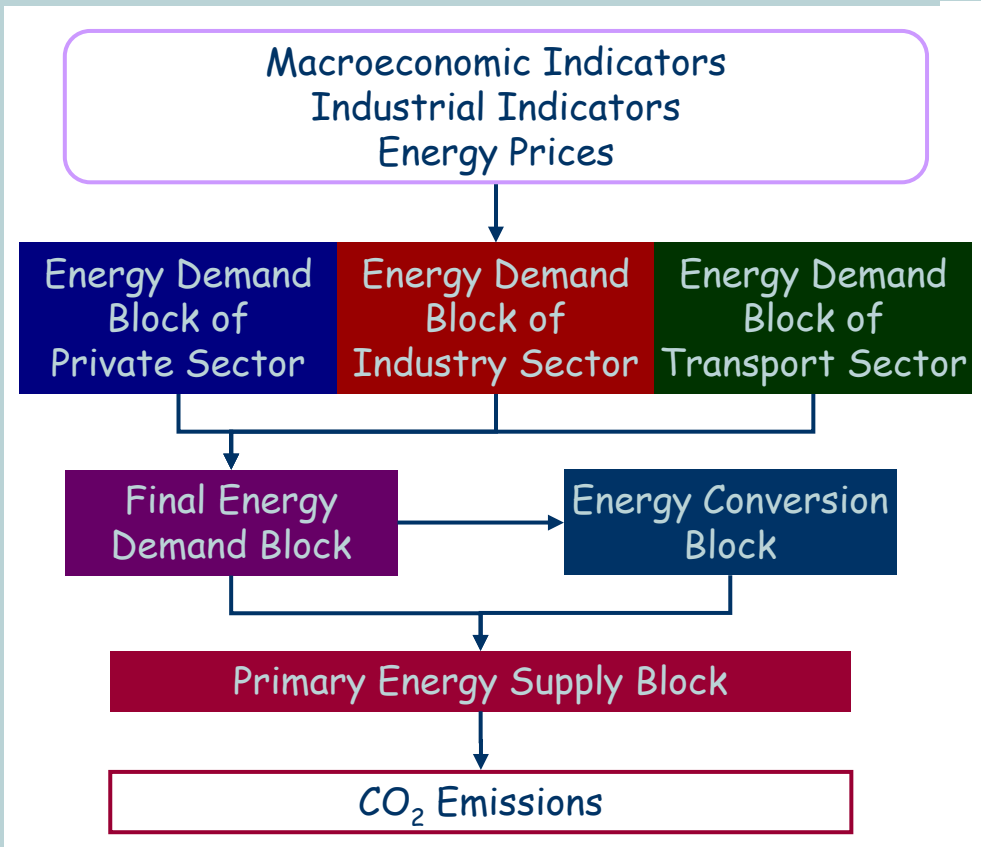
Macro Economy Sub-Model

- Input: (1) foreign factors (world trade and crude oil prices)
  (2) fiscal and financial factors (Gov.inv., tax, interest).
  (3) population factors (pop.by each age group).
- Output: (1) macro items (economic gr, goods price, IS balance)
  (2) production index by each industry type
  (3) production volume by major industry



Energy Supply-Demand Sub-Model

- The energy demand block of industry/private/transport sectors estimates the energy demand of each sector.
- The final energy demand block calculates the total sum of final energy demand by energy source.
- The energy conversion block estimates the amount of energy input to meet the final energy demand.
- The primary energy supply block estimates the primary energy, the final energy demand, and CO_2 emissions.

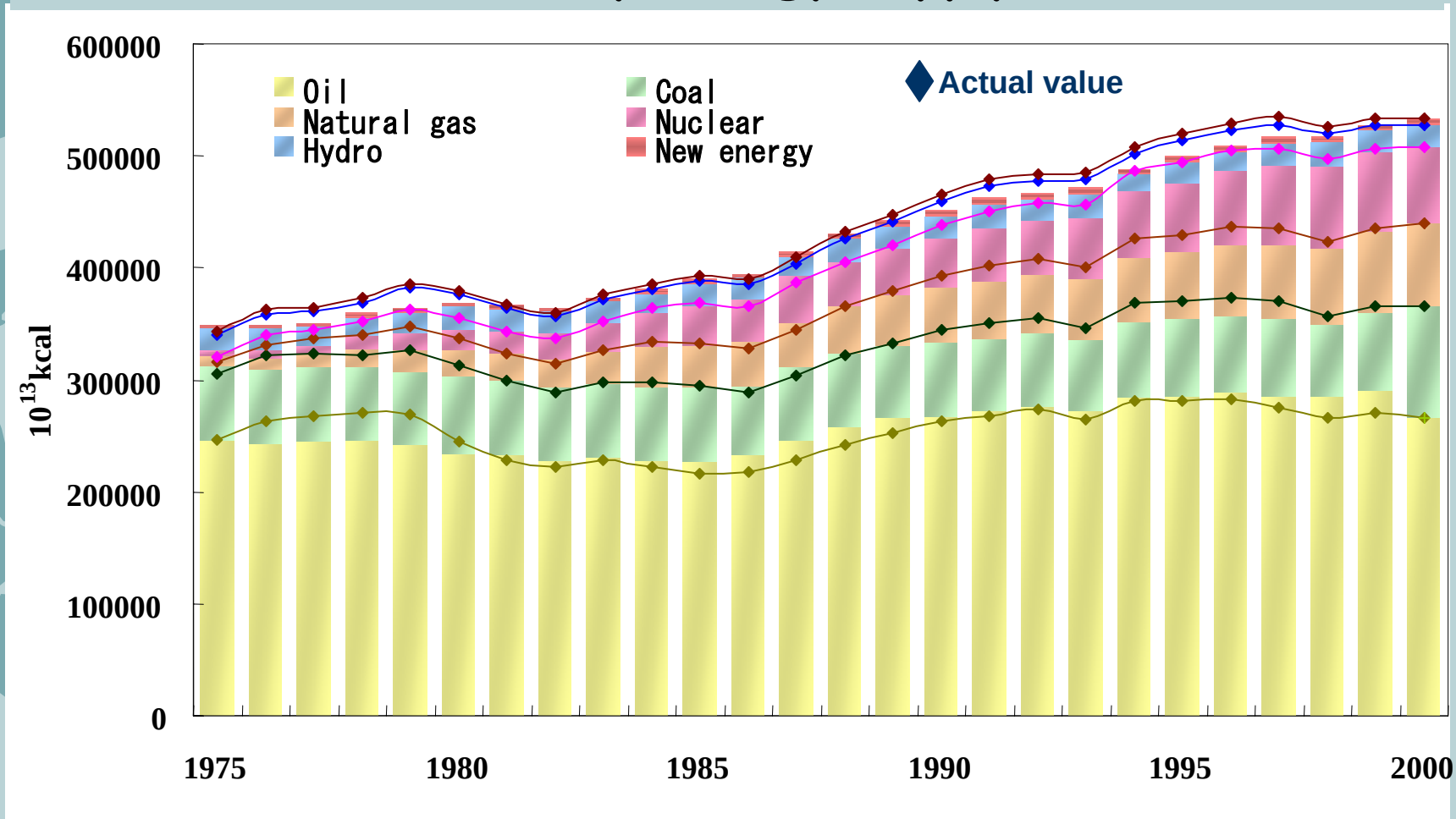


Procedure of Model Development

- Preparing data over the past 30 years for regression analysis
  - Parameters in econometric model is created on the basis of past statistical data. Actual historical values obtained over the long term are required.
- Constructing theoretical models
  - For an econometric model, structural equations (155) and definitional equations (220) are used to build a theoretical model.
- Estimating parameters by regression analysis
  - Parameters are estimated by means of regression analysis, such as the least square method and the maximum likelihood method.
- Evaluating the performance of the models
  - Final tests are conducted during a test period in order to evaluate the performance of the models. The final tests compare "the actual values" with "the estimated values". The estimated values are obtained by using calculated values substituted for all variables except the initial values such as the predetermined endogenous variables and exogenous variables.

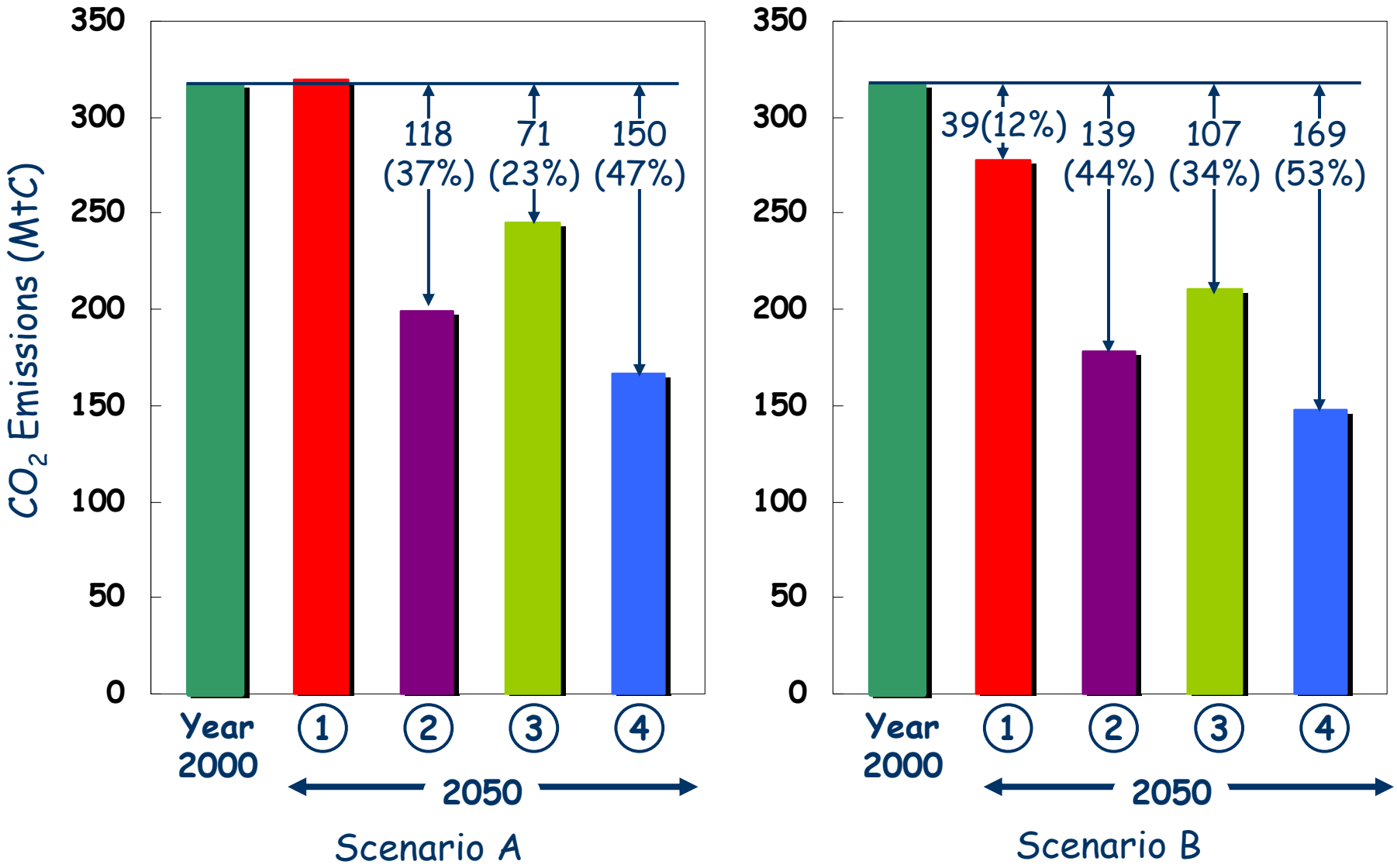
Estimation and Actual Value

Primary energy supply



The mean absolute percentage error (duration : 1985-2000)
1.8% (Total primary energy supply)

Example of Results




Thank you