Study on Urban Policy Integration of Energy Related Environmental Issues in Selected Asian Mega-Cities

: Background and Research Plan

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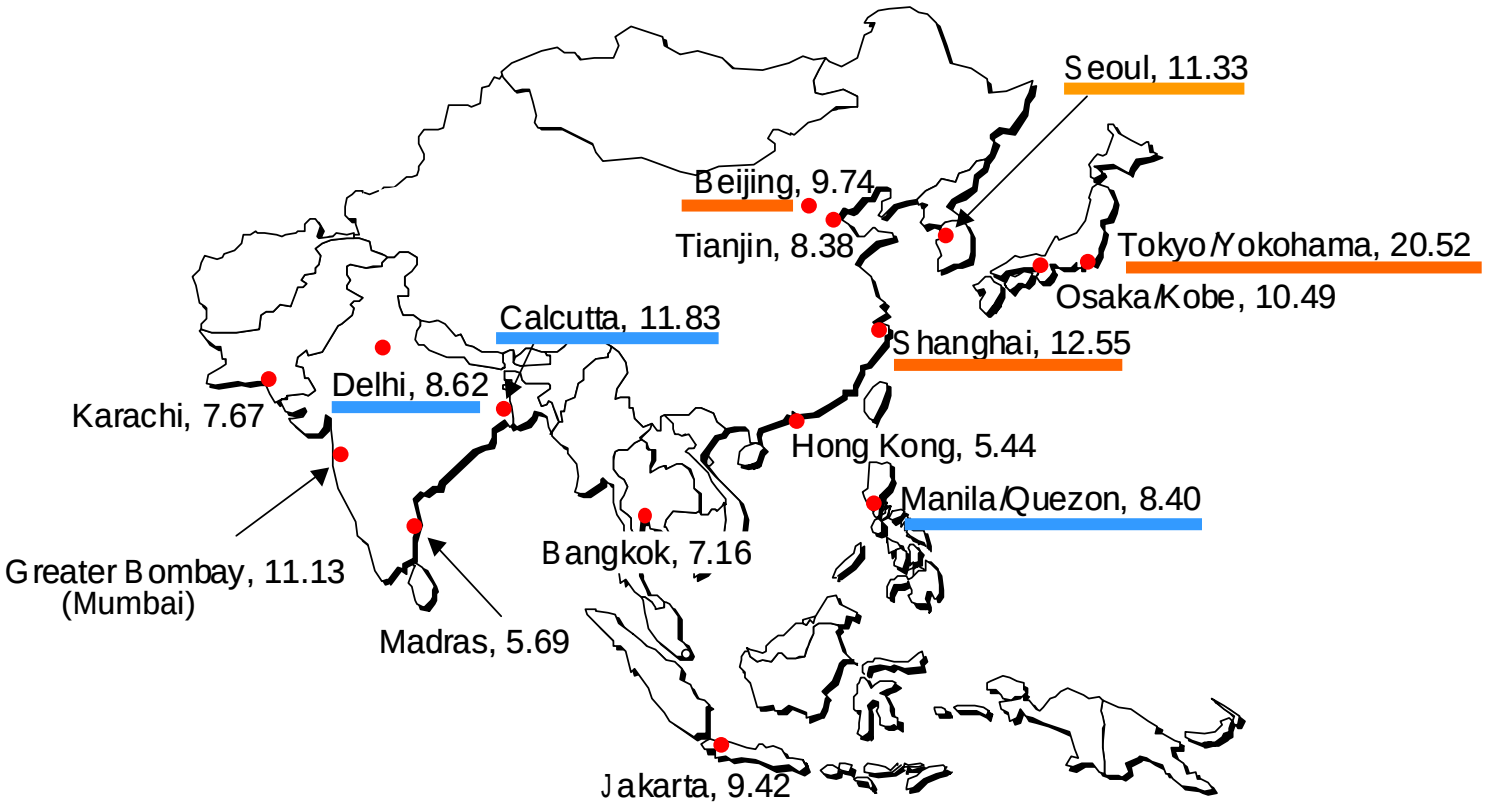
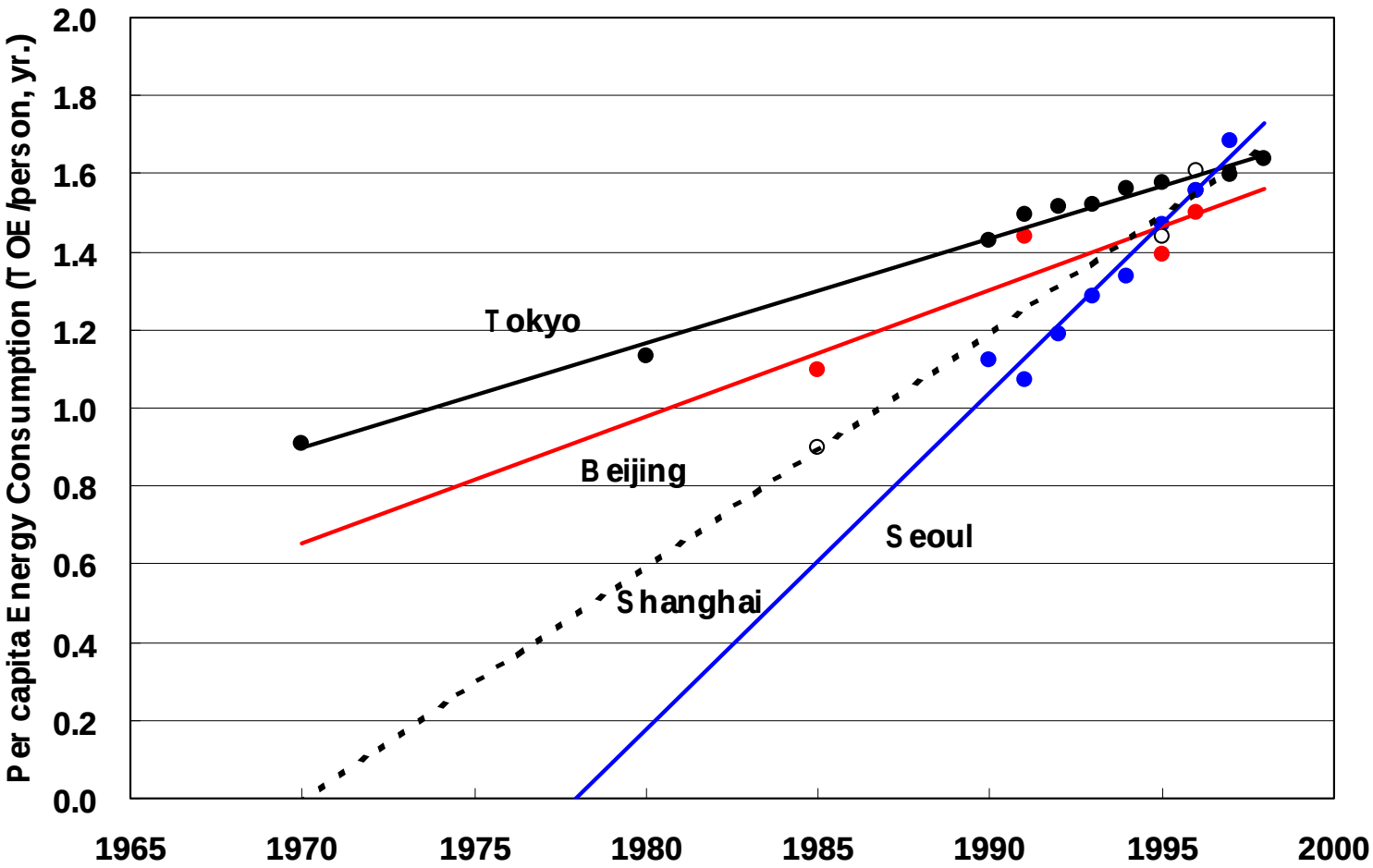
IGES Urban Environmental Management Project

Mega-Cities in Asia (Mega-Cities > 500 million)

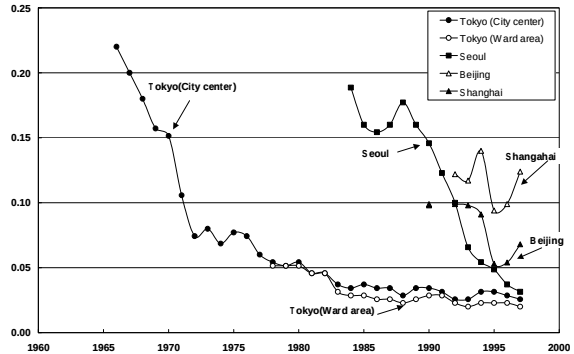


Data Source: **UNEP & WHO, 1992**

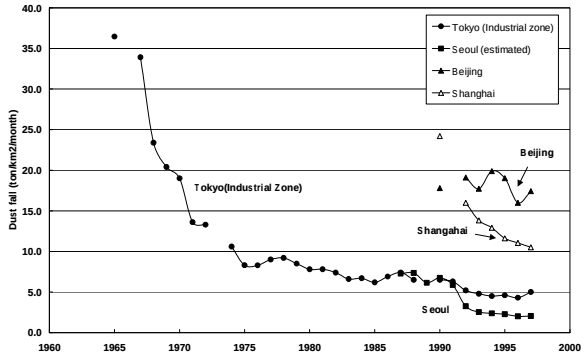
Per capita Energy Consumption (TOE/person, year)



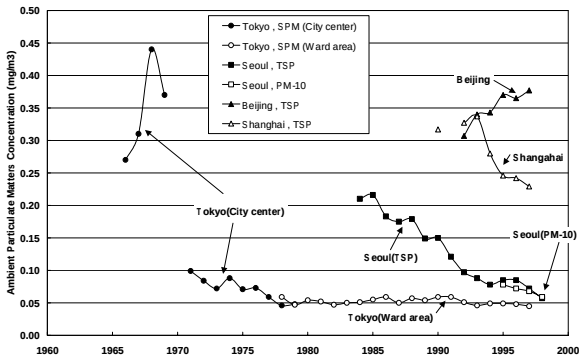
Comparison of major air quality indicators in 4 Mega-Cities



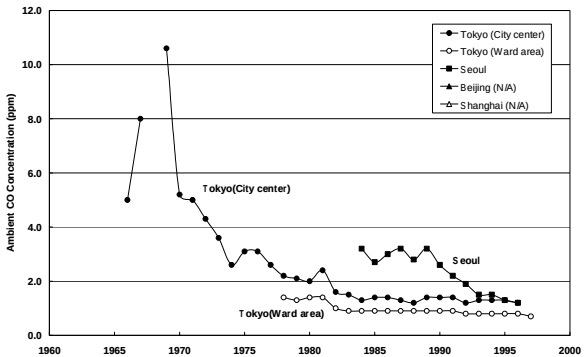
(A) Ambient SOx concentration (mg/m^3)



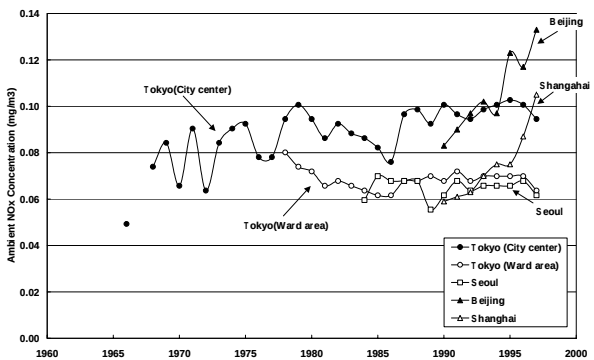
(B) Dust fall (ton/km^2/month)[1]



(C) Ambient PM concentration (mg/m^3) [2]



(D) Ambient CO concentration (mg/m^3)



(E) Ambient NOx concentration (mg/m^3) [3]

Background

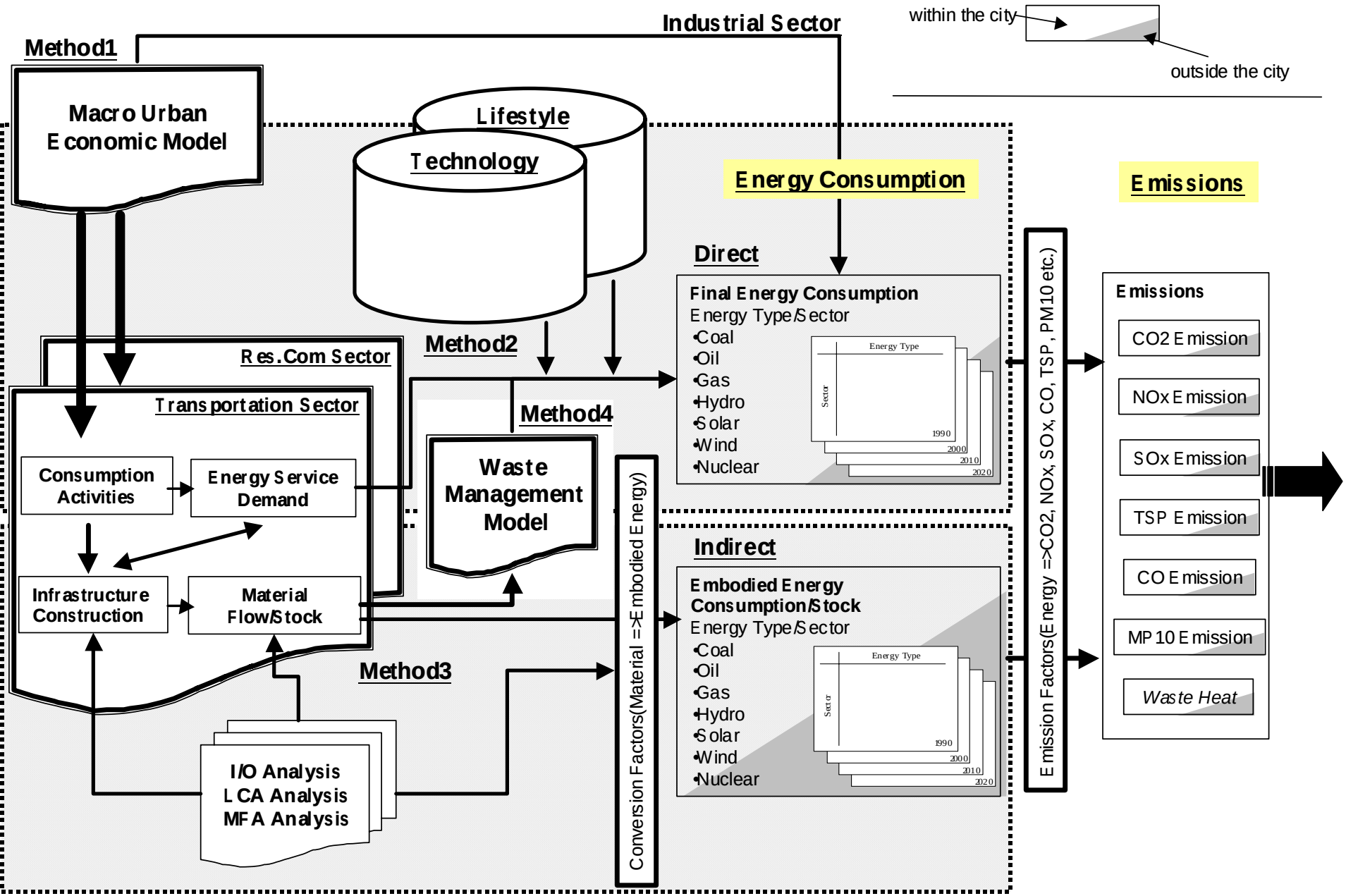
- Urbanization in Asia
- Climate Change and Cities
- Local and Global Env. Issues
- Engine of Economic Growth
- Urban Infrastructure and Lifestyle Change
- Learning Curve
- Needs for Policy Integration
- Needs for Policy Assessment Tools and Indicators

Why Mega-Cities?

- Considering the potential urban growth of smaller cities, under 5 million in Asia, the mega-cities may not determine the future of the region.
- However, the mega-cities are top-runners in the country in terms of urban development, economic growth, industrial transformation, lifestyle change and policy implementation.
- Hence, their experiences could be good models to other small and medium-sized cities.
- Another technical reason why we target on the mega-cities is placed around the data issue, since the development of international comparable data sets for cities is much behind national data.

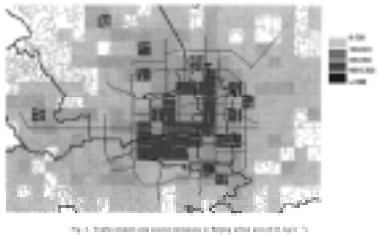
Outline of the Study

- This research will focus on the Asian mega-cities including Tokyo, Seoul, Beijing and Shanghai, where economic growth and consumption of energy and resources are placed as centers.
- We will analyze the energy consumption patterns of various urban sectors, and then develop an integrated urban model to project future profiles of energy consumption and environmental emissions in the selected mega-cieties.
- We will develop some user interface linking the policy options and the model to make it into a policy tool, in order to assess the various related policy options as well as their synergy effects that enhance the effectiveness of local policies.


within the city
outside the city
Industrial Sector
Method1
Macro Urban Economic Model
Lifestyle
Technology
Energy Consumption
Emissions
Direct
Final Energy Consumption
Energy Type/Sector
•Coal
•Oil
•Gas
•Hydro
•Solar
•Wind
•Nuclear
Energy Type
Sector
1990
2000
2010
2020
Emissions
CO2 Emission
NOx Emission
SOx Emission
TSP Emission
CO Emission
MP 10 Emission
Waste Heat
Emission Factors(Energy =>CO2, NOx, SOx, CO, TSP , PM10 etc.)
Res.Com Sector
Transportation Sector
Method2
Method4
Consumption Activities
Energy Service Demand
Waste Management Model
Infrastructure Construction
Material Flow/Stock
Method3
I/O Analysis
LCA Analysis
MFA Analysis
Conversion Factors(Material =>Embodied Energy)
Indirect
Embodied Energy Consumption/Stock
Energy Type/Sector
•Coal
•Oil
•Gas
•Hydro
•Solar
•Wind
•Nuclear
Energy Type
Sector
1990
2000
2010
2020

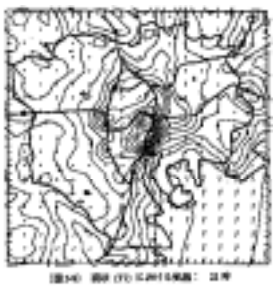
Distribution Method/Spatial Database (GIS, Mesh Data, RS)

Impact Assessment



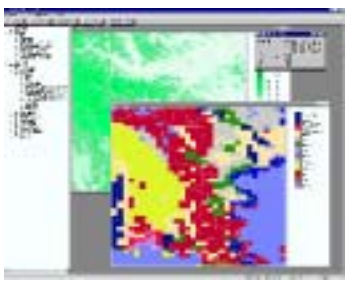
Source: *J. Hao et al. / Atmospheric Environment 34 (2000) 453-465*

Example1: Urban Air Pollution in Beijing



Source: http://www.env.t.u-tokyo.ac.jp/~hanaki/restopic1-j.html#Heat

Example2: Heat Island in Tokyo



Source: http://www.kke.co.jp/major/oyo/10gis-ap.htm

Example3: Urban Planning

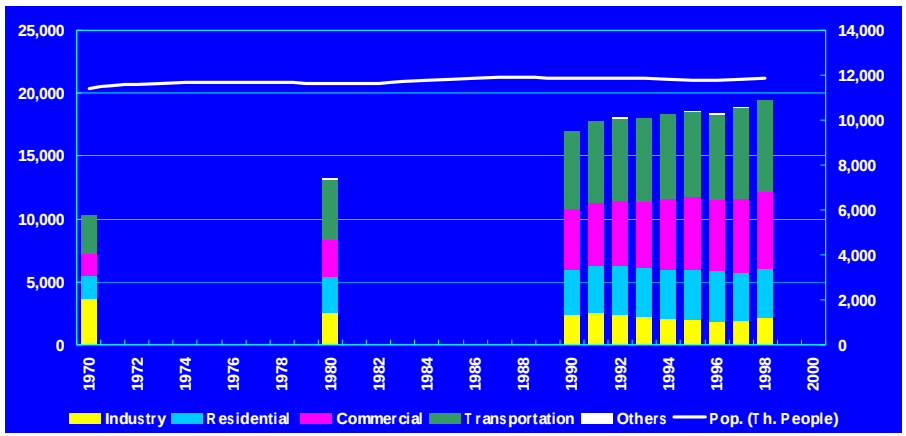
Policy/Scenario Generation

Energy Related Policy Package

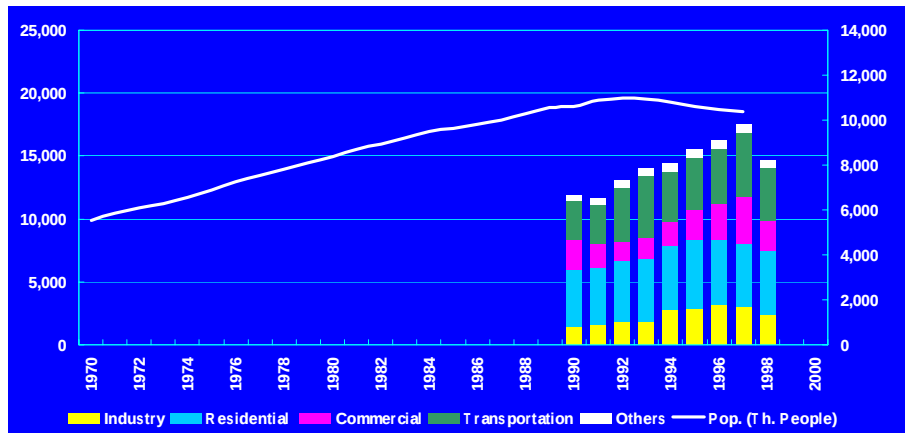
Urban Planning	Regulations Economic Instruments …
Air Pollution Control	Regulations Economic Instruments …
GHGs emission mitigation	Regulations Economic Instruments …
Recycling Society Zero Emission	Regulations Economic Instruments …
Others	Regulations Economic Instruments …

Feedback to
the Driving Force

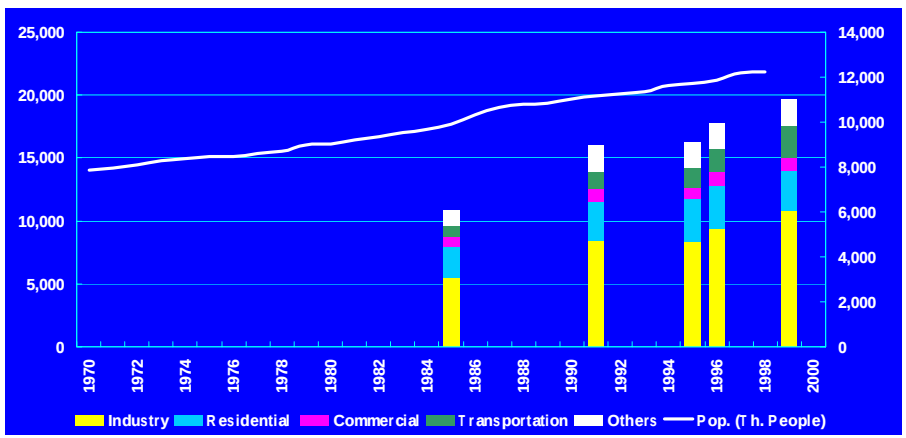
Final Energy Consumption by Sector (1,000 TOE) and Population (1,000)



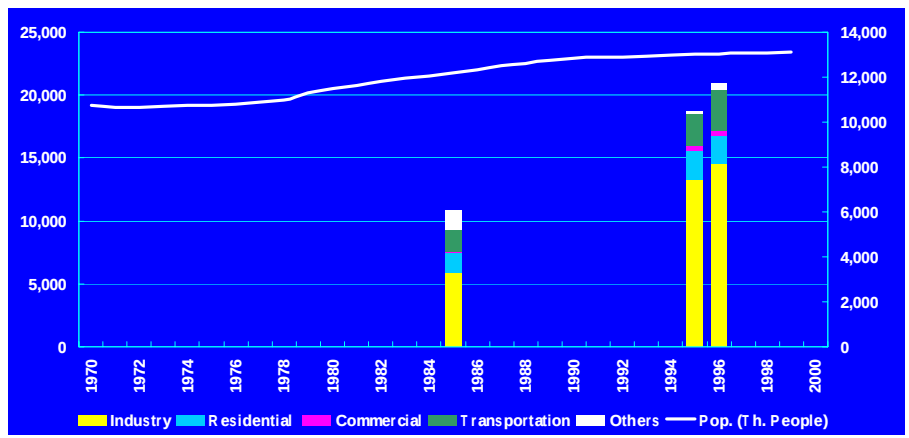
Tokyo



Seoul

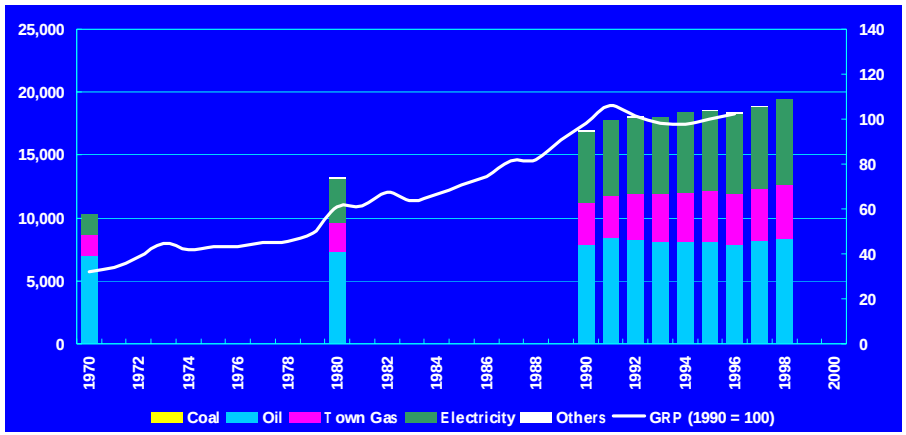


Beijing

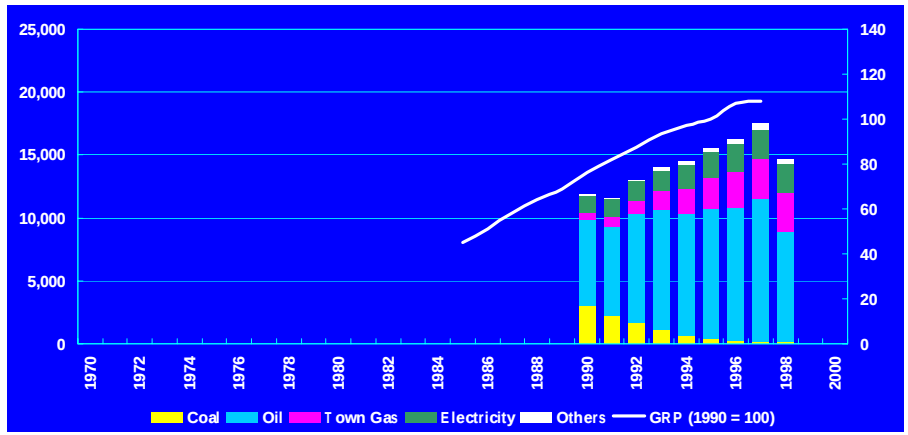


Shanghai

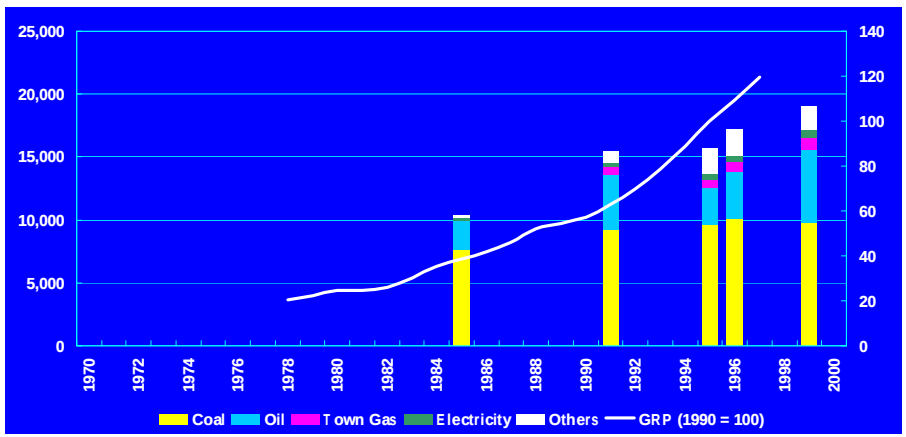
Final Energy Consumption by Source (1,000 TOE) and GRP (Gross Regional Product) Index (1995 = 100)



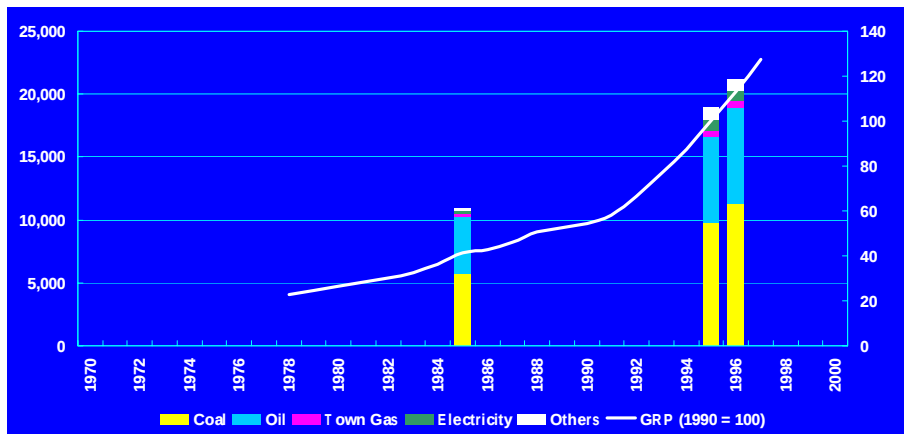
Tokyo



Seoul



Beijing

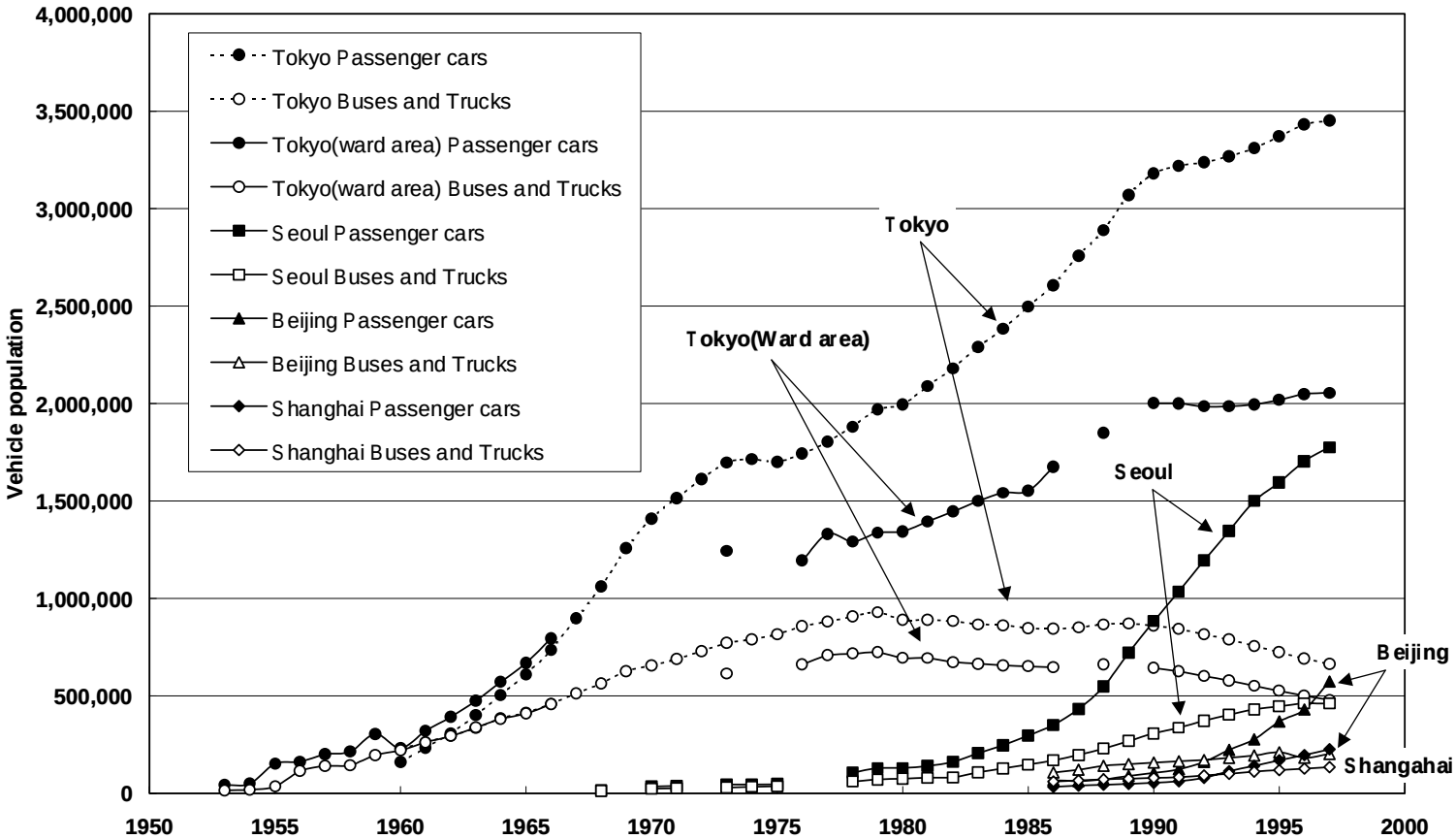


Shanghai

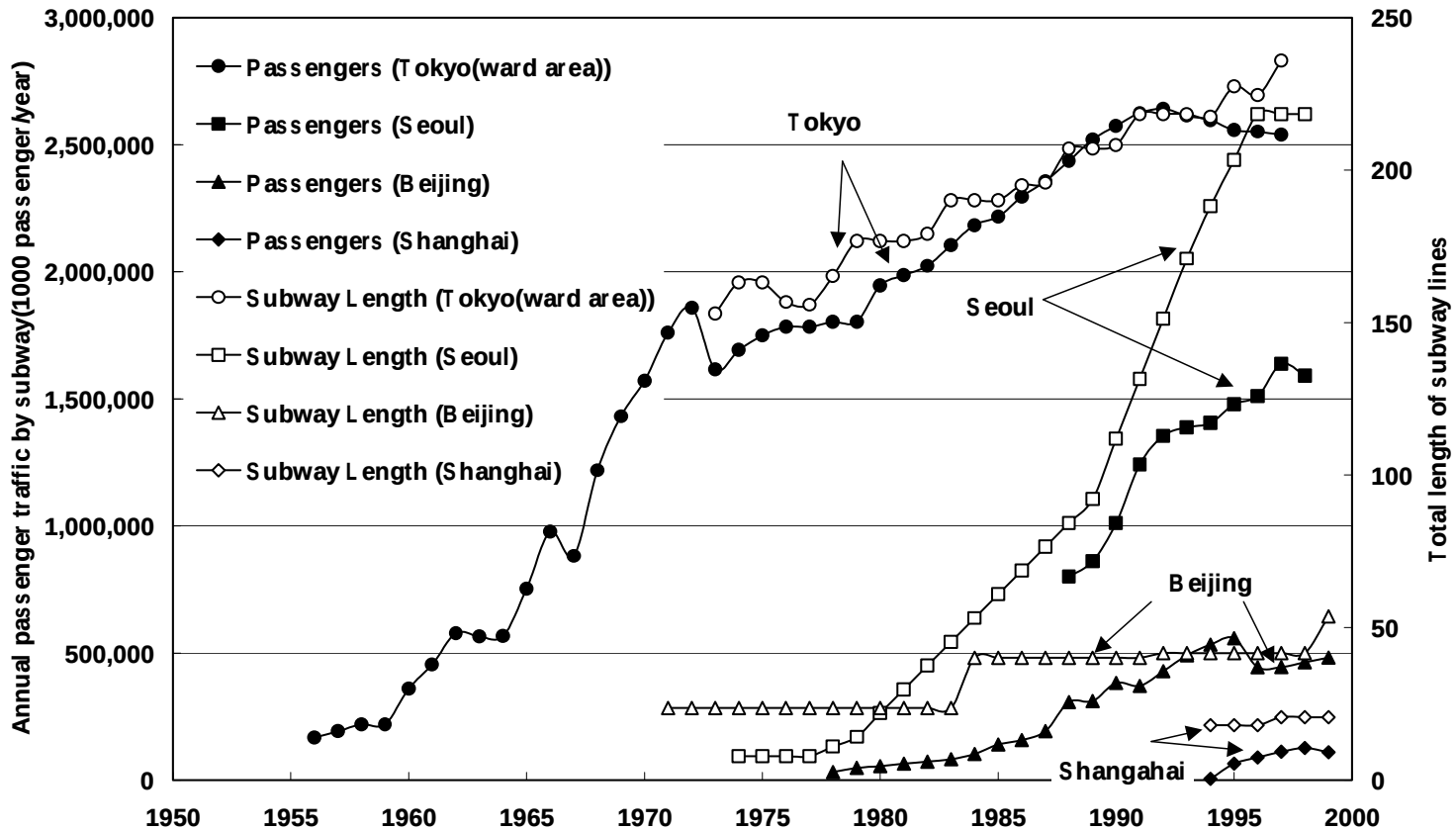
Macro Economic Sector

- To generate BaU (Business as Usual) scenario of macro parameters and to measure the effect of urban/local financial program of the city
- A top-down approach combining macroeconomic activities, local government finances, households income and expenditures, transportation modes, energy use and emissions
- The model is based on the seven systems of equations: 1) equations of local demography, 2) equations of GRP, 3) equations of energy consumption for industries, 4) equations of the local government finances, 5) equations of households incomes and expenditures, 6) equations of transportation modes and energy use, 7) equations of pollution, recycling and waste treatment

Transportation Sector (1): Vehicle Population

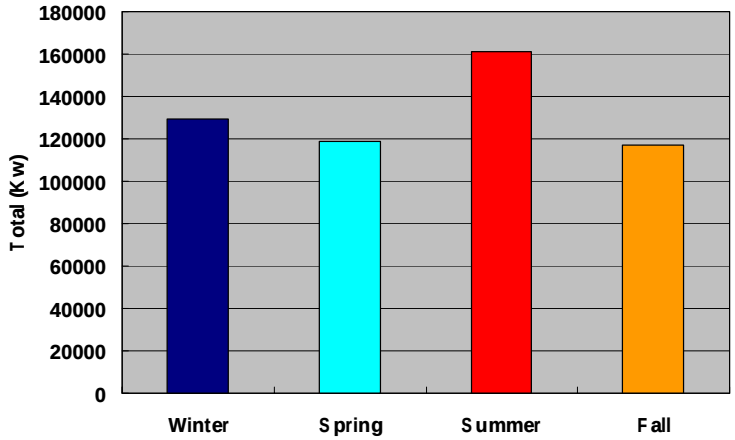


Transportation Sector (2): Subway Construction

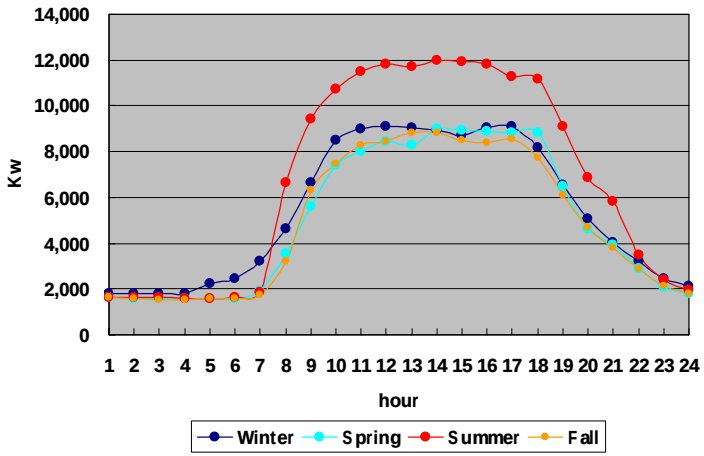


Transportation Sector

- To establish a GIS-based bottom-up model package linking a modal split model and a conventional assessment model on road traffic, in order to analyze and assess the entire transportation system.
- Analysis on future transportation demand (up to 2020) including the projection of the future growth of vehicle use, construction of mass transit infrastructure and so on.
- To identify a series of cost-effective policy measures to reduce both local pollution and GHG emissions particularly from road transportation.
- To develop an integrated strategy of energy supply, land use and air environment improvement for the sustainable transportation system in the study cities.



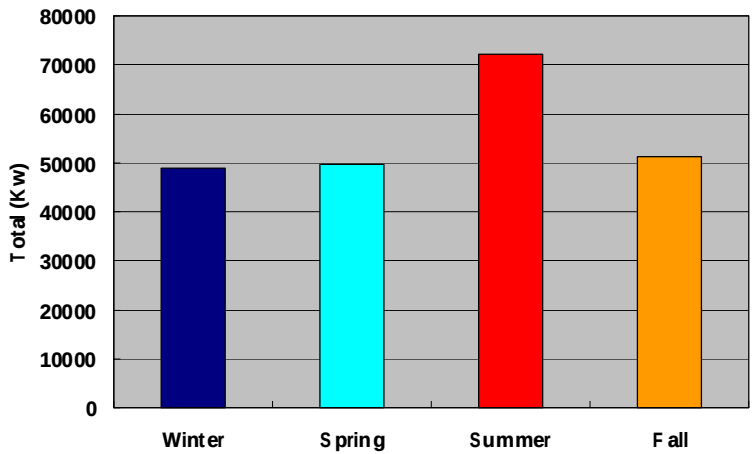
(A) Total per day by season



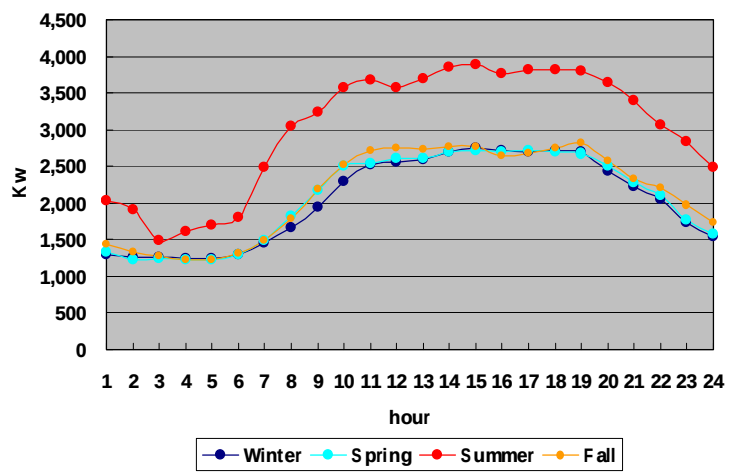
(B) Hourly load curves by season

Electricity Use for Offices in Seoul

Data Source: Roh, Dong S., KEEI



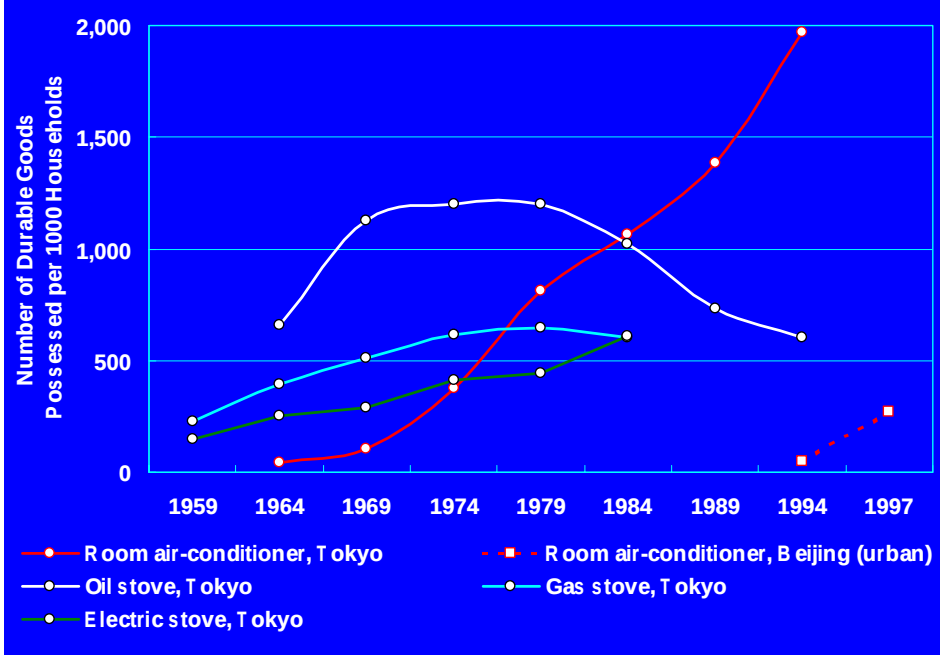
(A) Total per day by season



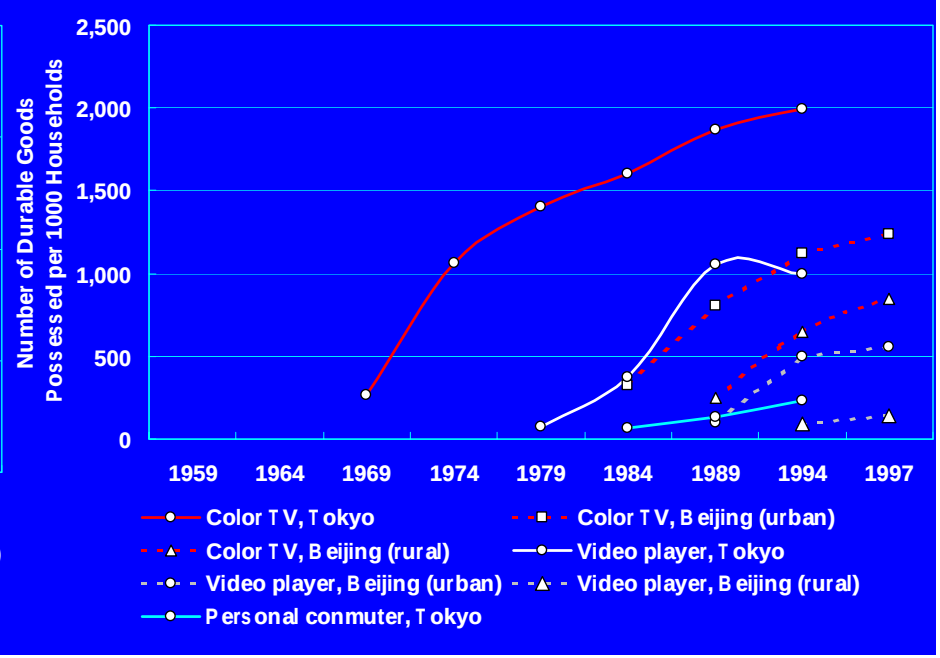
(B) Hourly load curves by season

Electricity Use for Hotels in Seoul

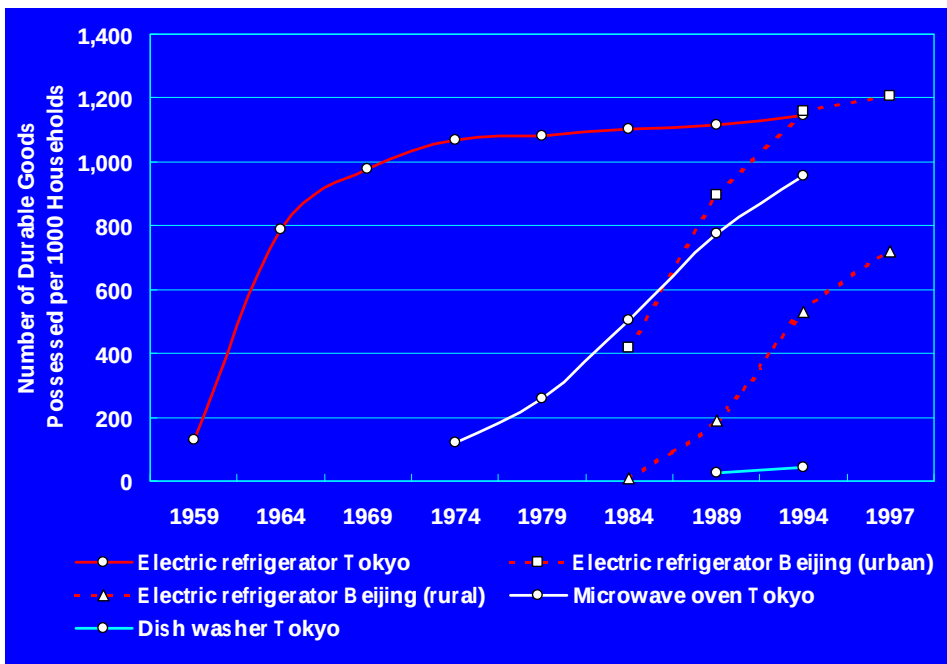
Data Source: Roh, Dong S., KEEI



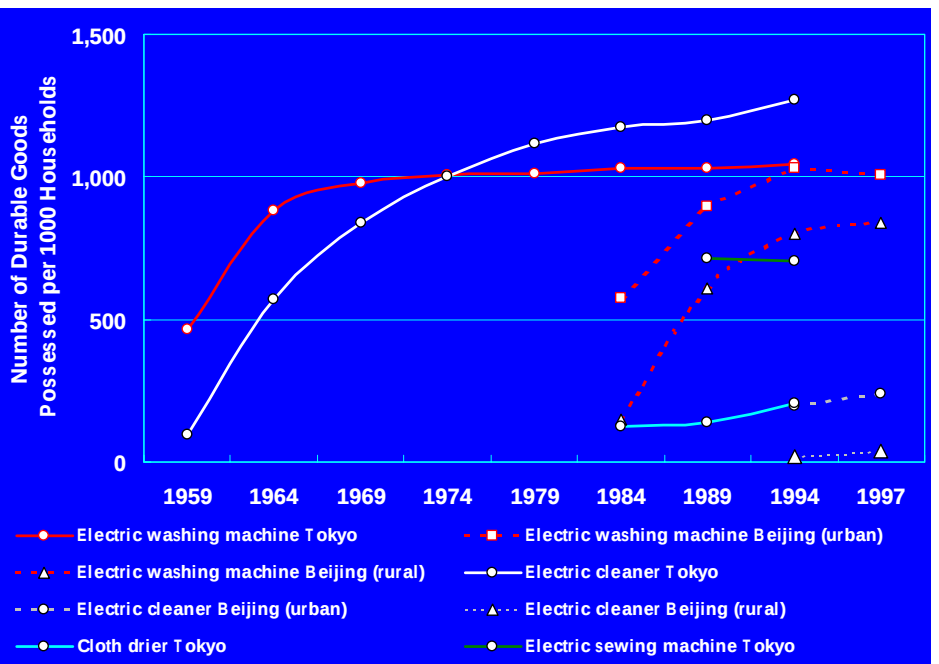
Air-conditioning & Heating



Entertainment



Kitchen

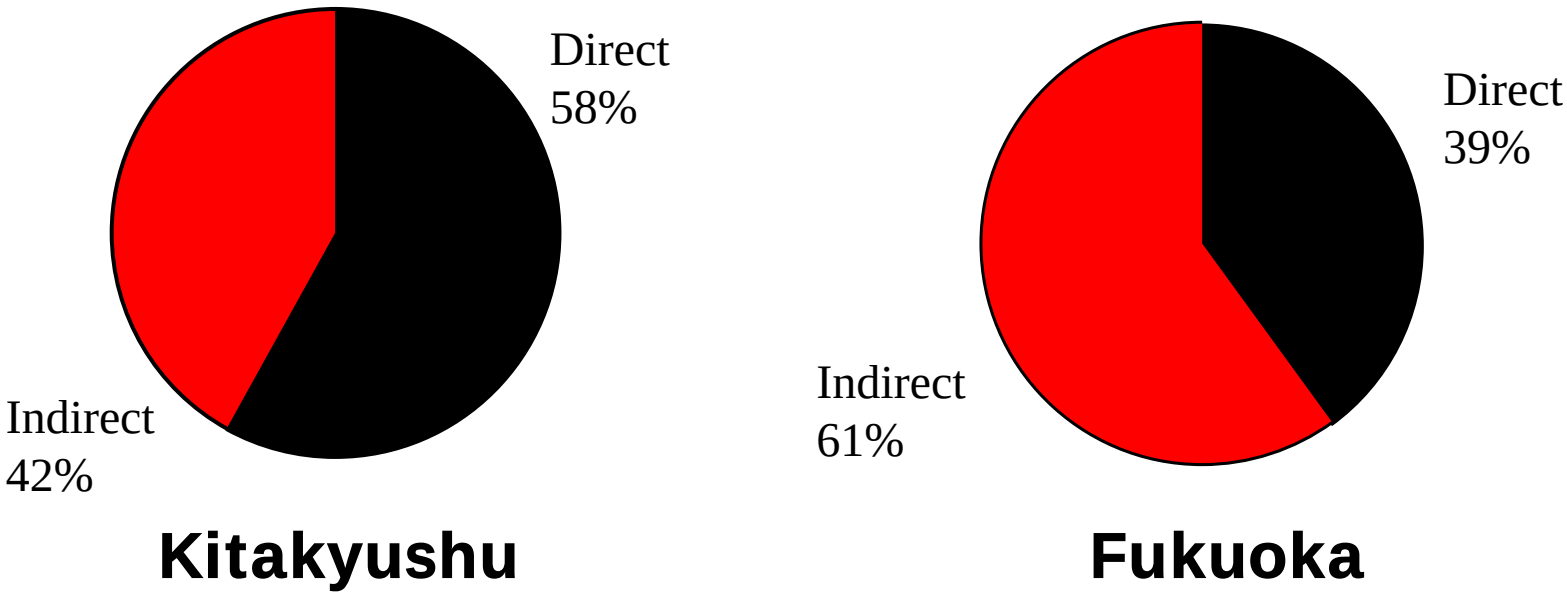


Other housekeeping works

Residential & Commercial (ResCom) Sector

- To analyze total energy demand of the buildings in the city by developing the bottom-up model.
- The energy load curves by different energy services including space heating/cooling, space lighting, cooking and hot water, electric appliances and so on in the representative buildings for household and commercial sector are analyzed to identify the relationship with lifestyle and behavioral factors.
- Future change in unit energy consumption per service will be estimated by accumulating the individual effects of technology improvements, improvement of building materials and structures, and lifestyle changes.
- To evaluate the potential contribution to CO_2 reduction of urban energy infrastructures such as co-generation system and community central heating and air-conditioning.

Direct and Indirect Energy Consumption



Source: Kanagawa and Imura (1993)

MFA (Material Flow Analysis), Embodied Energy and Waste Management Sector

- To identify the self-dependency and material flow of a city by analyzing regional Input-Output tables at city level.
- The structure models of urban infrastructure will be developed to estimate the amount of the different construction materials aiming to forecast material demand of urban infrastructure stocks in the future.
- Improvement of the embodied energy in the typical construction materials will be projected based on the perspective of technology progress in order to estimate future embodied energy demand of further increase of urban infrastructure stocks.
- To evaluate potential contribution of CO2 reduction by “Waste-to-Eenrgy” policy, primarily focusing on incineration waste heat and landfill gas.

Goals of the Model

- Comprehensive model
- Integration of top-down and bottom-up approach
- Policy oriented model
- Simple and common structure
- Not data-intensive model