

# **IGES International Workshop on the Clean Development Mechanism**

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## **Basic Structure of IGES GHG Emission Model - Initial GHG Projection of Japan -**

**Tae Yong Jung  
Institute for Global Environmental Strategies, Japan  
Choon-Geol Moon  
Hanyang University, Korea**

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- Future Research Plan

# IGEM Structure (Brief)

## ○ Theory Review

- ⊗ **Economic Theories : Macro Economics, International Economics, Energy Economics, Environment Economics, Economic Development, Computable General Equilibrium**
- ⊗ **Econometric (Statistic) Theories: Statistic Inference, Estimation Methodologies & Techniques, Data Handling**
- ⊗ **Engineering/Technology: Assessment of Technology Specifications, Cost Evaluation**

# IGEM Structure (Brief)

## ○ Characteristics

### ⊗ Country-specific Hybrid Model

- ☞ Three Countries : China, Japan, Korea
- ☞ Open Macro Economic Model
- ☞ Econometric/CGE Model
- ☞ Energy/GHG Emission Model
- ☞ Link with Bottom-up Model (Hard Linkage)

### ⊗ CDM Analysis Model

- ☞ Project-base Analysis
- ☞ Bilateral Financial Flows

# IGEM Structure (Brief)

## ○ Characteristics

### ⊗ Estimation Methods

- ☞ **Unit Root Test: Statistical Test for Non-Stationary Variables**
- ☞ **Co-integration Method : Most Advanced Statistic (Econometric) Inference to Estimate Long-run Relationships**
- ☞ **Error-Correction Method: To Estimate Short-run Variations (Equilibrium Condition)**

# IGEM Structure (Brief)

## ○ Characteristics

### ✿ Estimation Methods

- ▣ **Kalman Filter Technique: The Application of Electric Engineering Signal, Allowing Time-varying Coefficient Estimation**
- ▣ **Autoregressive Distributed Lag Specification(ARDL): ARDL(1,1) is specified.**
- ▣ **System Estimation Method: To Capture the Inter-fuel Substitution in Energy Demand Equations**

# IGEM Structure (Brief)

## ○ Characteristics

### ⊗ CGE Methods

- ☞ **Open/Dynamic/ Multi-Sector Model**
- ☞ **Capital Accumulation with AEEI and International Financial Flows for CDM Analysis**
- ☞ **Multi-tier KLEM Production Function with Armington Assumption**
- ☞ **Fuel-substitution Elasticity from Econometric Estimation (Localization of Parameters)**

# IGEM Structure (Brief)

## ○ Characteristics

### ⊗ CGE Methods

- ☞ **Five Blocks: Production, Private Consumption, Gov't & Public, Investment, Foreign Sectors**
- ☞ **Production Sector: 9 Energy-producing Sectors, Energy intensive Industries, Transport, Service**
- ☞ **Consumption Sector: Stone & Geary Utility Function (Max.) ⇒ Linear Expenditure System**
- ☞ **Gov't Sector: Income (Tax) vs. Expenditure**  
⇒ **Net Gov't Savings**



# IGEM Structure (Brief)

## ○8 Modules

### ⊗ Macro Economic Module

📖 Demand Side of an Economy

📖 Simple Keynesian Open Macro Economic Model

**Example: Consumption Function**

- Error Correction Model (Short-run)

$$\Delta C_t = \delta_1 \Delta C_{t-1} + \delta_2 \Delta y_{t-1}^m + \beta \left( C_{t-1} - (a_0 + a_1 y_{t-1}^m + a_2 r_{t-1} + a_3 W_{t-1}) \right) + u_{\Delta C, t}$$

- Co-Integration Model (Long-run)

$$C_t = a_0 + a_1 y_t^m + a_2 r_t + a_3 W_t$$

- Time-varying Coefficient (If necessary)

$$\beta, \delta_1, \delta_2$$

# IGEM Structure (Brief)

## ○ 8 Modules

### ✿ Bilateral Financial Module

- ▣ Linkage between Two Countries

- ▣ CDM Project: Financial Flow Analysis

### ✿ Computable General Equilibrium (CGE) Module

- ▣ Input-Output Tables of Each Country

- ▣ Energy Balance Table

- ▣ Social Account Matrix (SAM) Construction

- ▣ Sector Classification: Flexible

- ▣ Localization of Parameters for Calibration: Based on Estimation, if possible.

# IGEM Structure (Brief)

## ○ 8 Modules

### ⊗ Energy Demand Module

- ▣ **Each End-use Final Energy Demand**
- ▣ **Sector Classification: Flexible (Data Availability)**
- ▣ **Econometric Estimation**
- ▣ **GHG emissions are deriving.**

### ⊗ Energy Supply Module

- ▣ **Energy supply is assumed to meet demand.  
(Equilibrium Assumption)**
- ▣ **Transformation Sector: Engineering Approach to  
Figure out Primary Energy Demand**

# IGEM Structure (Brief)

## ○ 8 Modules

### ✿ Linkage Module

- ☞ **Technical Assessment of CDM Project: Bottom-up approach is preferable.**
- ☞ **Hard Linkage with Bottom-up Model: AIM (maybe)**
- ☞ **Advantage of Hard Linkage: IGEM can be tangible model. (Soft linkage makes the model large.)**
- ☞ **Still, the soft linkage of top-down and bottom-up models is the most challenging work.**

# IGEM Structure (Brief)

## ○ 8 Modules

### ✿ Scenario Module

- ▣ Scenario Generator: Systematic Way

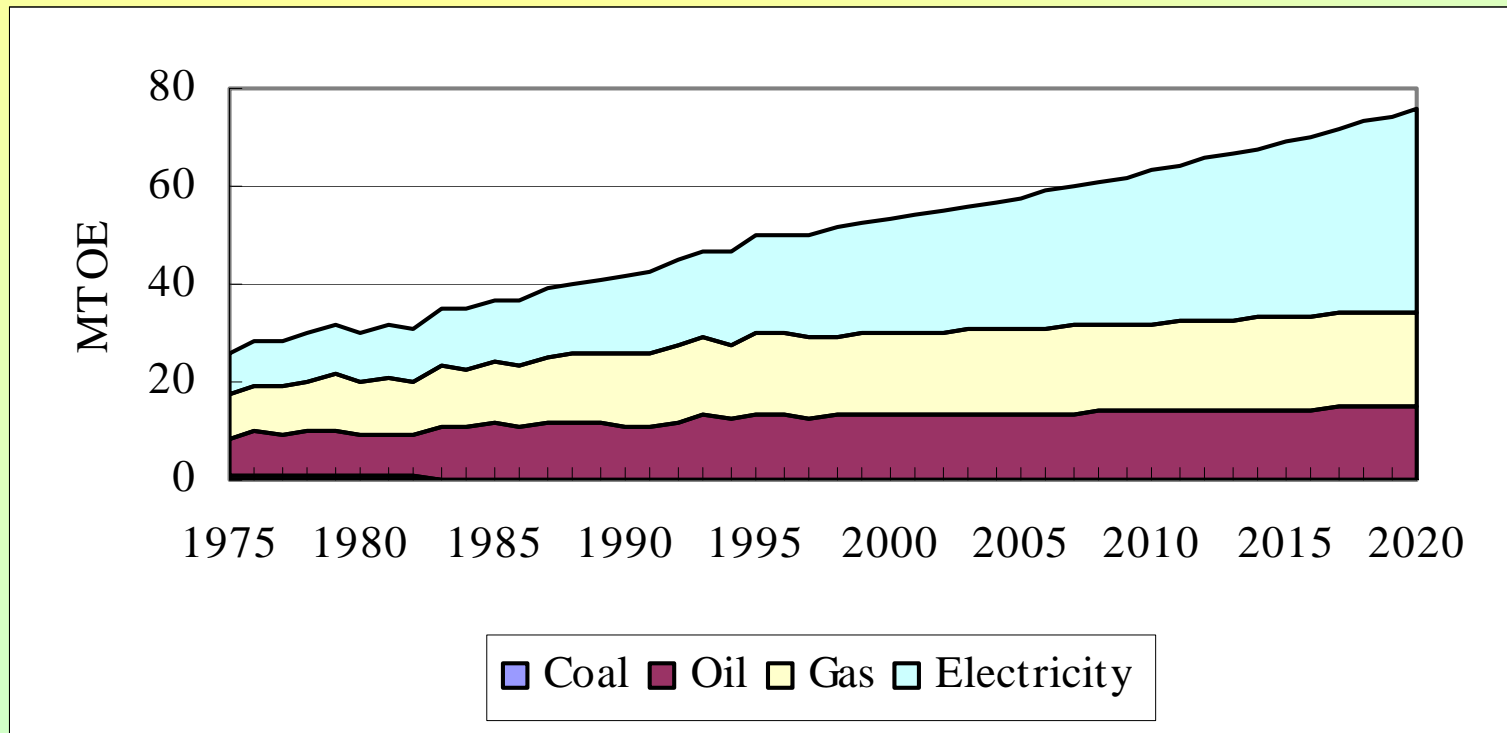
- ▣ Marginal Change Analysis: Due to CDM project, what is the deviation from BaU projection, in terms of energy, GHG emission

### ✿ Output Module

- ▣ Output Generation: Economic Activities, Energy, GHG Emissions

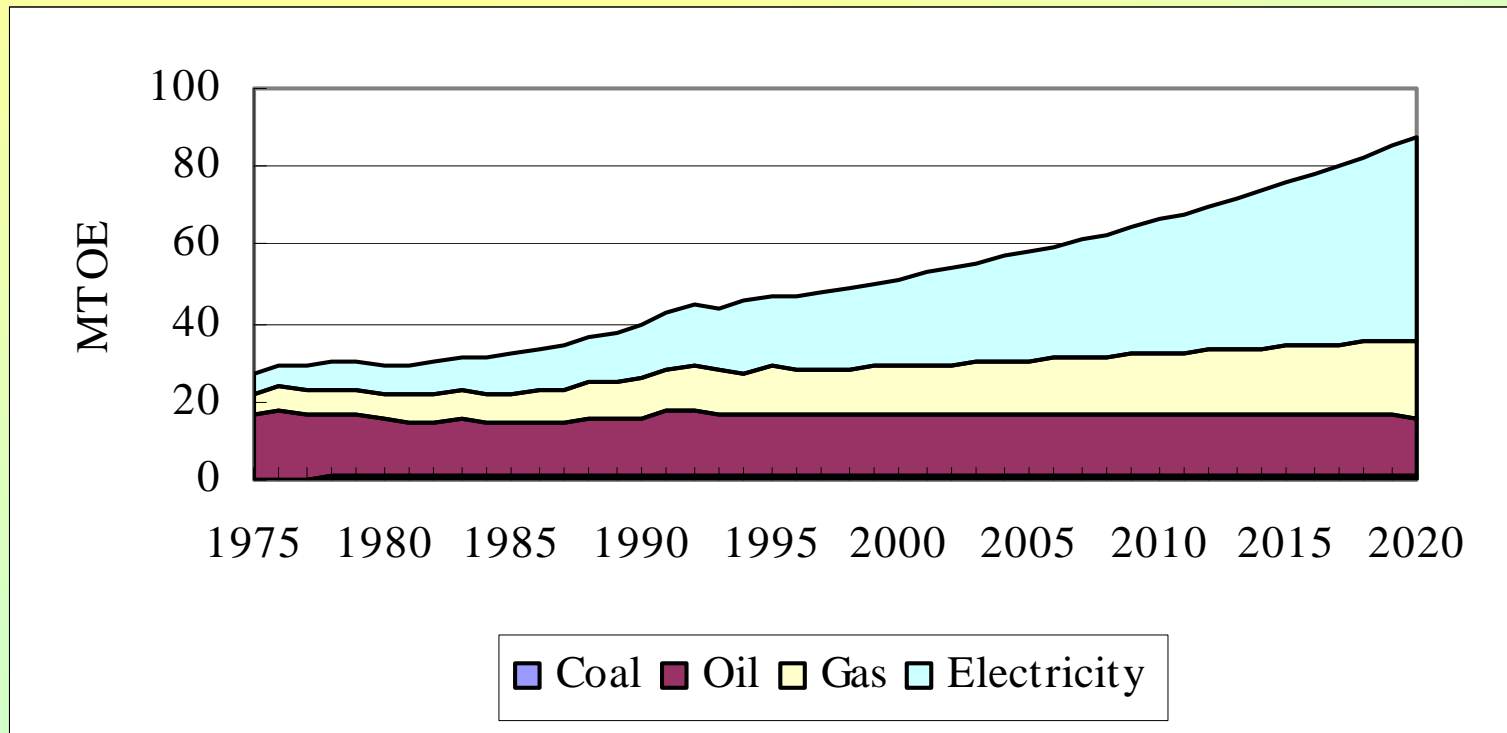
# Initial Results of Japan (BaU)

## Energy Demand (Residential Sector)



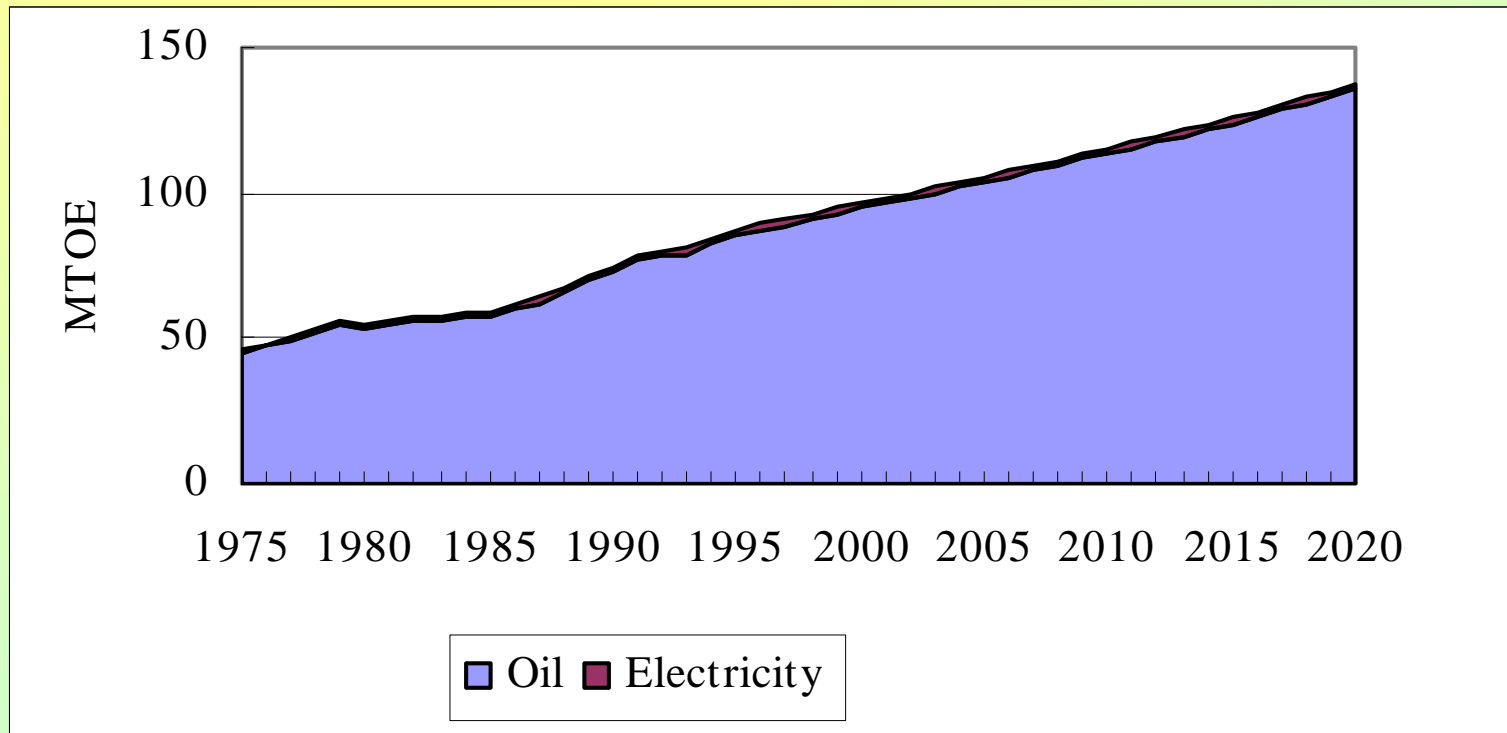
# Initial Results of Japan (BaU)

## Energy Demand (Commercial Sector)



# Initial Results of Japan (BaU)

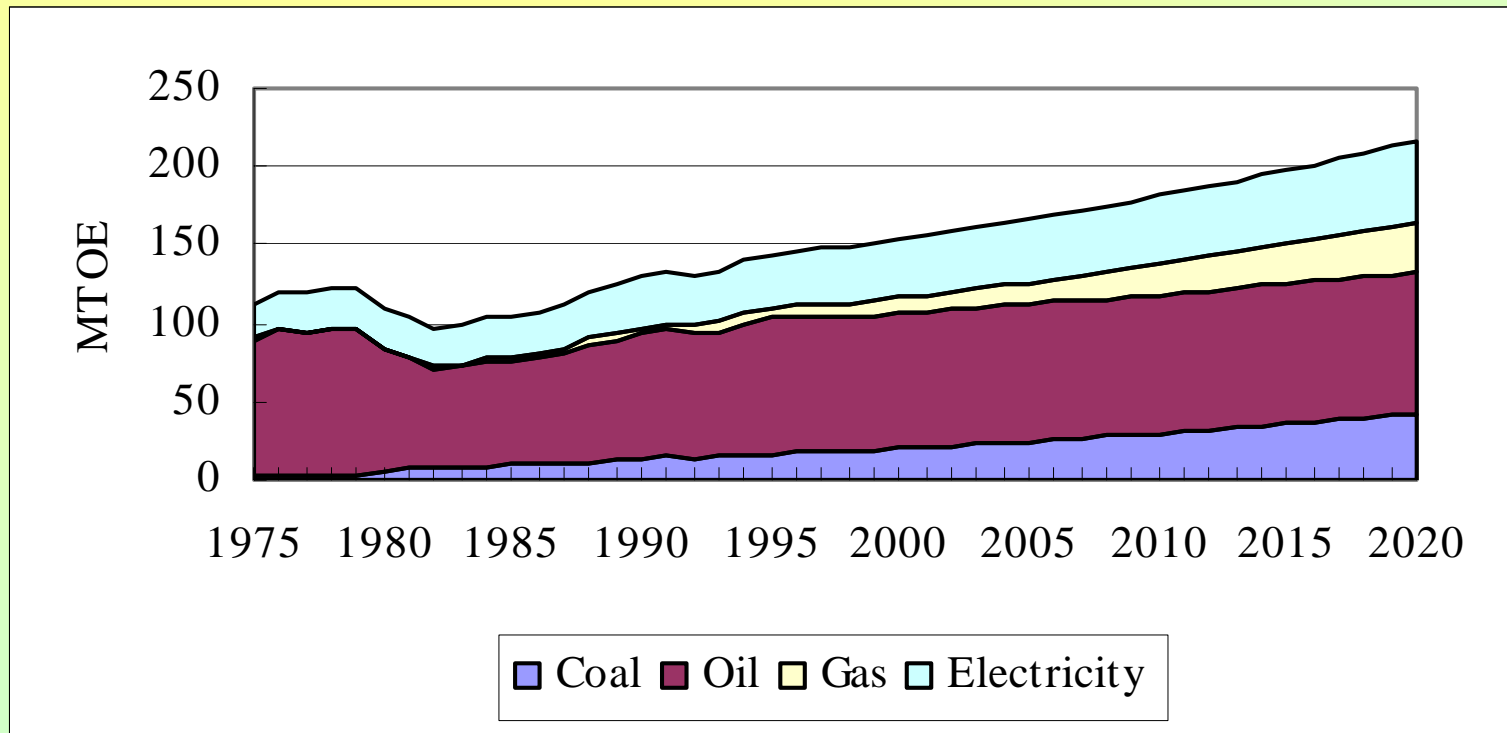
## Energy Demand (Transportation Sector)





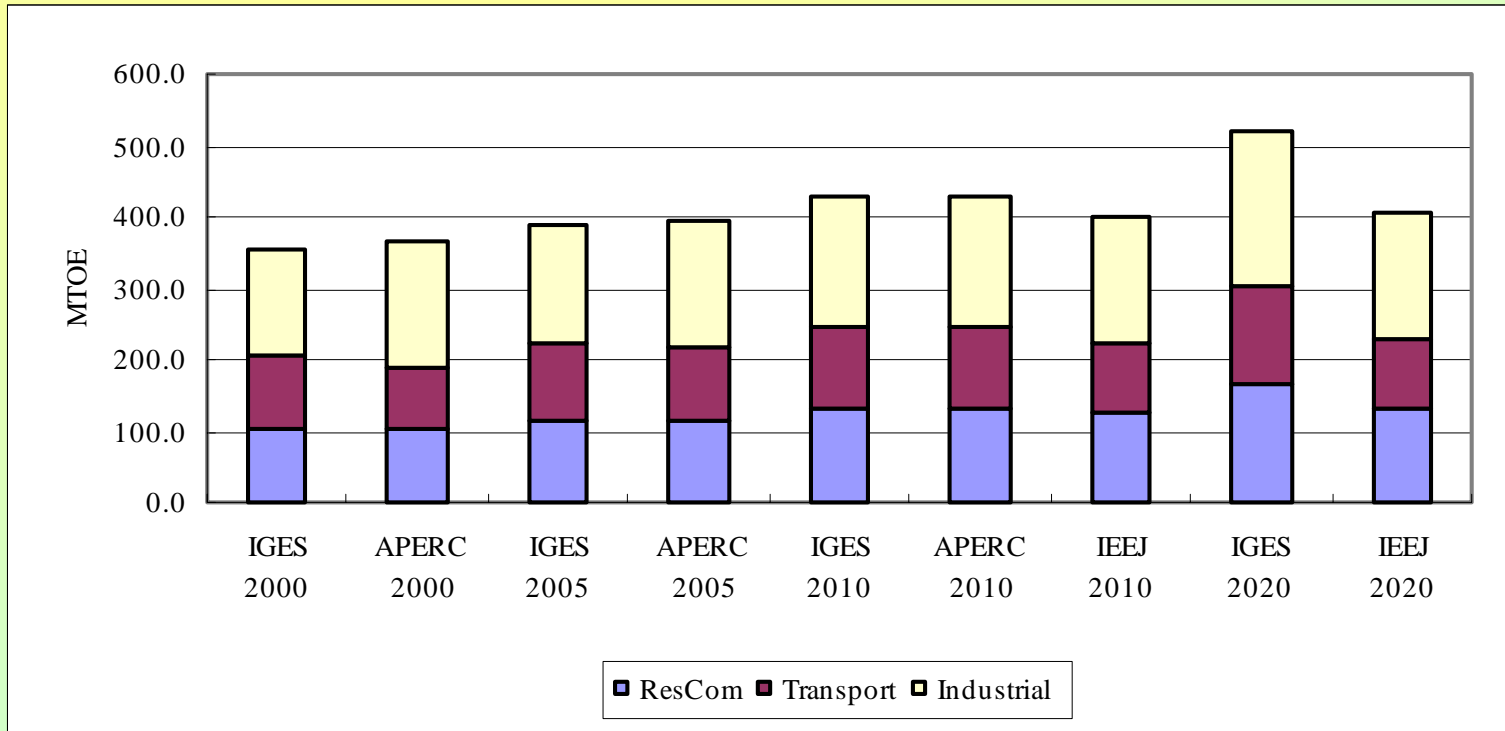
# Initial Results of Japan (BaU)

## Energy Demand (Industrial Sector)



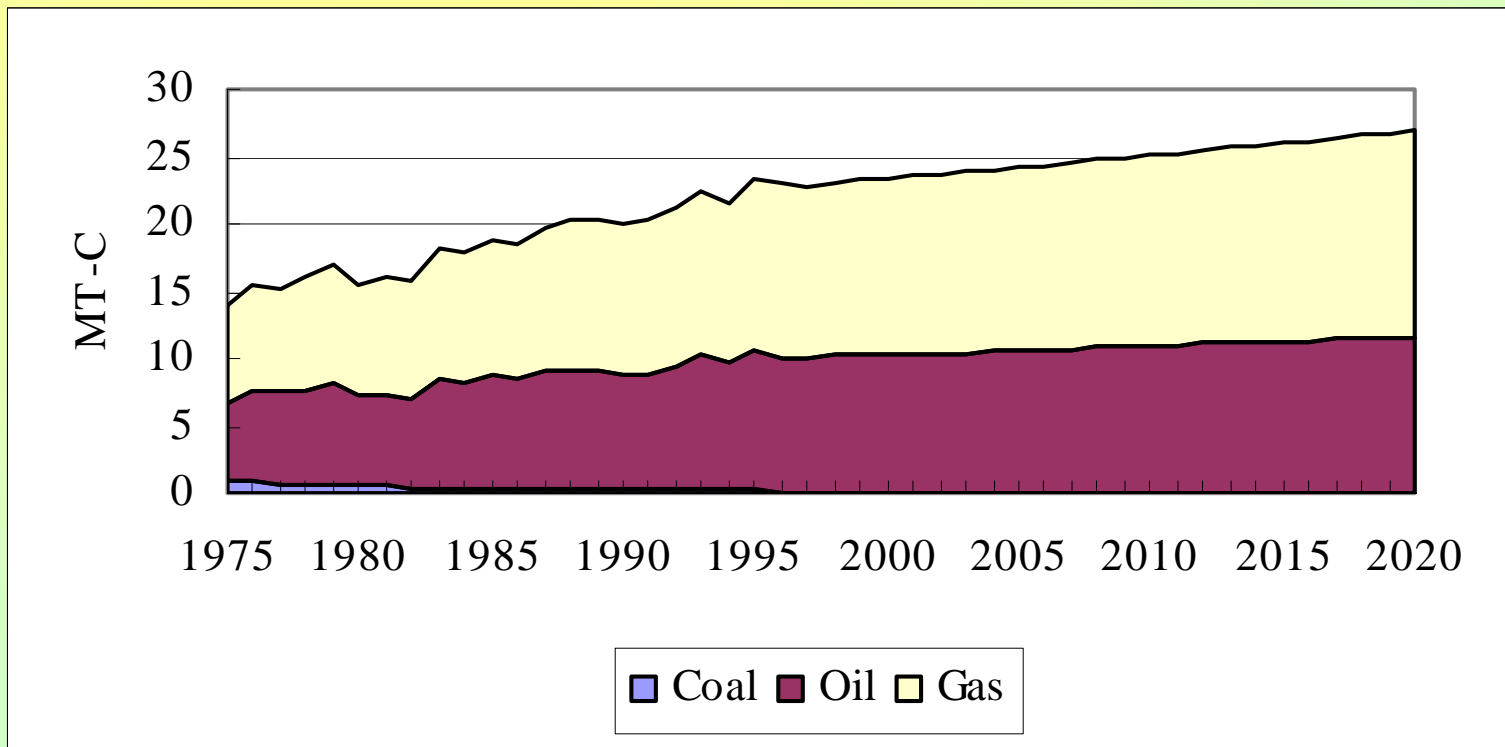
# Initial Results of Japan (BaU)

## Comparison with Other Models



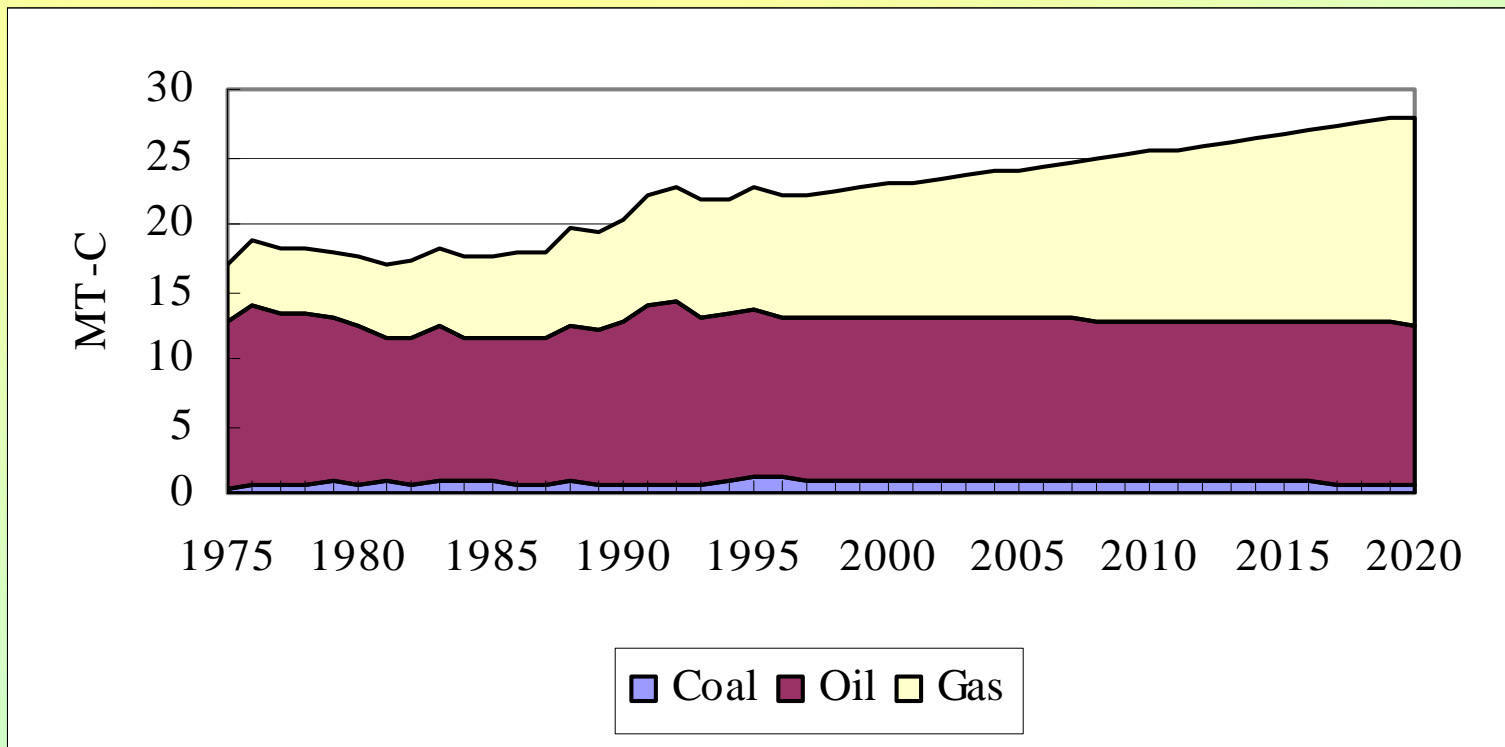
# Initial Results of Japan (BaU)

## CO<sub>2</sub> Emissions (Residential Sector)



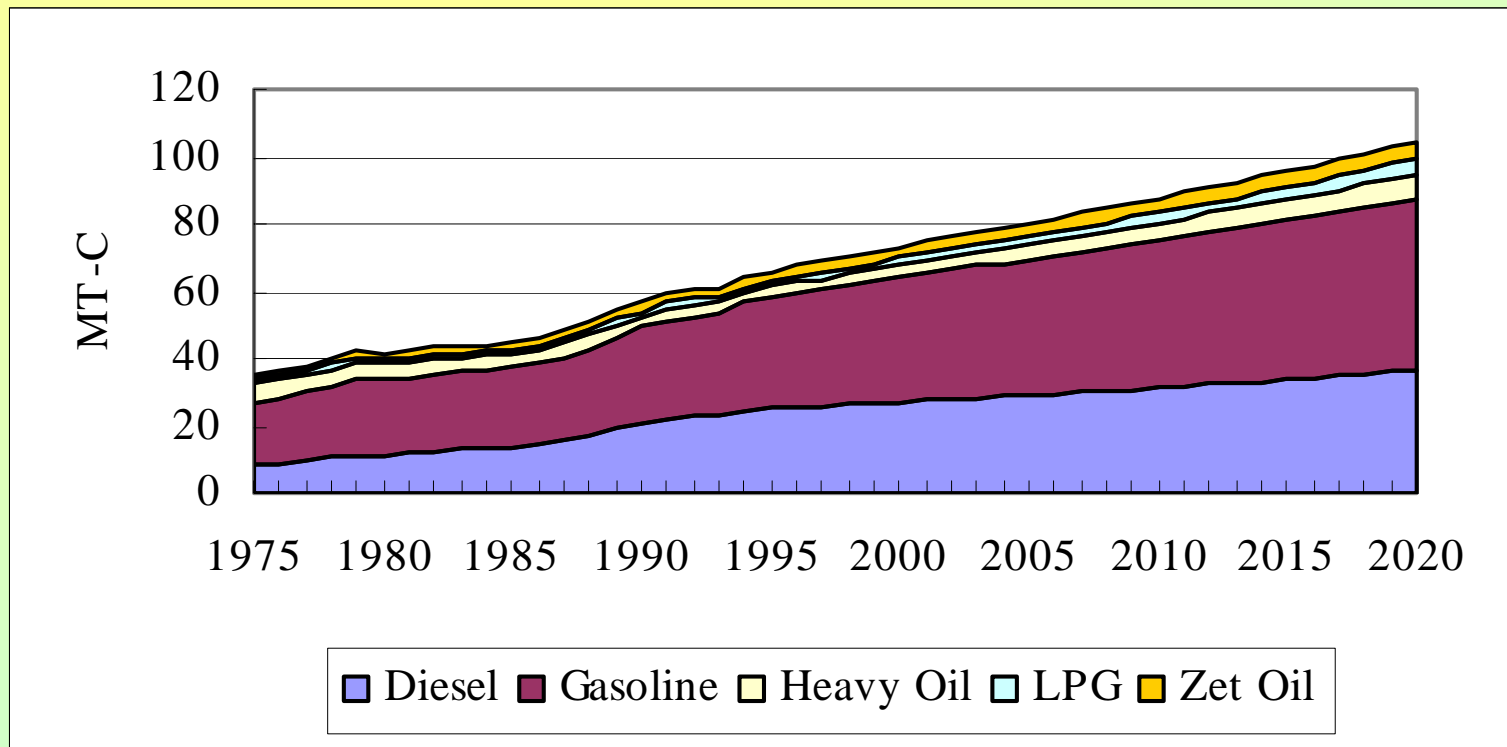
# Initial Results of Japan (BaU)

## CO<sub>2</sub> Emissions (Commercial Sector)



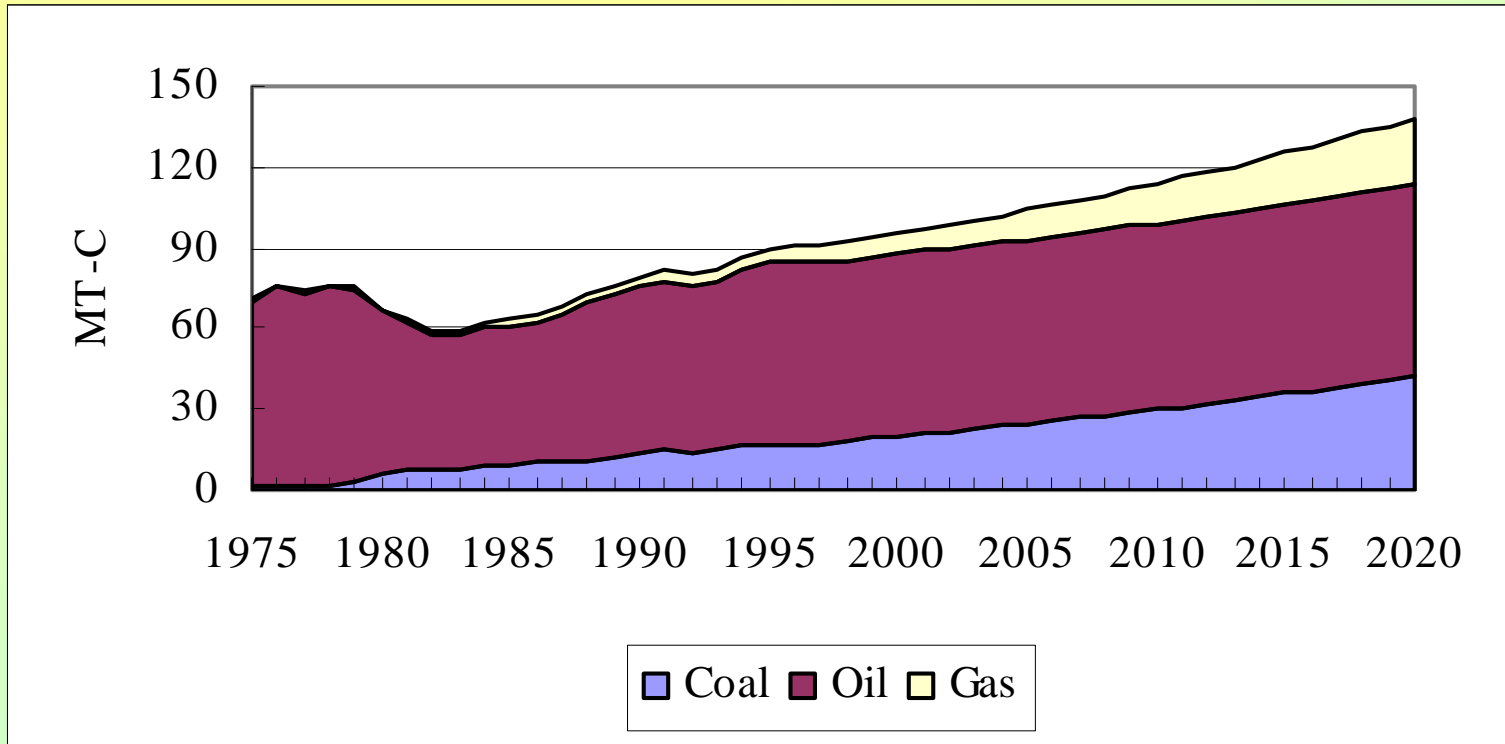
# Initial Results of Japan (BaU)

## CO<sub>2</sub> Emissions (Transportation Sector)



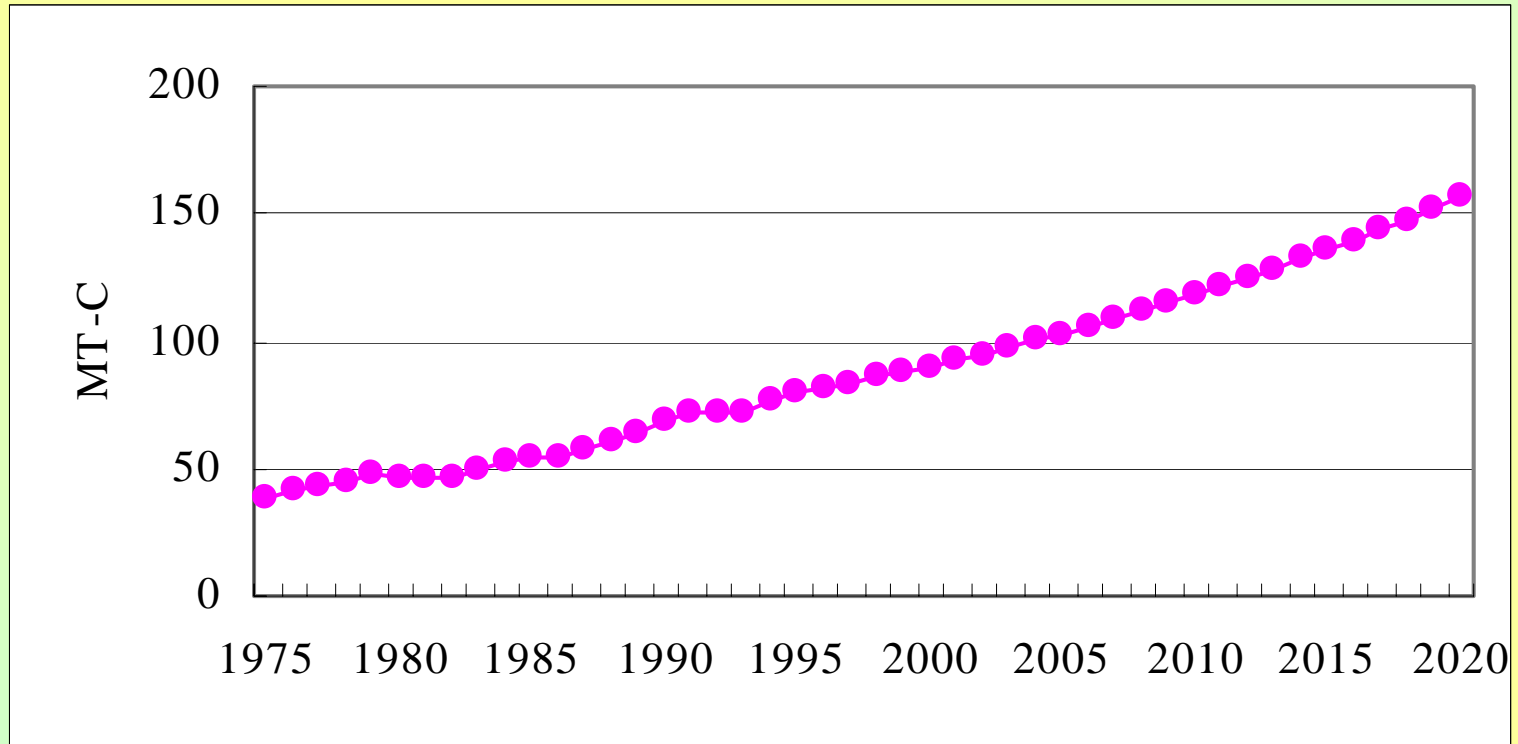
# Initial Results of Japan (BaU)

## CO<sub>2</sub> Emissions (Industrial Sector)



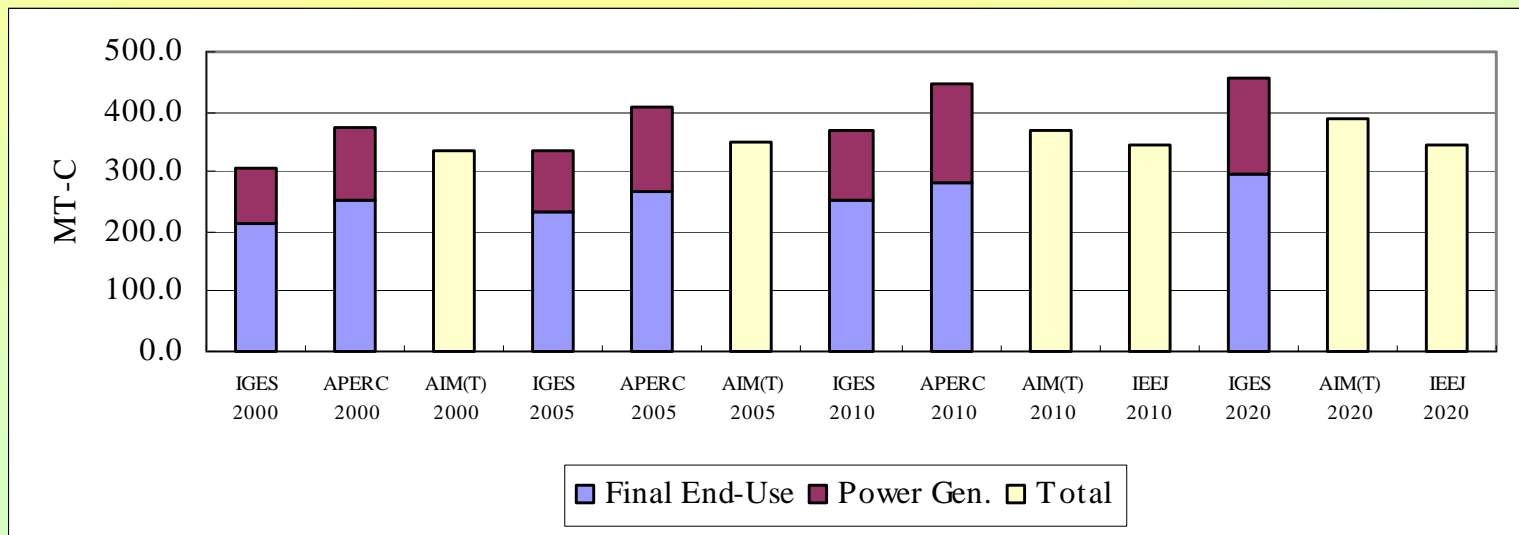
# Initial Results of Japan (BaU)

## CO<sub>2</sub> Emissions (Power Generation Sector)



# Initial Results of Japan (BaU)

## Comparison with Other Models





# Future Research Plan

## ○ CDM Analysis (by April, 2000)

### ✿ First Stage: CDM between Japan and China

▣ Feasible CDM Projects: To Collect Information

▣ Analysis based on IGEM

## ○ Final Results (after April, 2000)

✿ To Complete Three Countries Analysis

✿ To Report the Results Based on IGEM

✿ To Disseminate Outputs in Various Occasions

# Future Research Plan

## ○ Expansion to Other Countries (May, 2000 - )

⊗ India

⊗ Russia

📄 **Joint Implementation Analysis**