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Recent Modeling Activities of IGES: The Case of Korea (GEMA-K)

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Greenhouse Gas Emission Model for Asia (GEMA) Structure

- Characteristics
  - Country-specific Hybrid Model
    - Three Countries : China, Japan, Korea (So far)
    - 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

GEMA Structure

- 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)

GEMA Structure

- Characteristics
  - Estimation Methods
    - Autoregressive Distributed Lag Specification(ARDL): ARDL(1,1) is specified.
    - SURE Estimation Method: To Capture the Inter-fuel Substitution Elasticities in Energy Demand Equations (Trans-log Cost Function & Share Equations)

GEMA Structure

- Characteristics
  - CGE Methods
    - Open/Dynamic/ Multi-Sector Model
    - Capital Accumulation and International Financial Flows for CDM Analysis
    - Multi-Level KLEM Production Function with Armington Assumption
    - Fuel-substitution Elasticity from Econometic Estimation (Localization of Parameters)
    - AEEI is accounted for.

GEMA Structure

- 8 Modules
  - Macro Economic Module
    - Demand Side of an Economy
    - Simple Keynesian Open Macro Economic Model

      Example: Consumption Function

      - Error Correction Model (Short-run)

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

      - Co-Integration Model (Long-run)

$$C_t = a_0 + a_1 y^m_t + a_2 r_t + a_3 W_t$$

      - Time-varying Coefficient (If necessary)

β, δ_1, δ_2

GEMA Structure

- 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.

GEMA Structure

- 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

GEMA Structure

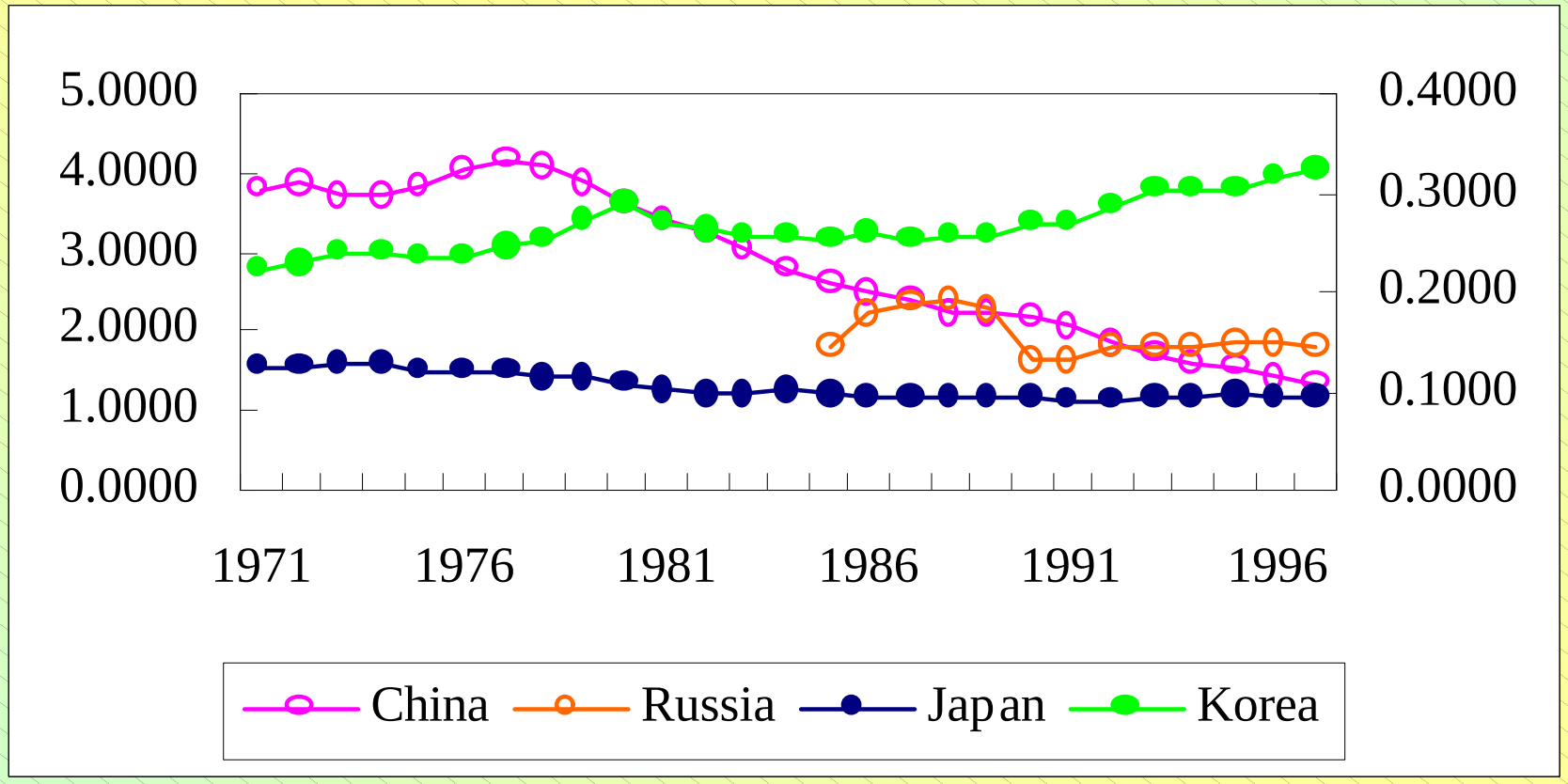
- 8 Modules
  - Linkage Module
    - Technical Assessment of CDM Project: Bottom-up ap proach is preferable.
    - Hard Linkage with Bottom-up Model: AIM (maybe)
    - Advantage of Hard Linkage: GEMA can be tangible model. (Soft linkage makes the model large.)
    - Still, the soft linkage of top-down and bottom-up mode ls is the most challenging work.

GEMA Structure

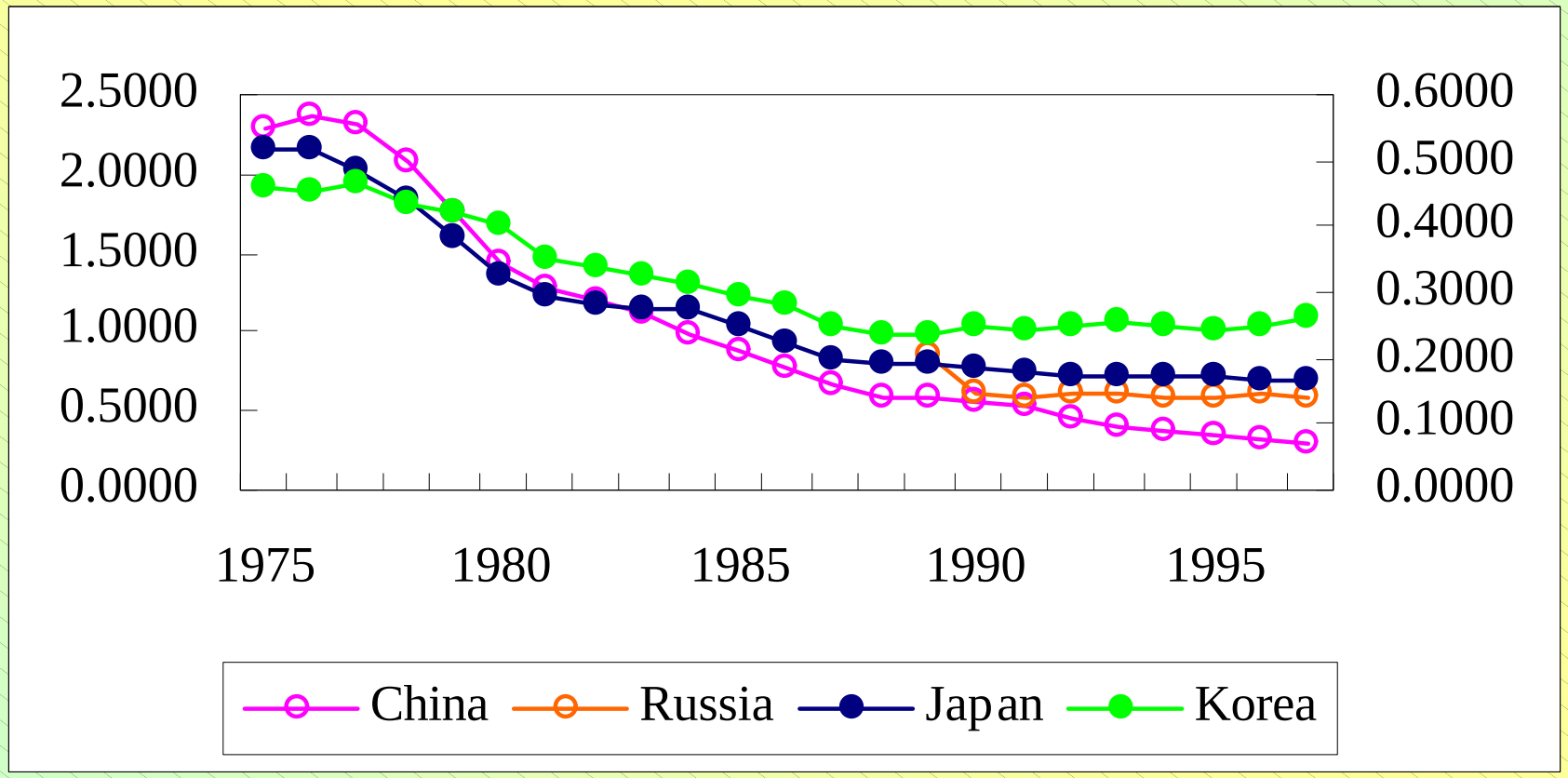
- 8 Modules
  - Scenario Module
    - Scenario Generator: Systematic Way
    - Marginal Change Analysis: Due to CDM project, what is the deviation from BaU projection, in terms of energy, GHG emission
  - Output Module
    - Output Generation: Economic Activities, Energy, GHG Emissions

Base Issue for Int'l Comparison

(Energy Intensity, Exchange Rate, TOE/1000US $)

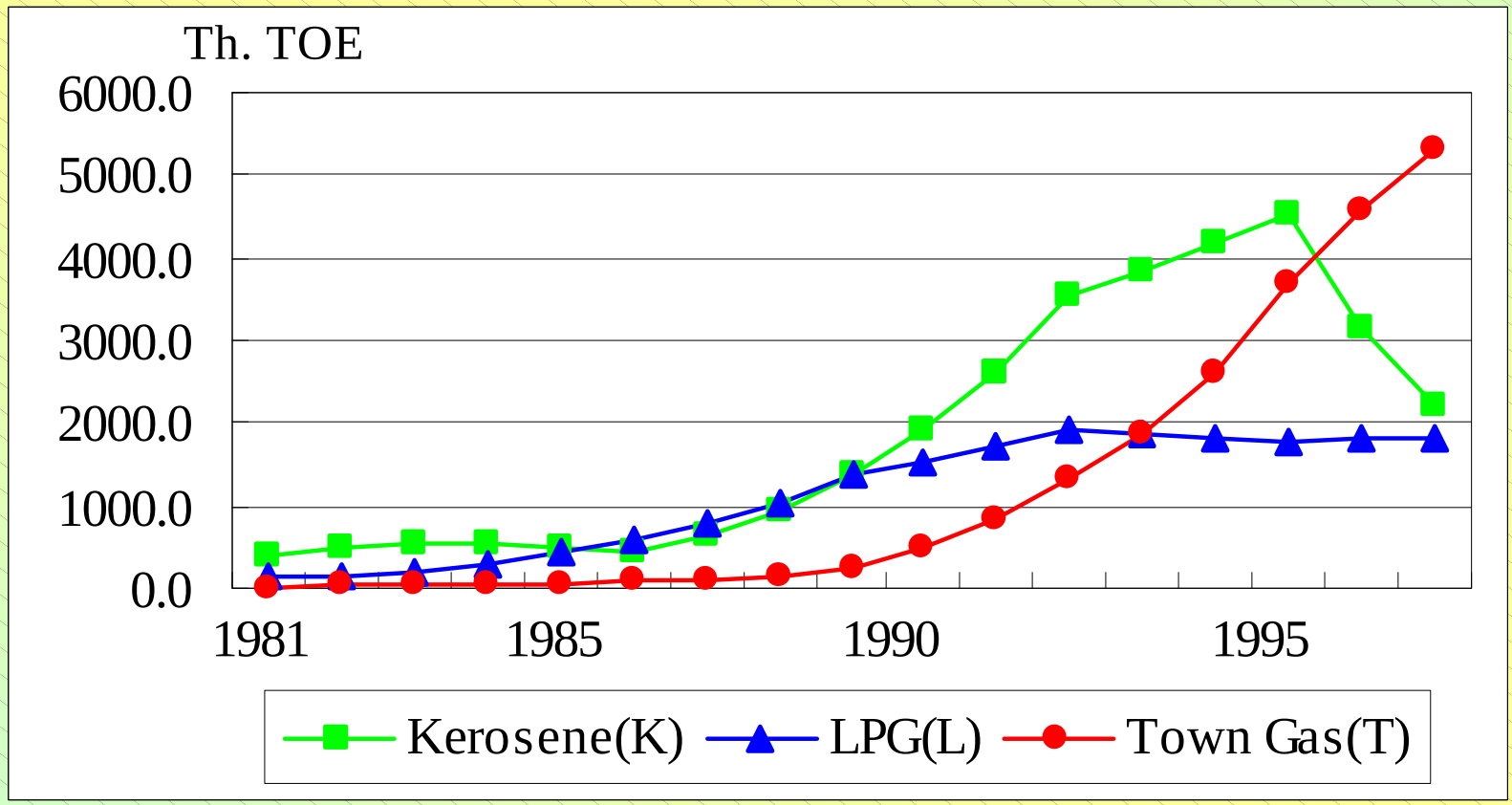


Base Issue for Int'l Comparison
(Energy Intensity, PPP, TOE/1000US $)

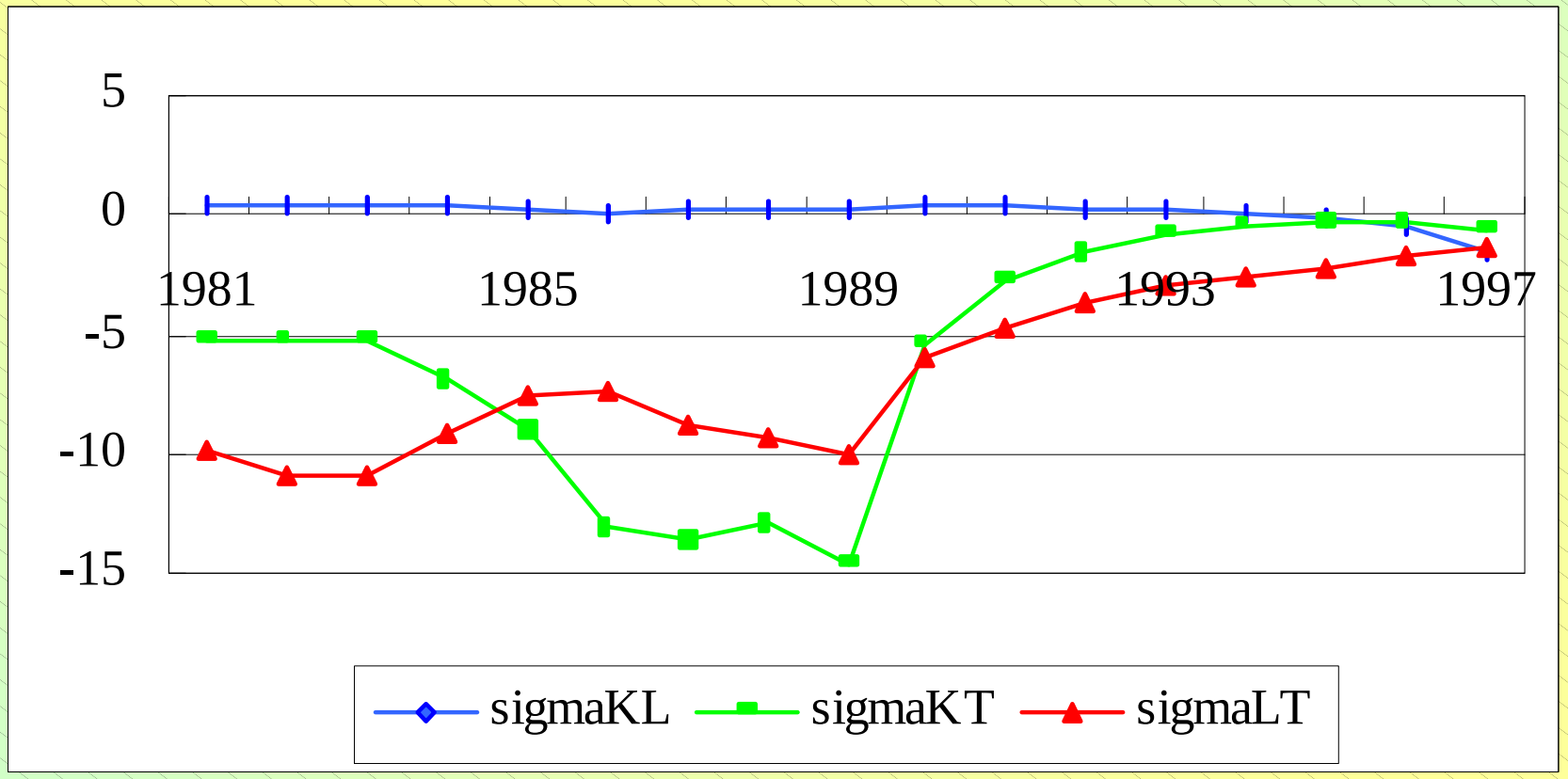


Energy Demand Trend (Historical)

(Example: Residential Sector)

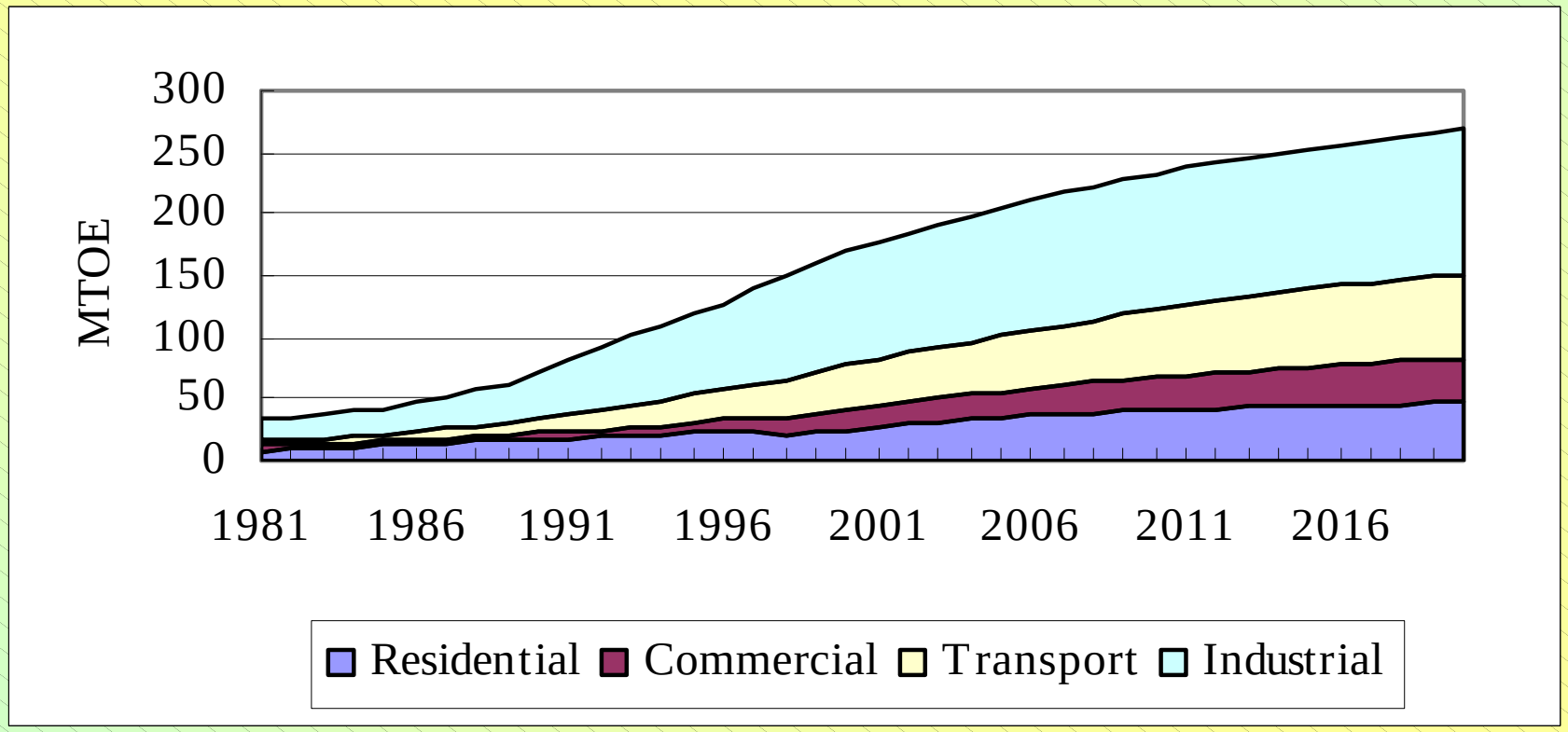


Estimation of Fuel Substitution Elasticities (Example: Residential Sector)



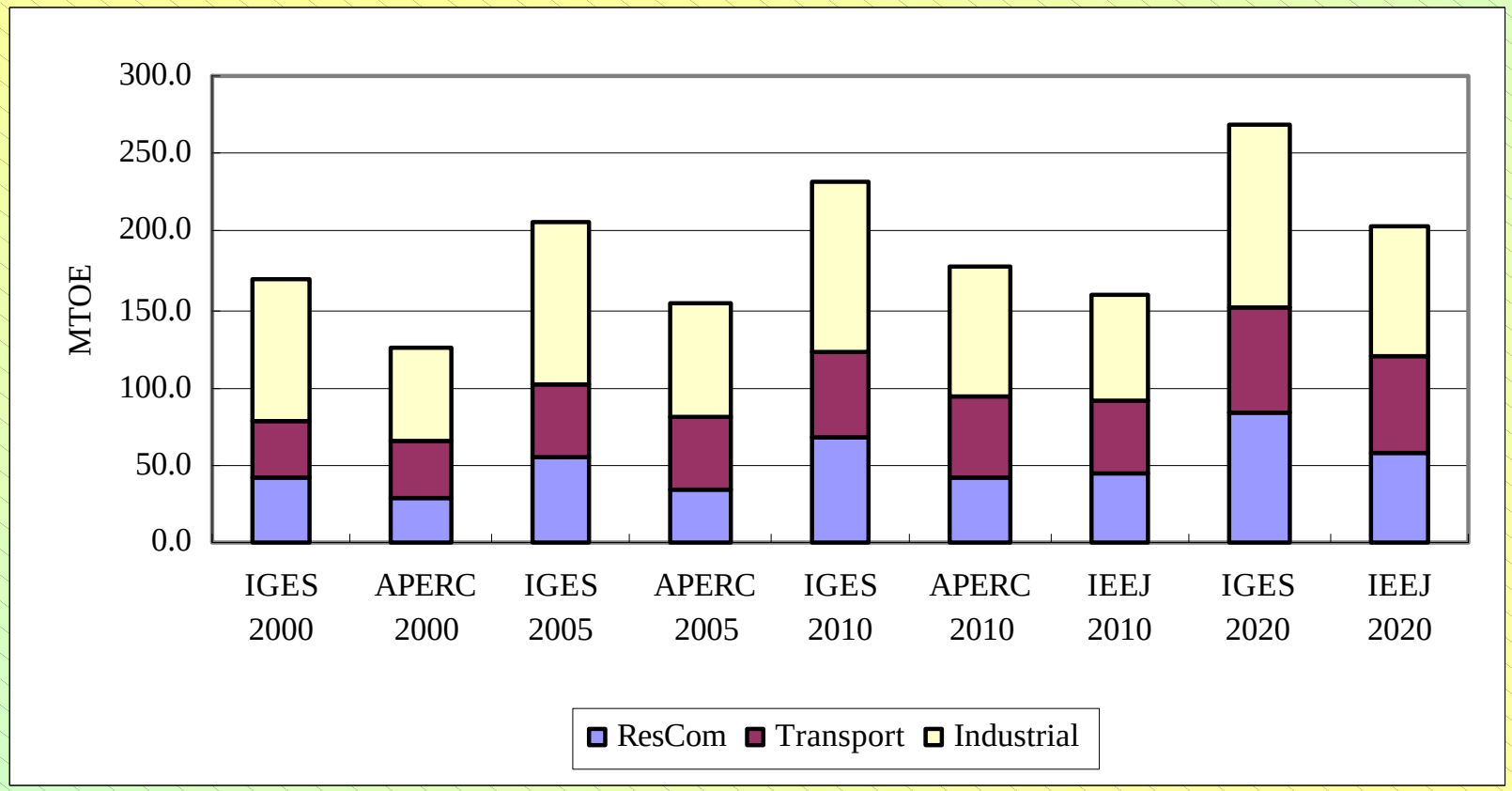
Initial Results of Korea (BaU)

Total Energy Demand Projection



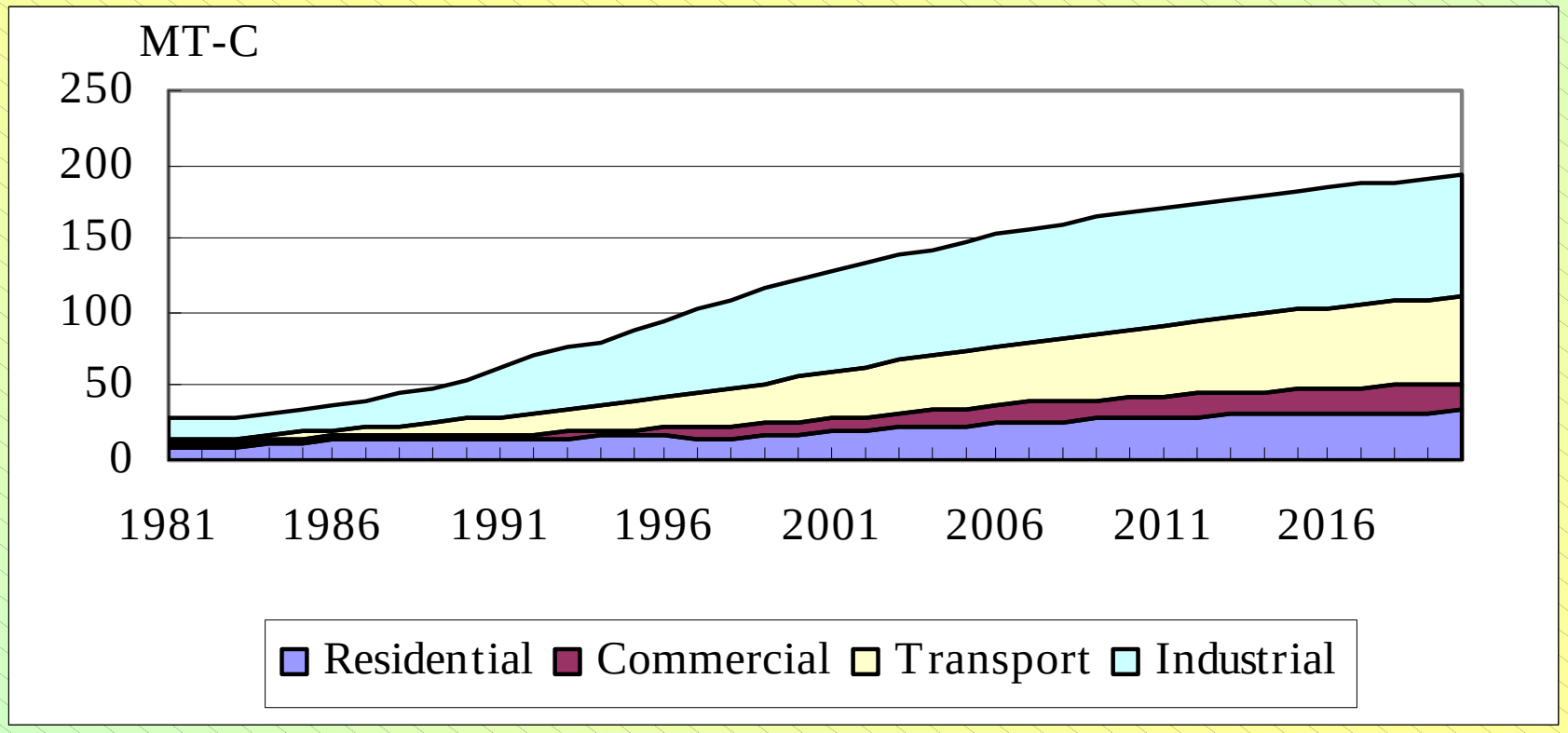
Initial Results of Korea (BaU)

Comparison with Other Models



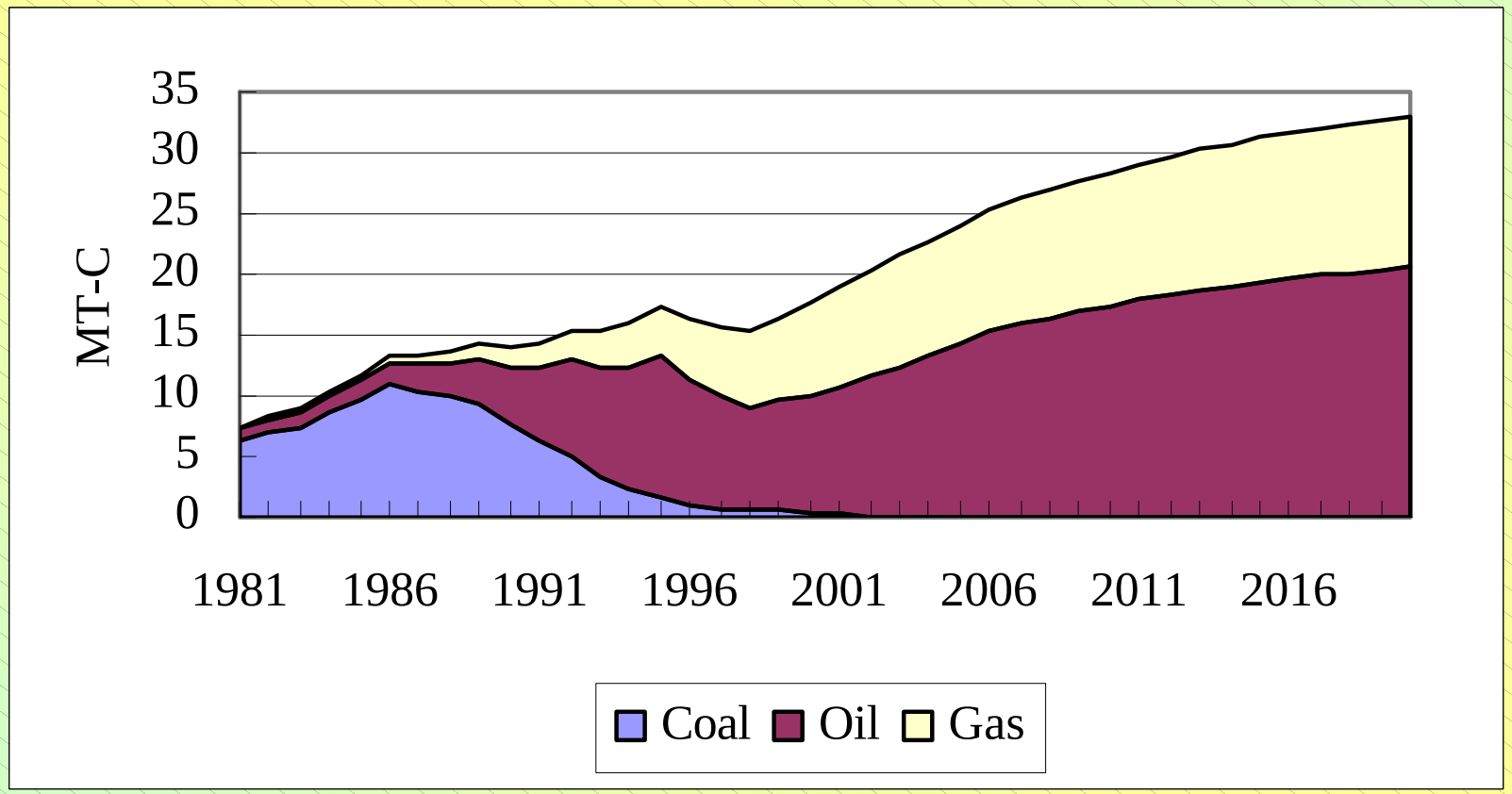
Initial Results of Korea (BaU)

Total CO_2 Emissions Projection



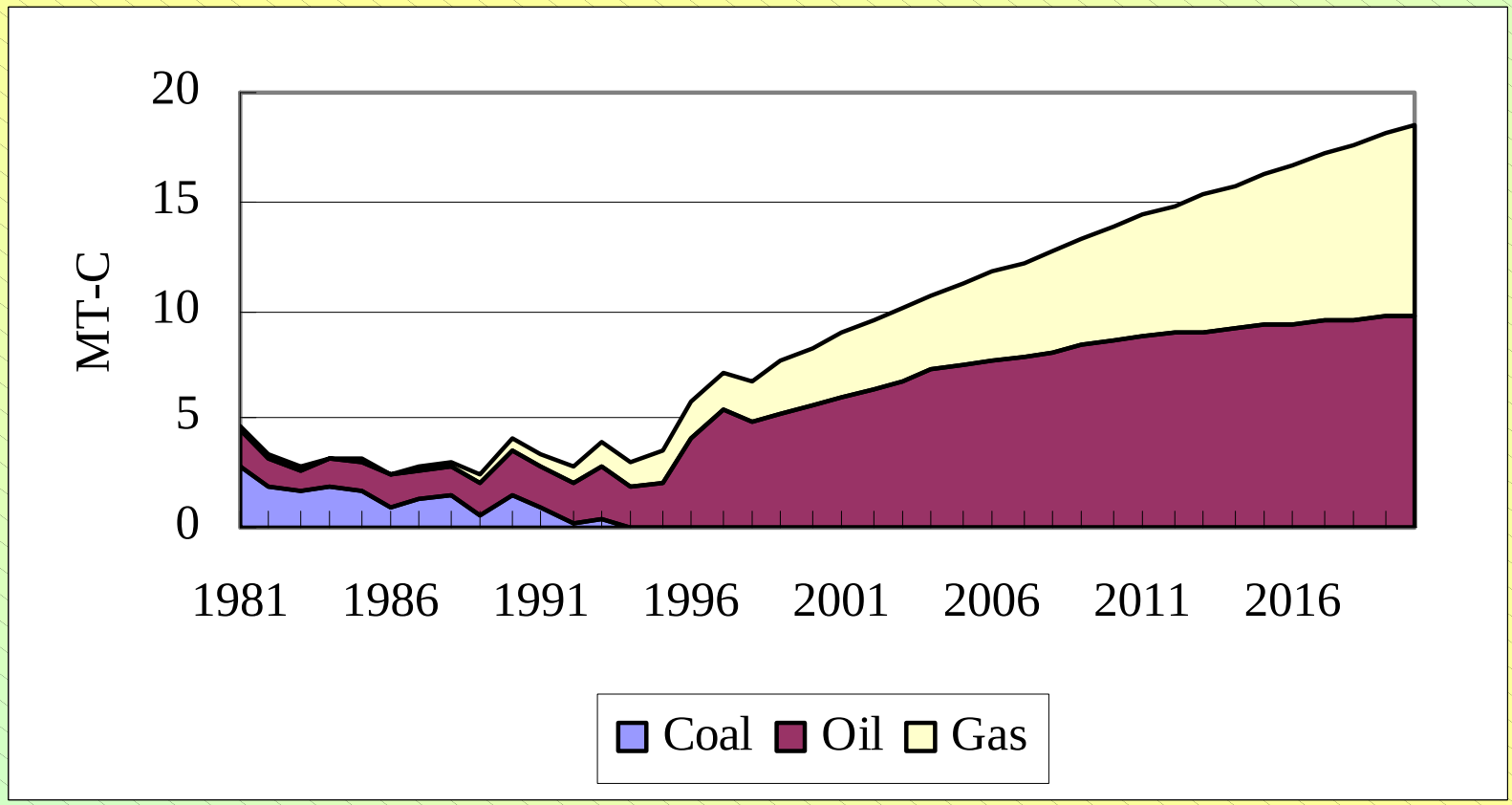
Initial Results of Korea (BaU)

CO_2 Emissions (Residential Sector)



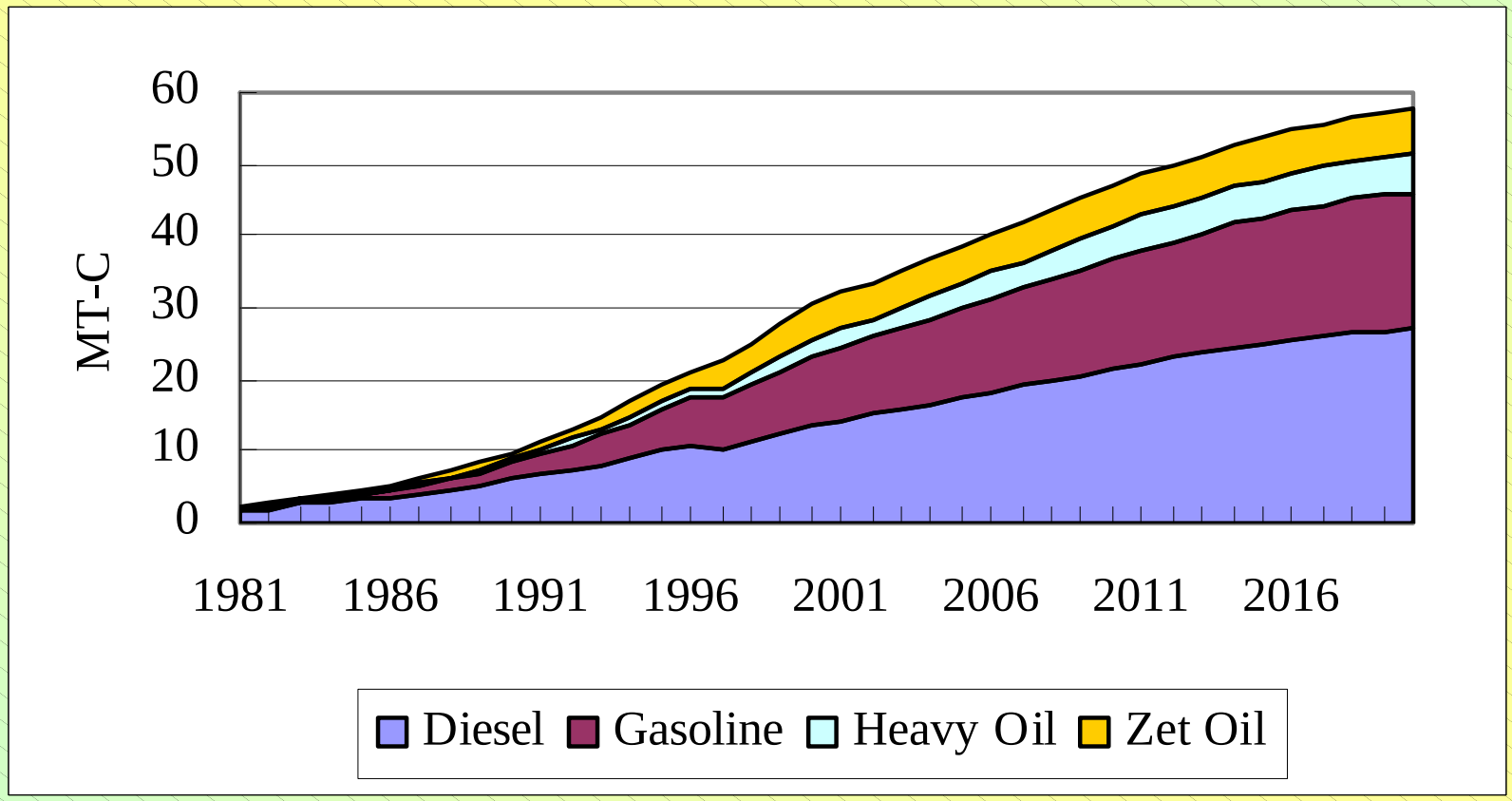
Initial Results of Korea (BaU)

CO_2 Emissions (Commercial Sector)



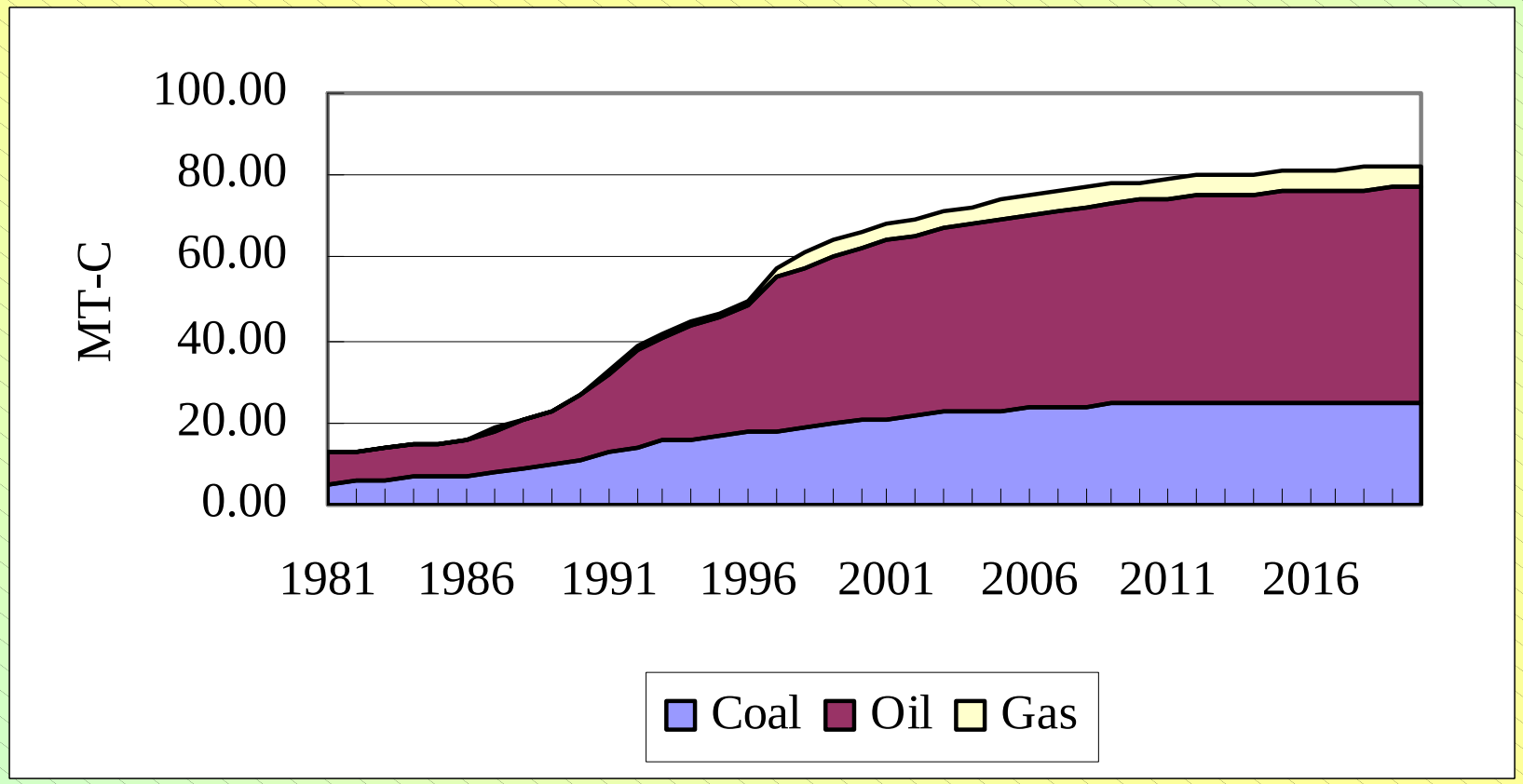
Initial Results of Korea (BaU)

CO_2 Emissions (Transportation Sector)



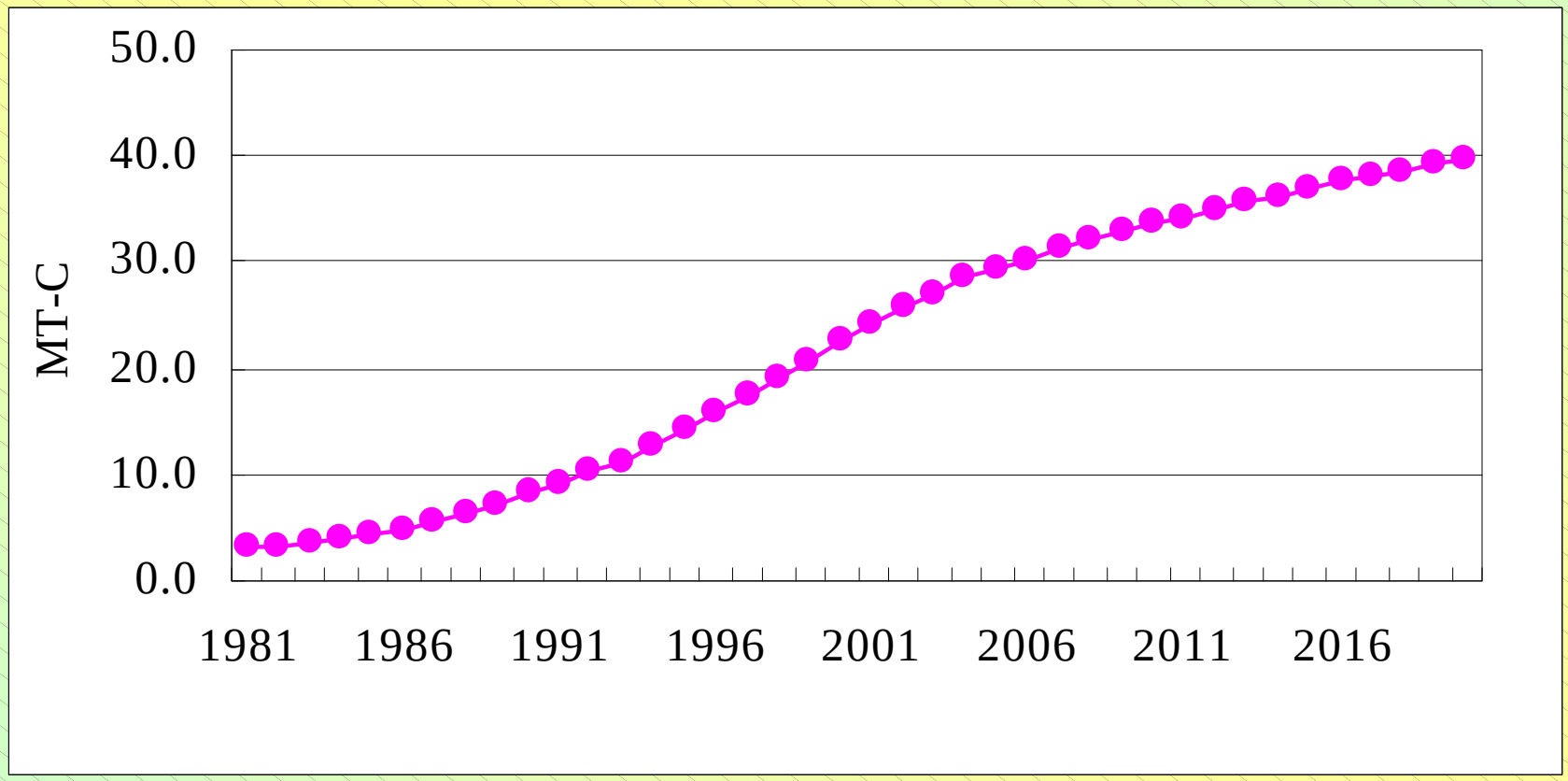
Initial Results of Korea (BaU)

CO_2 Emissions (Industrial Sector)



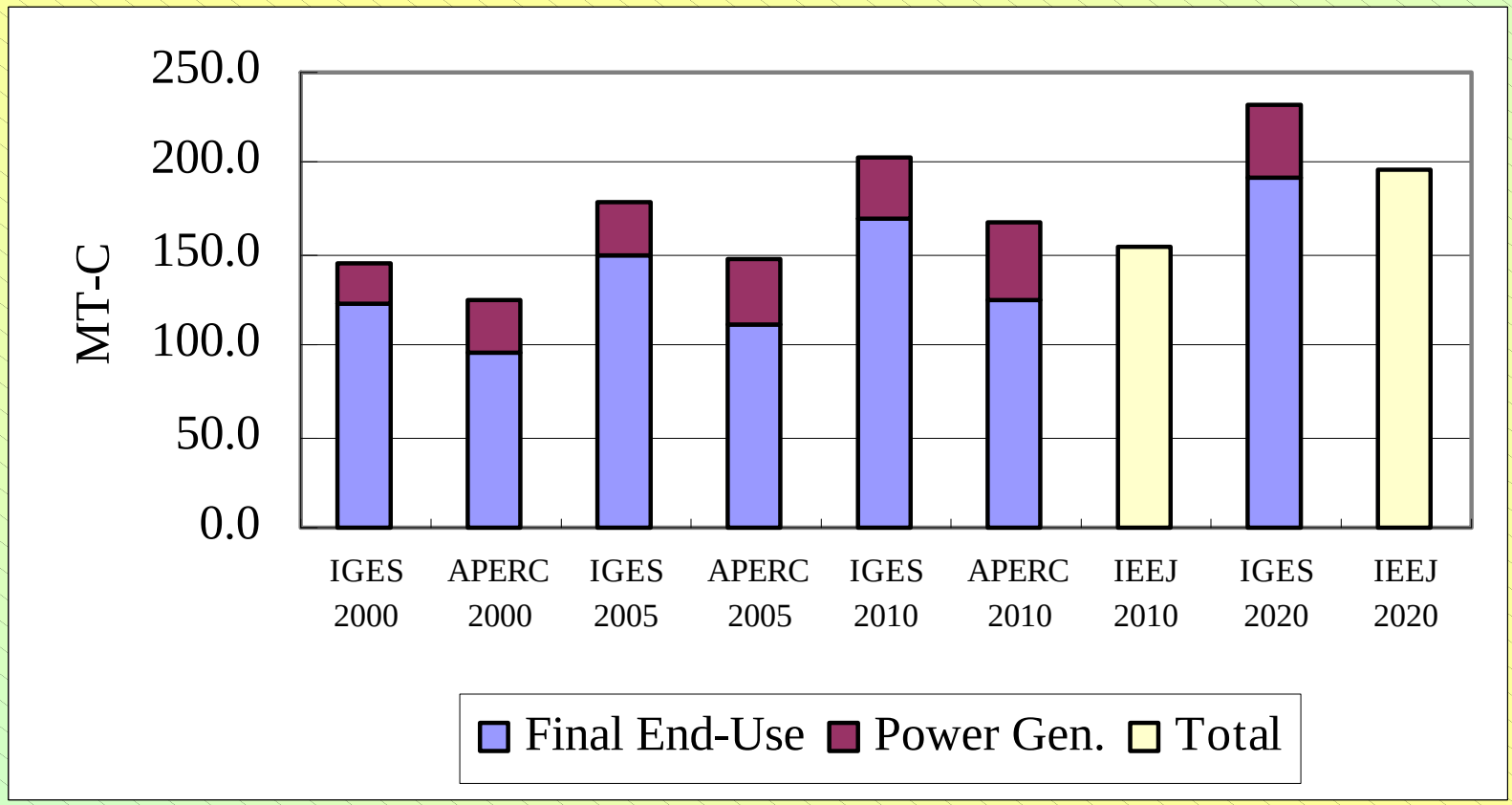
Initial Results of Korea (BaU)

CO_2 Emissions (Power Generation Sector)



Initial Results of Korea (BaU)

Comparison with Other Models



Further Extension of GEMA

- **Modeling**
  - **Limited Data/Rapid Structural Change**
    - **Some countries like Korea or China have limited historical data.**
    - **Rapid Change of Economic Structure**
  - **Local Parameter Estimation**
    - **Proper Representation of a Country Based on Parameters in This Model: not Easy**
    - **Estimation of AEEI for Each Country: not Easy**
- **Coverage**
  - **Next Stage: India/Russia (Initiated)**