Progress of Energy Technology Systems Analysis in JAERI

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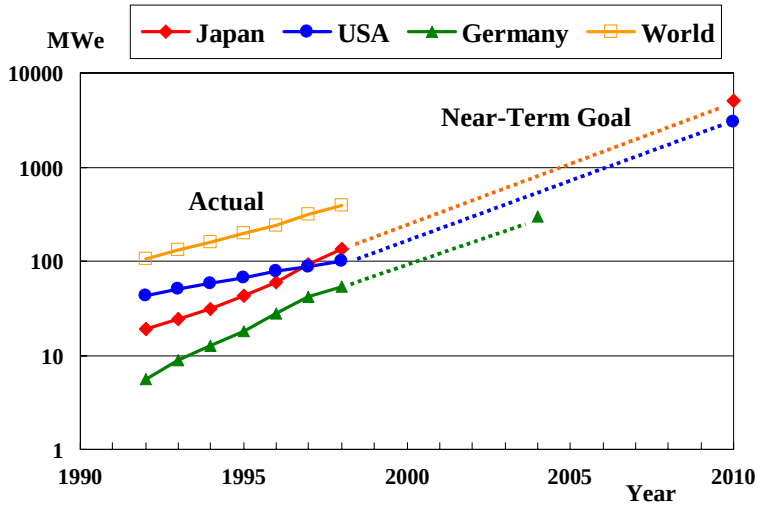
1. Assessment on Solar PV Systems

(1) Background

- **Increasing Importance of Electricity in Japan's Energy Systems with Increases of Consumption in Resid. & Commer. Sector**
- **Best Mix of Power Generation Technologies including Small Scale Renewable Energy Technologies**
- **High Generation Costs of these Technologies need Public Support at Initial Stage of Market Penetration**
- **ETSAP's Modeling Studies: Long-Term Social Benefit might Exceed Cost of Supporting their Market Penetration**
- **Remaining Subject: Development of Reliable Data on Technology Progress**

(2) Installations and Production of PV Systems

Cumulative Installations of PV Systems in Selected Countries and in the World



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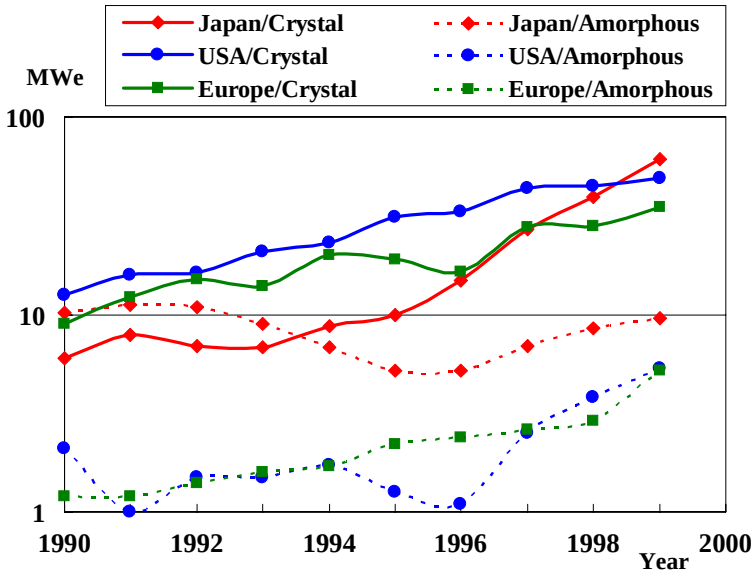
Regional Production of PV Module by Types of Module



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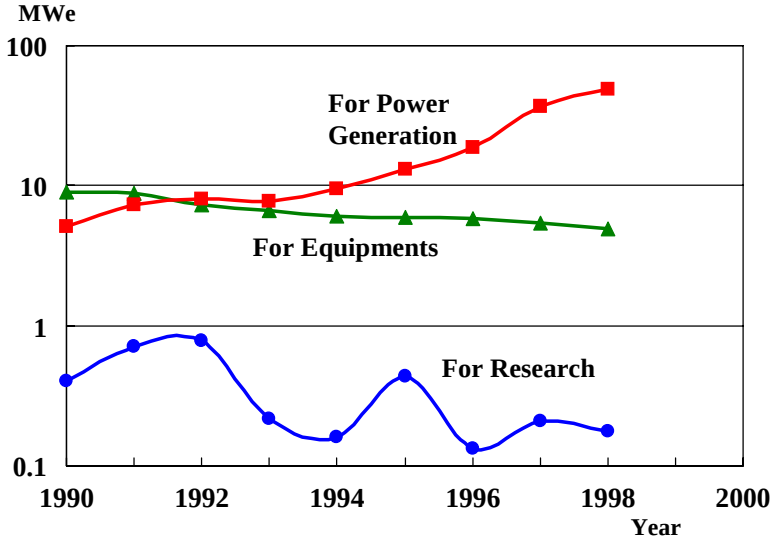
Annual Production of PV Module in Japan by Application Purposes



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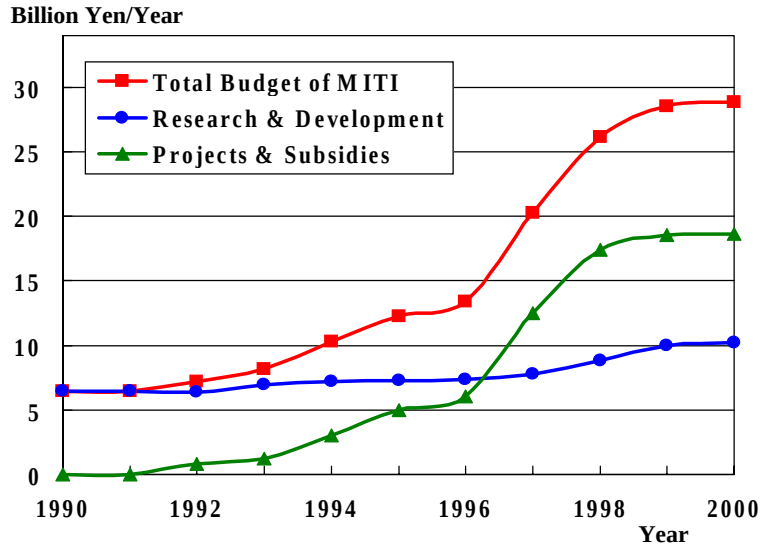
Government Budget on R&D and Market Penetration of PV Systems in Japan



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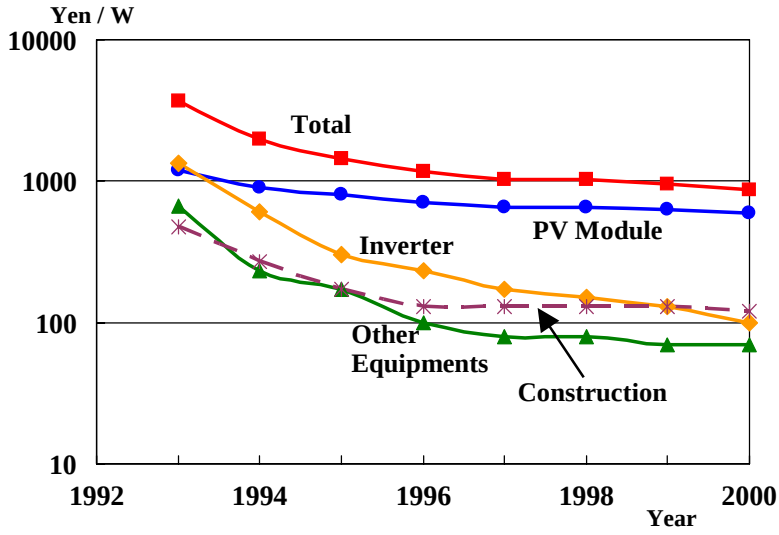
(3) Sale Prices of PV Systems

Reduction in Prices of Residential PV Systems



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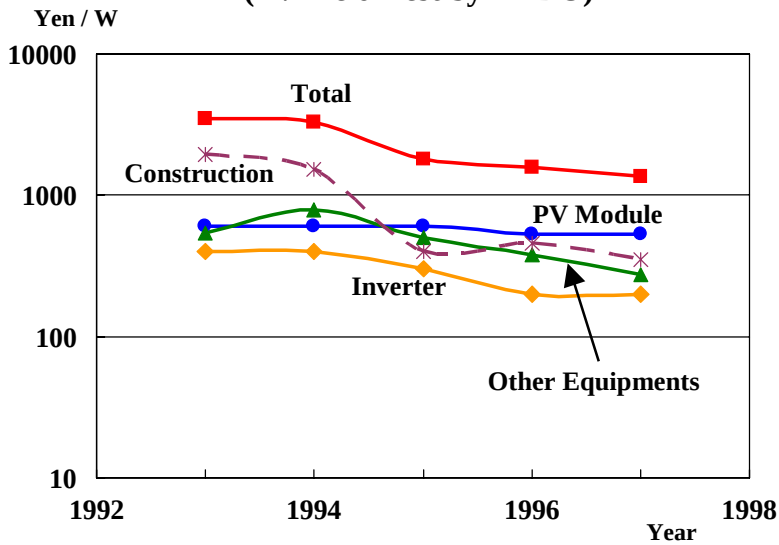
Installation Costs of 10 kW PV Systems (PV Field Test by NEDO)



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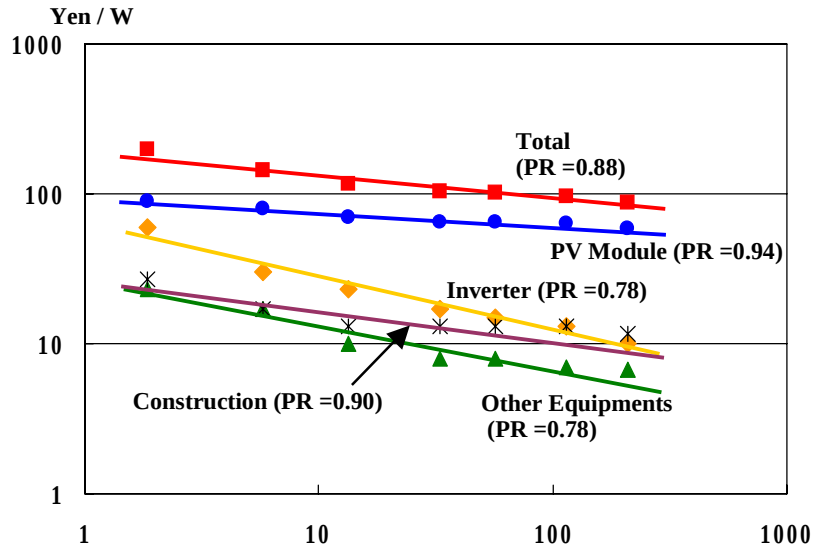
Short-Term Progress Ratio of Residential PV Systems



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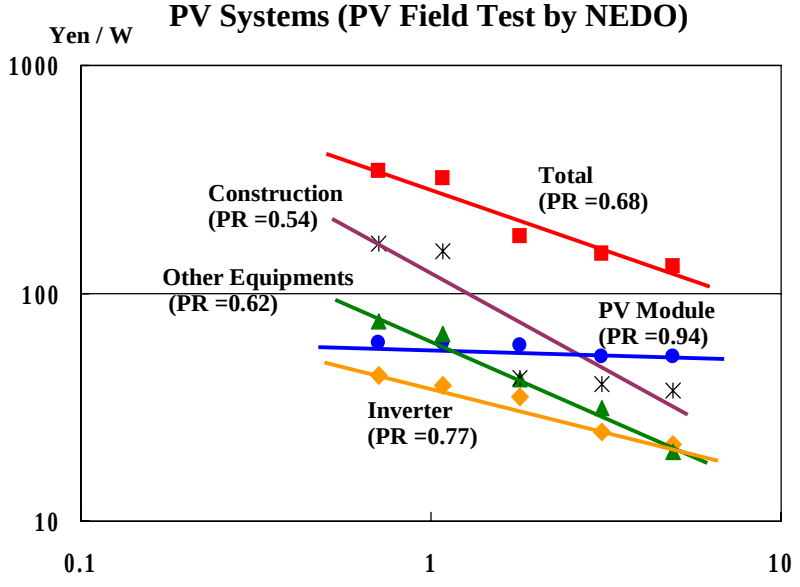
Short-Term Progress Ratio (PR) of Public Facility PV Systems (PV Field Test by NEDO)



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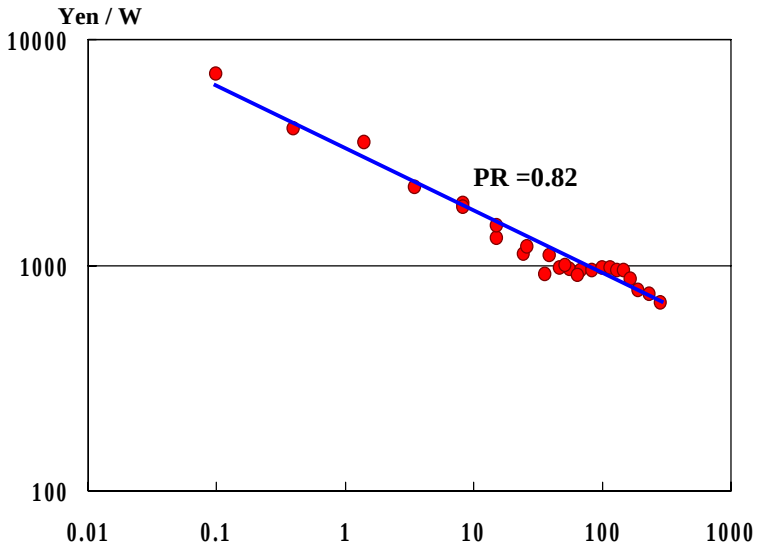
Progress Ratio of PV Module in Japan



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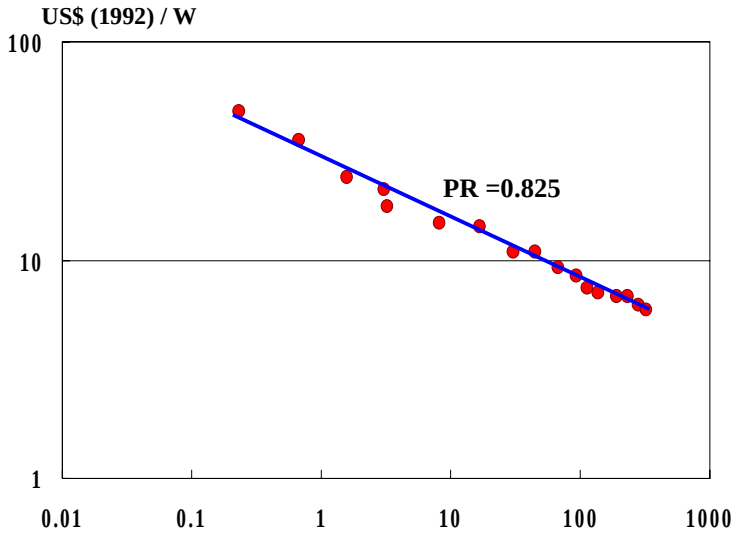
Progress Ratio of PV Module in the United States



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(4) Summary of Results

- **Short-term progress ratio (PR) of residential solar PV systems in Japan was 0.88, while PR of public facility solar PV system was much lower (0.54) because of substantial reduction in construction costs.**
- **In the recent development of solar PV systems, prices of components other than PV module have reduced substantially, and PV module occupies 68% of total system prices in 1999.**
- **This means that future price reduction of solar PV systems depends on the decrease in the prices of PV module.**
- **According to long-term historical data of PV module prices and amount of production, long-term PR was 0.82, consistent with the data in the U.S.**
- **The difference in short-term and long-term PRs of PV module needs further investigation.**
- **Relevance of price reduction with a unit scale of production facilities is also an important subject remaining.**

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2. Development of an Energy–Economy Model and Application for Energy Technology Assessment

(1) Outline of Macro Economic Model

- **Long-term Neo-Classical Economic Growth Model with a Linear Equation System**
- **14 Production Sectors* with Fixed Input-Output Coefficients**
  *** 1. Agriculture, 2. Mining, 3. Textile, 4. Pulp & Paper, 5. Chemicals, 6. Petroleum & Coal Products, 7. Ceramics, 8. Primary Metals, 9. Machinery, 10. Other Manufacturing, 11. Construction, 12. Electricity & Gas, 13. Transport & Communication, 14. Services**
- **Economic Growth based on Total Factor Productivity**
- **Substitution of Capital and Labor allowed within Constraints**
- **Optimum Consumption and Investment with Maximizing Discounted Utility of Consumption**
- **Linkage with Energy Model:**
  Energy Service Demand + Costs of Fuel Imports

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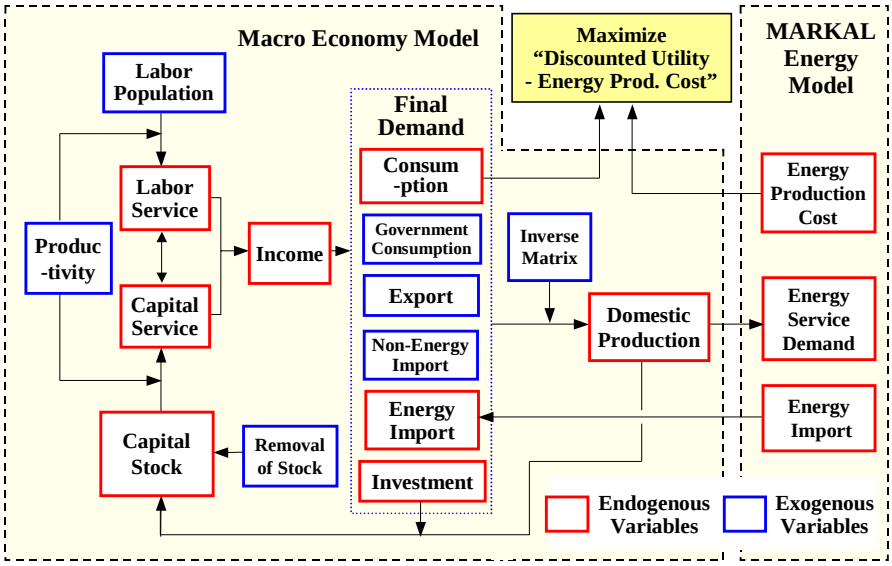
Basic Structure of Energy-Economy Model



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(2) Application for Analyzing Role of Nuclear Energy

(a) Objective

To analyze macro economic impacts of nuclear phase-out particularly via the increase of fuel import costs, and thereby to examine the model and to identify the items of necessary improvements.

(b) Assumptions

- **Time Period: 1995 - 2050**
- **Economic Growth Rate:** **2000-2010 1.5%**
  2010-2030 1.0%
  2030-2050 0.5%
  2000-2050 0.9%

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● Analytical Cases

Case		Nuclear Power *1	Constraints on CO_2 Emission (50 Years During 2002.5 - 2052.5)	
			Cumulative *4 (Billion Ton)	Annual Average (Billion Ton)
Base Case	N1 N2	Yes	54.5 52.5	1.09 1.05
	R1 R2	No	54.5 52.5	1.09 1.05
Sensitivity Case	R2a *2 R2b *3	No	52.5 52.5	1.05 1.05

*1 Yes: Installed Capacity 80GWe in 2030, 100GWe in 2050
No : No Nuclear Investment after Year 2000

*2 Increase in Prices of High-Price LNG: Low-Price LNG *1.2 ➔ *1.5

*3 R2a + Expansion of Solar PV Capacity 100GWe in 2050 ➔ 140GWe

*4 52.5 billion ton is close to the minimum amount of CO_2 emissions that can be attained by the changes of energy systems alone.

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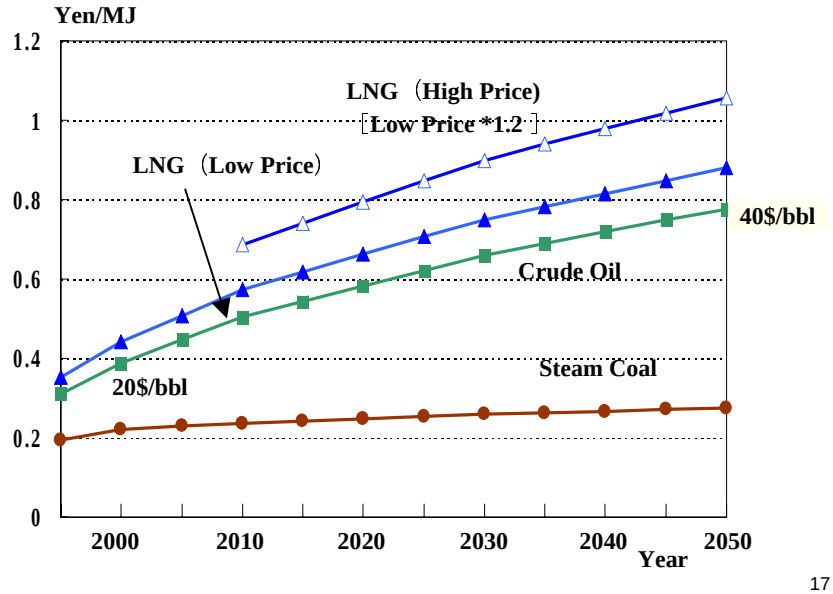
Prices of Imported Fossil Fuels



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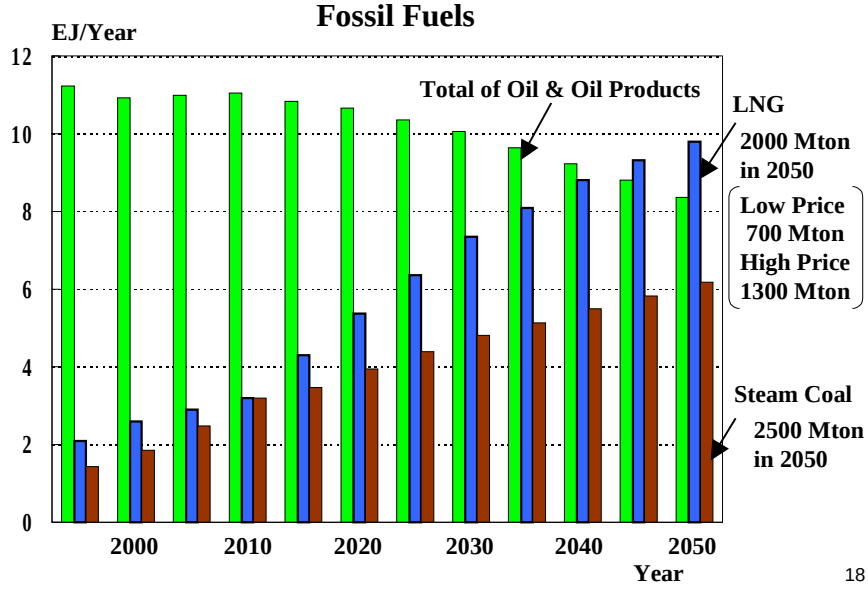
Constraints on Availability of Imported Fossil Fuels



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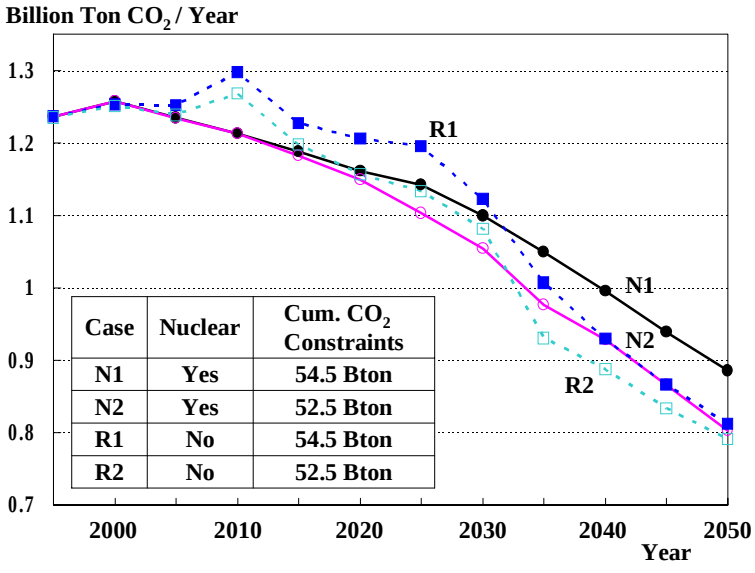
(c) Results of Base Cases

Annual CO_2 Emissions in Base Cases



Case	Nuclear	Cum. CO_2 Constraints
N1	Yes	54.5 Bton
N2	Yes	52.5 Bton
R1	No	54.5 Bton
R2	No	52.5 Bton

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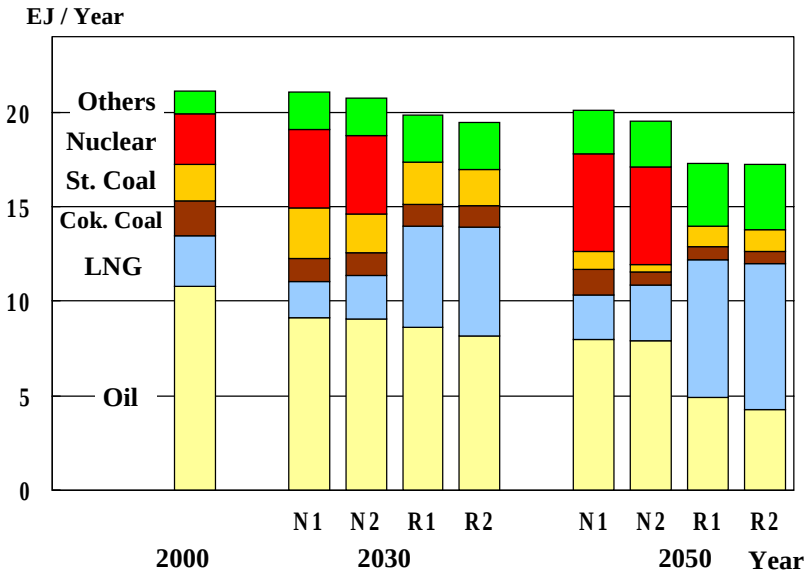
Changes in Primary Energy Consumption



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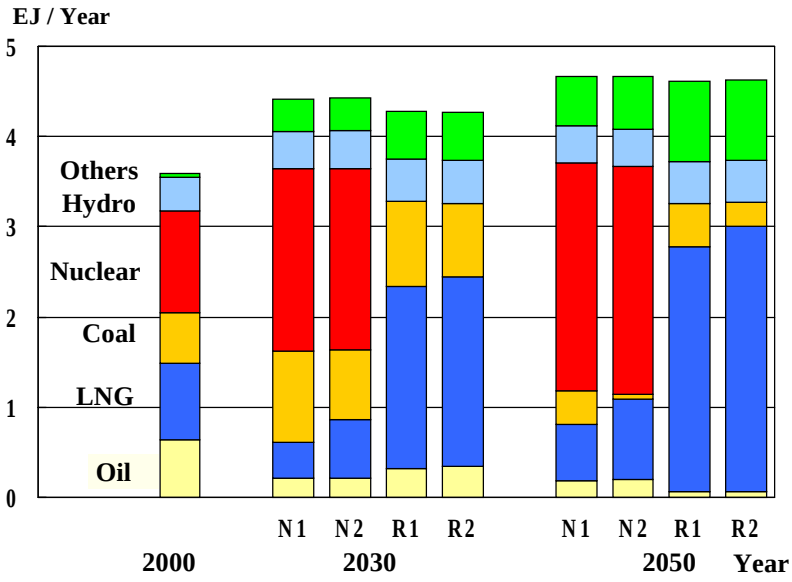
Changes in Electric Power Generation



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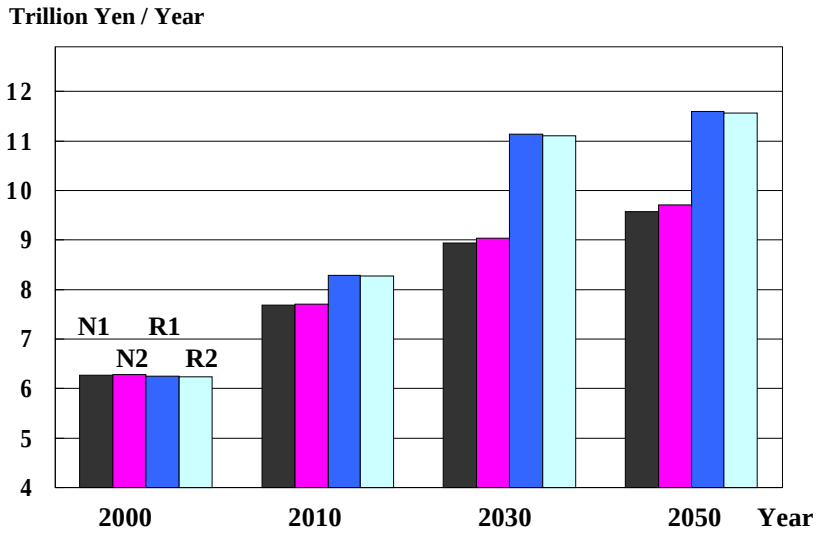
Costs of Fuel Import (Calculated by MARKAL)



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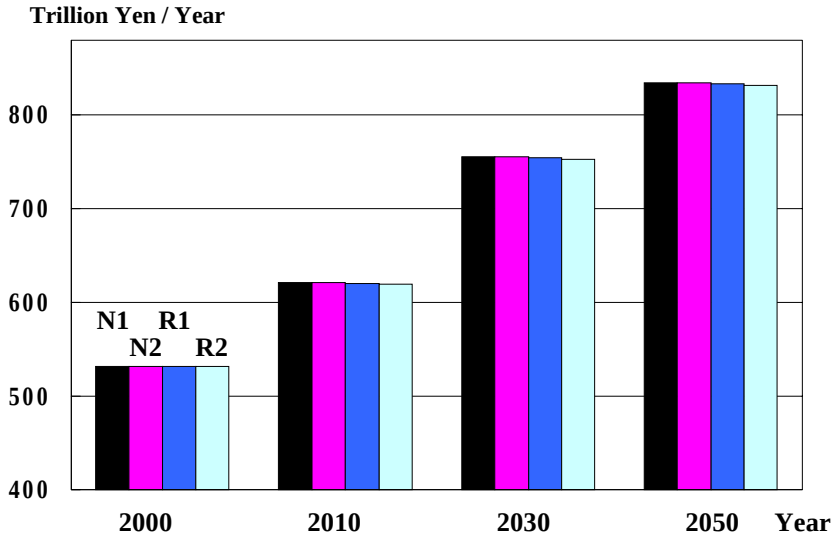
Gross Domestic Production (GDP)



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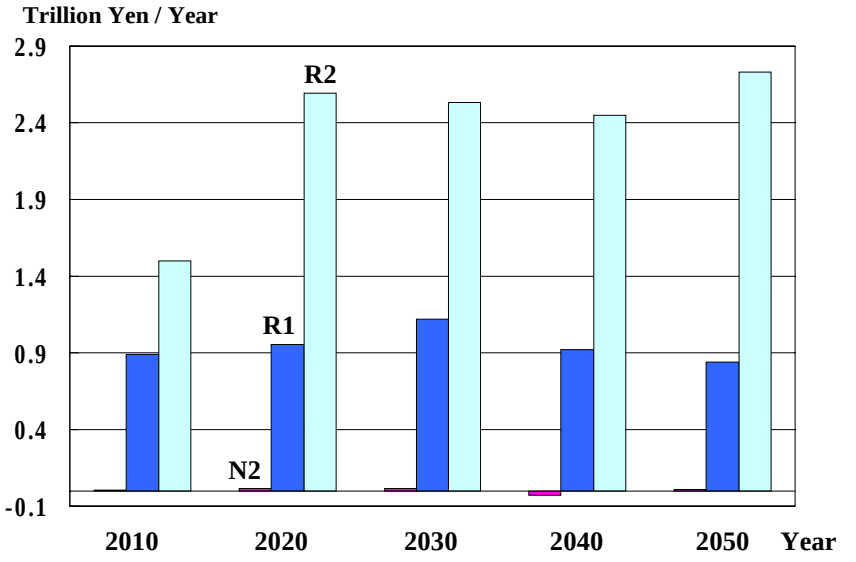
Reduction of GDP from Case N1



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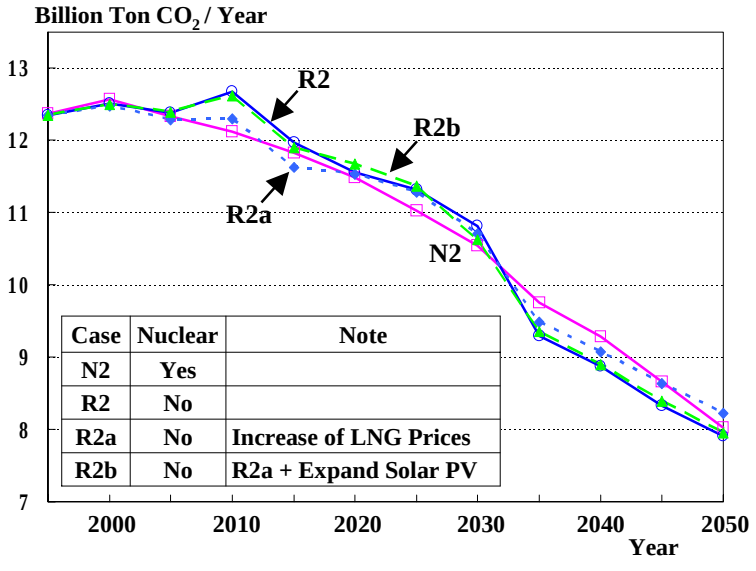
(d) Results of Sensitivity Cases

Annual CO_2 Emissions in Base Cases



Case	Nuclear	Note
N2	Yes	
R2	No	
R2a	No	Increase of LNG Prices
R2b	No	R2a + Expand Solar PV

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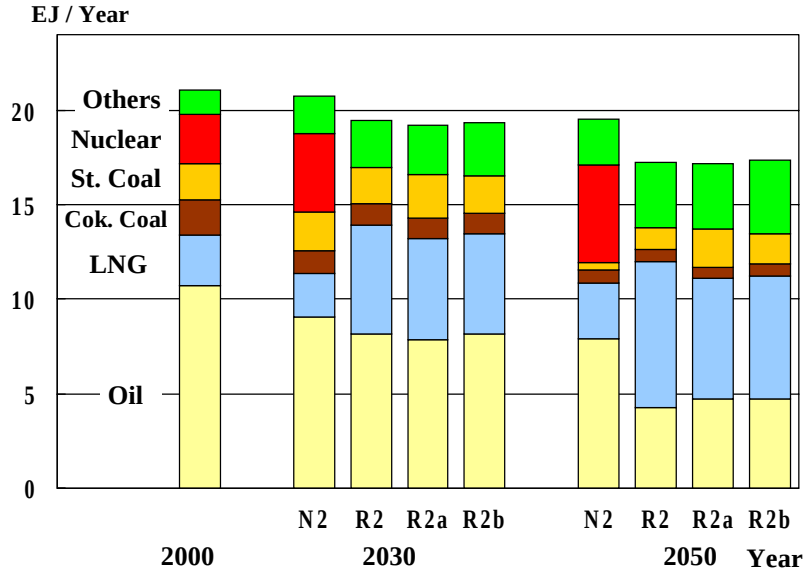
Changes in Primary Energy Consumption



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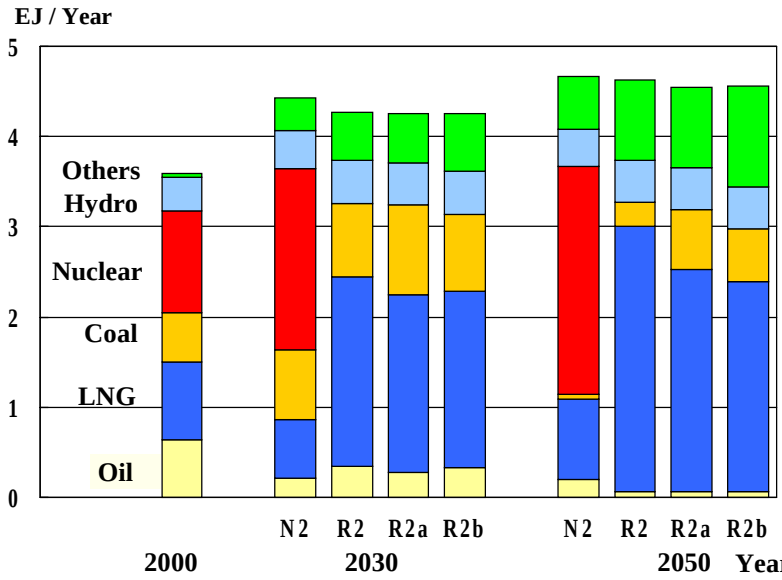
Changes in Electric Power Generation



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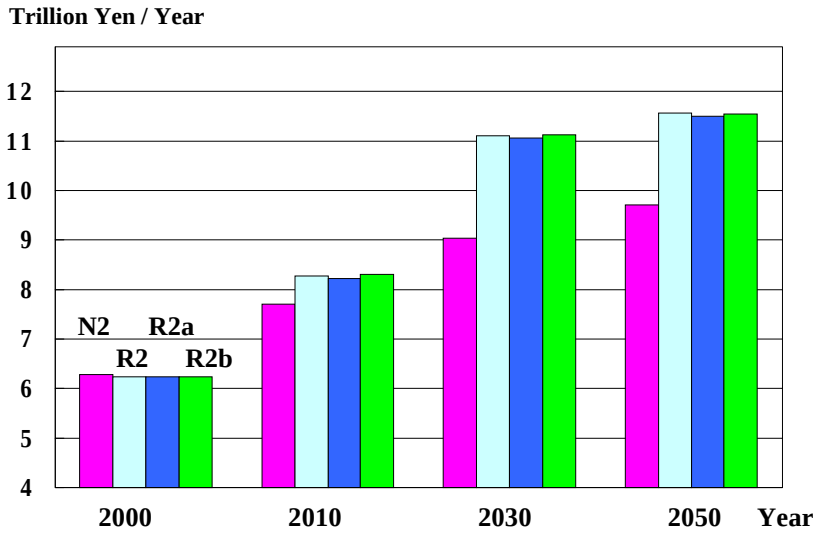
Costs of Fuel Import (Calculated by MARKAL)



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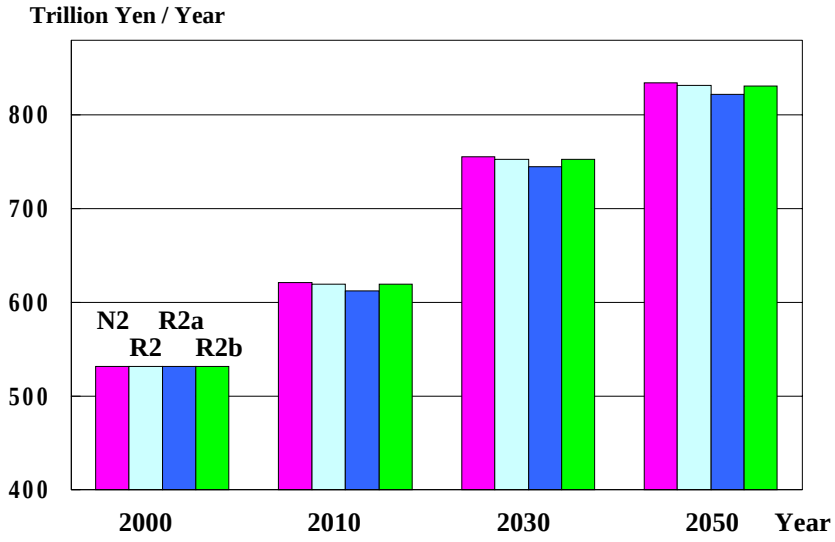
Gross Domestic Production (GDP)



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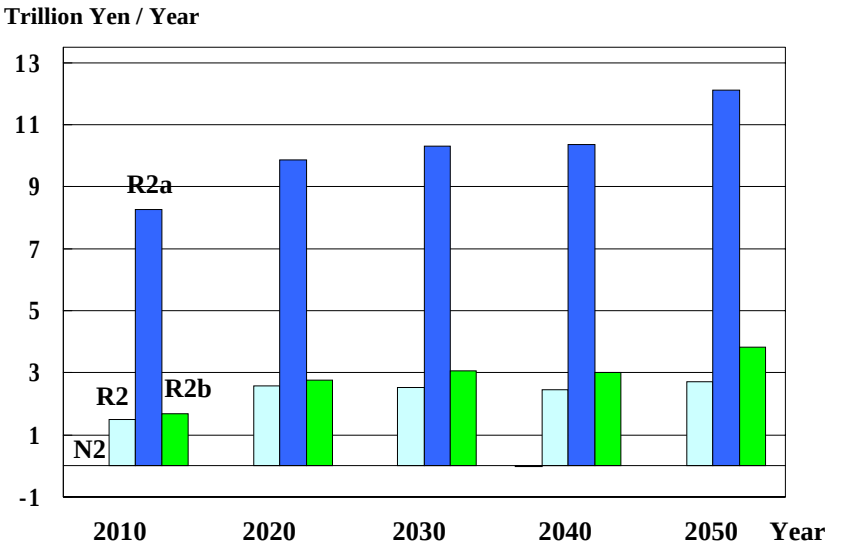
Reduction of GDP from Case N1



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(3) Summary of Results

Results of Analysis:

- **Increases of Annual Fuel Import Costs by Nuclear Phase-out were about 2 Trillion Yen. But impact to GDP was very Small.**
- **When Increase of Natural Gas Prices Assumed, GDP Loss was 10 Trillion Yen or Higher. But, GDP Reduction Rates were Less than 2%, and when Expanded Uses of Renewable Energy were Assumed, GDP Loss Reduced to much Smaller Amounts.**
- **The Results Obtained still Depended on Modeling and Assumptions.**

The Linked Model should be still Improved:

- **Inter-Industry Transactions: Currently Fixed I-O Coefficients**
  ➔ Intermediate Inputs and Outputs as Endogenous Variables.
- **Linkage of the Models: Currently UED and Fuel Import Costs**
  ➔Changes in Energy Systems (Investments, Consumption, Production Costs) should be Reflected on Activities of Energy Industries in the Economy Model.

Also Important Subject:

- **Study on Realistic Ranges of Future Changes in Economic Structure, i.e. I-O Structure, Final Demand Structure of Goods and Services.**

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