S-3 Low-Carbon Society Scenario toward 2050: Scenario Development and its Implication for Policy Measures

1. Long-term Scenario Development Study to Integrate Environmental Options using Simulation Models（Abstract of the Interim Report）

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1. Introduction

To avoid serious climate change impact, there is discussion to limit the global mean temperature increase at 2℃ from pre-industrial level. Then the GHG reduction target in 2050 can be required to be 50% of 1990 emission level. It implies that reduction rate for Japan will be around 60-80%. We need Japan low-carbon society scenarios to achieve such ambitious target. A large part of social infrastructure is likely to be replaced by 2050; therefore, it would be possible to propose concrete policy packages including institutional change, technology development, and lifestyle change towards meeting the target of a low carbon society in 2050.

2. Research Objectives

Assuming that such a degree of socioeconomic change is possible, the back-casting method was adopted in this study to examine the strategies for achieving the LCS. Some of the key aspects of this method are shown in Fig. 1. Among the most important steps of this process we could highlight the following:

1) to envision the direction of future Japanese socioeconomic structure towards 2050 within a certain range (for instance, Scenario A: active, quick-changing, and technology oriented, and Scenario B: calmer, slower, and nature oriented) and to describe the characteristics of those two types of societies qualitatively through brainstorming by experts (narrative version),
2) to quantify behavior of people and households (how people spend time, what services will be needed), design of city and transportation (what kinds of city and houses people live in, how people travel), and industrial structure (estimation of the structural changes by a multi-sector computable general equilibrium model) for each scenario, and to estimate energy-service demand for each scenario (for instance, the volume of cooling [calories], hot water supply [liter], crude steal production [ton], and transportation demand [ton-km,

passenger-km]),

3) to calculate energy services demand, while satisfying the CO_2 emission reduction target that supports the estimated socioeconomic activity in each scenario; to explore the appropriate combination of energy services demand, end-use energy technology (air conditioner, thermal insulation, boiler, steal plant, hybrid car, etc.), types of energy supply and energy supply technologies, based on the consideration of the available volume of energy supply (shown as (5) in Fig. 1), its cost-efficiency and its political feasibility; to identify the types of energy demand and supply technologies as well as their shares, and finally,

4) to quantify the primary and secondary energy demands and the amount of resulting CO_2 emissions.

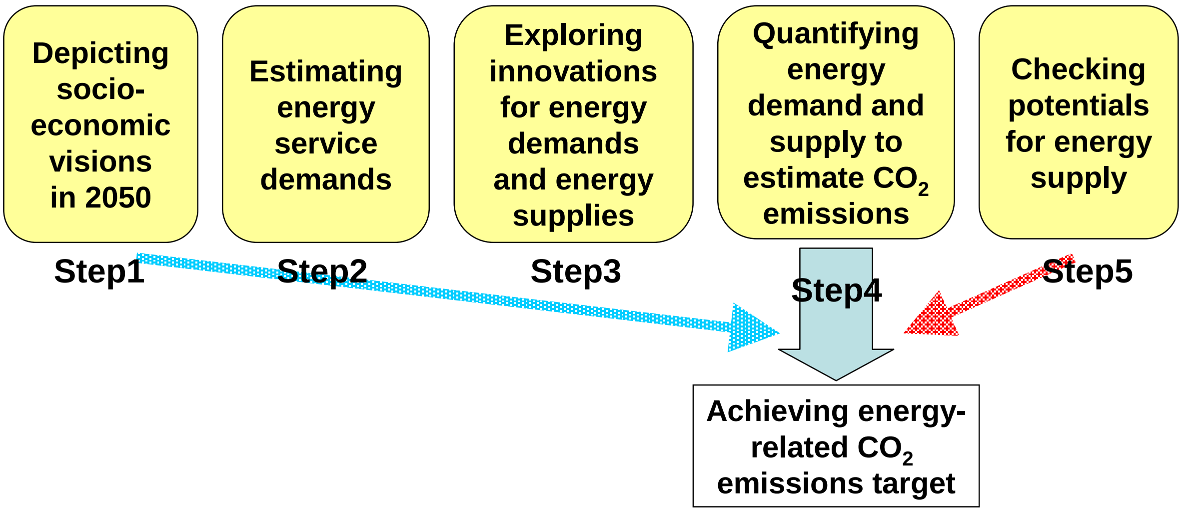


Fig. 1　LCS scenario approach

3. Research Results

To achieve the LCS, the following socio-economic prerequisites are considered:

◇ Vibrant society maintaining a certain level of economic growth.

◇ Satisfying of the energy services demand as envisioned in the expected socio-economic scenarios.

◇ Consideration of innovative technologies, for example, electric vehicles and hydrogen vehicles; yet, this research does not take into account uncertain technologies such as nuclear fusion.

◇ Consistency with the existing long-term governmental plan, such as a plan of nuclear energy.

◇ Since the objective is to identify the carbon abatement potential of Japan, the policy options that aim at making the technological changes possible are out of the scope of this research project.

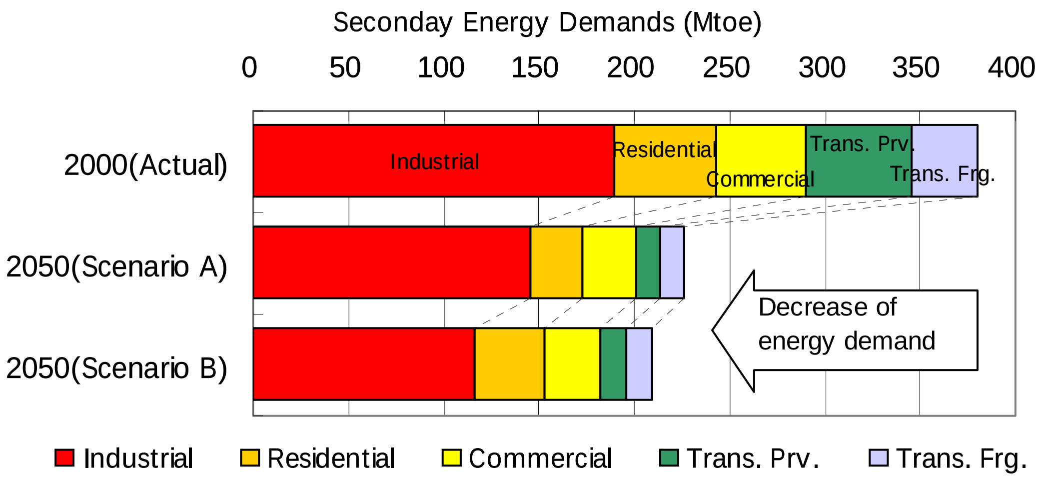
Satisfying the prerequisites mentioned above, a 70% CO_2 emission reduction below the

1990 level can be achieved by reducing 40-45% the energy demand and by introducing low-carbon energy supply (Fig.2, Fig.3). The annual direct cost related to a CO2 emission reduction of 70% by 2050 would range between JPY 6.7 and 9.8 trillion, which would account for around 1% of the estimated GDP in 2050. The energy demand-side emission reductions could be accomplished by combining a shrinking population scenario with promoting rational energy use, energy conservation and improvements in energy efficiency, while allowing the per capita GDP growth at 1-2% towards 2050.

Estimated reduction rates of sectoral energy demand (relative to the 2000 value) are as follows, where the range of reductions varies due to different scenarios in 2050:

- Industrial sector: reduction of 20-40% due to structural changes and introduction of energy-saving technologies.
- Passenger transportation sector: reduction of 80% due to proper land use, and improvement in energy efficiency and carbon intensity.
- Freight transportation sector: reduction of 60-70% due to better logistics management and improvements in the energy efficiency of vehicles.
- Household sector: reduction of 50% due to rebuilding and diffusion of high-insulated houses and introduction of energy-saving house appliances.
- Commercial sector: reduction of 40% due to renovation and rebuilding with high-insulated building and introduction of energy-saving office devices.

The energy supply side will also be low-carbon intensive by a combination of appropriate selection of improvement of energy efficiency and low-carbon content energy (partially including carbon capture and storage (CCS)).



Trans.Prv.: Transportation (Private), Trans.Frg.: Transportation (Freight)

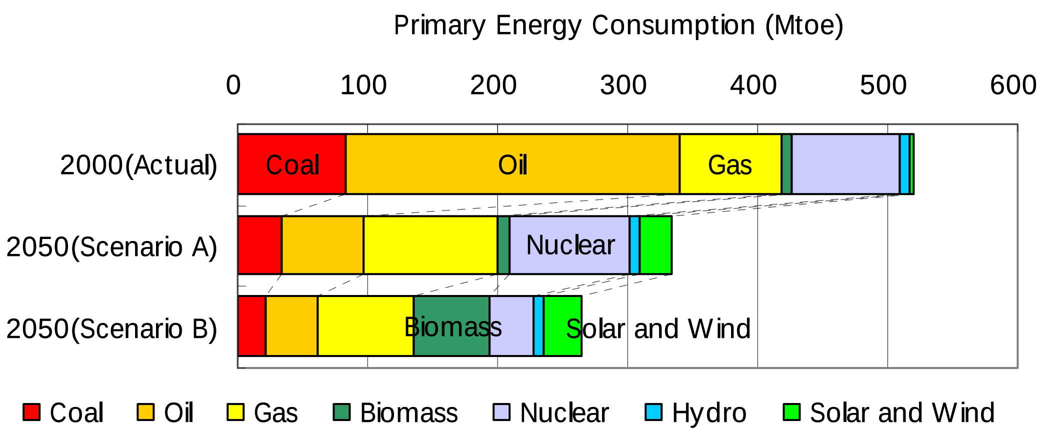
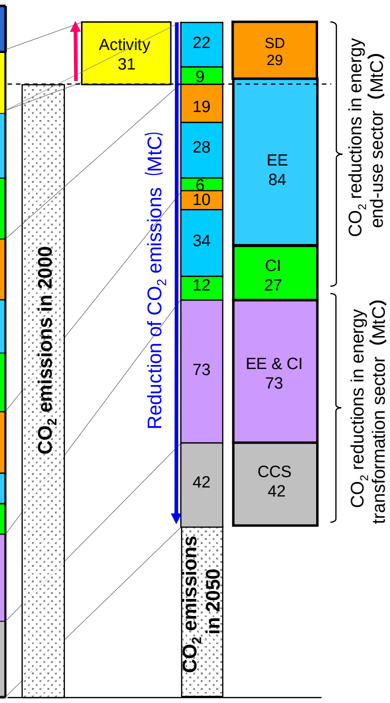


Fig. 2 Energy demands and supply for achieving 70% reduction of CO_2 emissions
(Mtoe: Million ton of equivalent)

	Main factors to reduce CO_2 emissions	Factors Class.
Soci-ety	• High economic growth • Decrease of population and number of households	Demand growth by activity level change
Industrial	• Energy efficient improvement of furnace and motor etc.	Energy Efficiency Imp. (EE)
	• Fuel switching from coal/oil to natural gas	Carbon Intensity Imp. (CI)
Residential and commercial	• High insulation dwelling and building • Home/Building energy management system	Reduction of service demands (SD)
	• Efficient air-conditioner, Efficient water heater, Efficient lighting system • Fuel cell system • Photovoltaic on the roof	Energy Efficiency Imp. (EE) Carbon Intensity Imp. (CI)
Trans-portation	• Intensive land-use, Concentrated urban function • Public transportation system	Reduction of service demands (SD)
	• Motor-driven mobiles: Electric battery vehicles, Fuel cell battery vehicles	EE & CI
Energy Transformation	• Nuclear energy • Effective use of electricity in night time with storage • Hydrogen supply with low-carbon energy sources	Carbon Intensity Imp. (CI)
	• Advanced fossil fueled plants + CCS • Hydrogen supply using fossil fuel + CCS	Carbon Capture and Storage (CCS)



EE: Energy Efficiency Improvement, CI: Carbon Intensity Improvement, SD: Reduction of Service Demand

Fig. 3 List of countermeasures for 70% reduction of CO_2 emissions, scenario A

In this study, the sustainable economy from the end of 1970s to the beginning of 1980s in Japan, following the reduction-first policy in 1970s, is examined from the Porter Hypothesis view. And the dynamic process where the firm’s action for rent-seeking which is shown as the remarkable elements by Oats, played important rolls in realizing the technological achievement to the regulation. At the same time, such a dynamic process where the success in technological development connected to the higher competitiveness could not be realized without higher energy price just coming after the reduction-first policy. This implies the future innovation-offset possibility under the expectation of incremental energy price which can be realized by the treaty after Kyoto Protocol.

In the industrial sector, the primary processing industries have a key to realize de-coupling or de-linkage between economic growth and material input of production. Larson showed the material demand per GDP in the iron and steel industry in U.S. recorded its peak in 1920 and stated that the era of materials already passed. From the ecological modernization point of view, Yánicke led a collaboration study to assess the material input in “dirty industries” in Europe, and he concludes that the demands of some basic materials in Europe also shows the penetration in the oil crisis, but neither relocation, nor their general decline and nor ecological modernization has been a strong enough to motor to go beyond the de-linkage after the crisis. In this study, the same kind of analysis is conducted and shows two points as its result. First, historically, a strong penetration in material demand is seen in the iron & steel industry and cement industry. In these sectors, decline in social infrastructure formation from the budgetary reason and historical perspective, can accelerate its trends. Especially, the demand penetration of the materials and increase in the stocked materials in the society will pressure the use of recycled materials for the future. A simple simulation in the iron & steel sector (figure 2) shows that the future potential of de-coupling is not a small.

5. Discussion

In order to achieve the LCS goals while satisfying the required amount of energy services at the same time, prompt actions should be taken at the earliest stage of the roadmap. Such actions involve structural changes in the industrial sector and investment in infrastructure. Moreover, it is necessary to accelerate development, investment, and use of energy-saving technologies and low-carbon energy technologies. The government should play a leading role in promoting a common vision towards LCS at the earliest stage, enforcing comprehensive measures for social and technological innovation, implementing strong measures for translating such reduction potentials into a reality, promoting measures for public investment based on long-term perspectives and leading incentives for private investment.

Major Publications

1) R. Kawase, Y. Matsuoka, and J. Fujino, “Decomposition analysis of CO2 emission in long-term climate stabilization scenarios”, Energy Policy, 34, 2113-2122, 2006

2) S. Ashina, and T. Nakata, “Analysis of implementation strategy of CHP systems for CO2 reduction in Japan’s residential sector”, Proceedings of the 29th IAEE International Conference, 1-17. 2006

3) T. Oka, Y. Fujii, and M. Ishikawa, “Maximum abatement costs for calculating cost-effectiveness of green activities with multiple environmental effects”, in G. Huppes, and M. Ishikawa (ed), "Qualified Eco-Efficiency", Springer, 2007

4) Y. Fujii, , "Historical Dynamic Interactions between the regulation Policy and the Pipe-End Technology Development in Japan: Case Studies of Developing Air Pollution Control Technology", in T. Terao, and K. Otsuka. (ed), "Development of Environmental Policy in Japan And Asian Countries", Palgrave Macmillan, 2007