S-3 Low-Carbon Society Scenario toward 2050: Scenario Development and its Implication for Policy Measures （Abstract of the Final Report）

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I. Overview

This project (S-3) focuses on the following issues:

1) Long-term scenario development study to integrate environmental options consistently using simulation models (S-3-1),

2) Long-term GHG reduction target setting considering effectiveness and validity (S-3-2), and

3) Assessment of environmental options considering future socio-economic conditions in

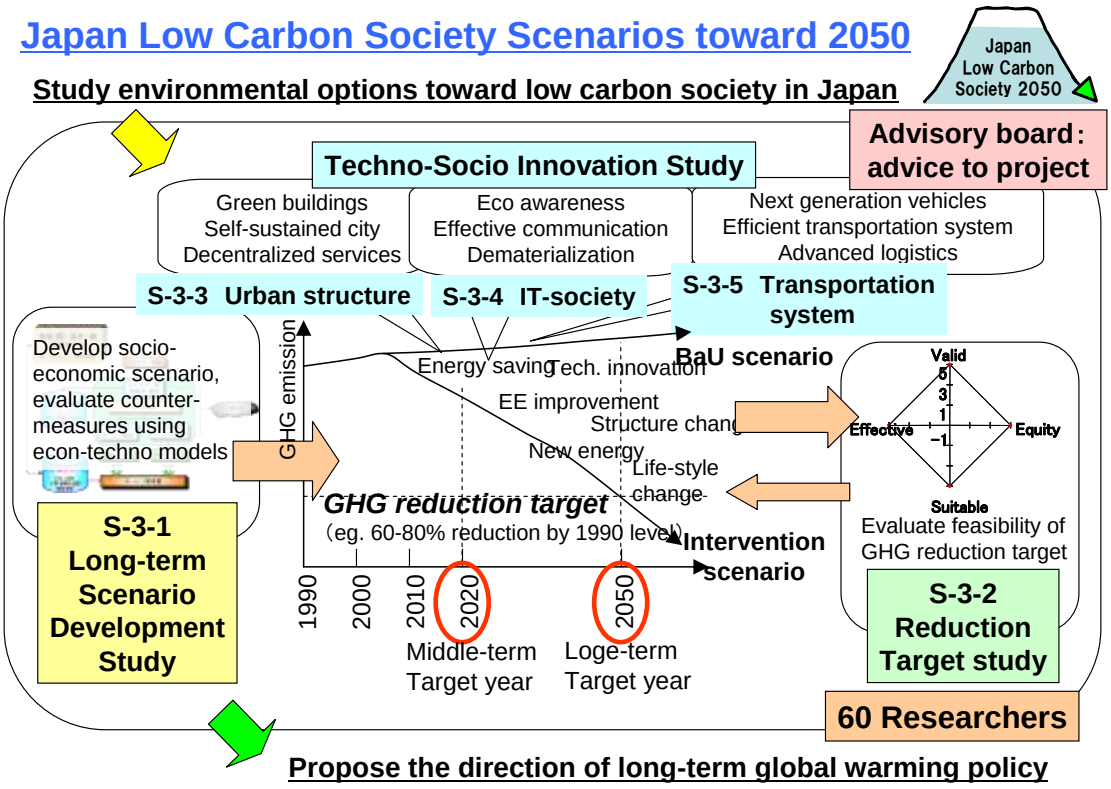
a) Urban system (S-3-3),

b) Information technology (IT) society (S-3-4) and

c) Transportation system (S-3-5).

We have the above 5 sub projects consisting of research experts in those areas. We have developed socially and technically consistent medium and long-term global warming policy (Fig.1).

The figure shows probable paths towards a low carbon society in Japan which are compatible with economic development and would enhance public interest leading to social and lifestyle changes.



[FY2004-2008, Global Environmental Research Program, MOEJ] http://2050.nies.go.jp

Fig. 1 Structure of "Low-Carbon Society Scenario toward 2050" Research Project

II. Scientific outcome

(1) Long-term Scenario Development Study to Integrate Environmental Options using Simulation Models

On February 15, 2007, "2050 Japan Low-Carbon Society" scenario team mentioned in its report entitled "Japan Low Carbon Society Scenarios: Feasibility study for 70% CO_2 emission reduction by 2050 below 1990 level" that Japan has the technological potential to reduce the emissions of CO_2, which is the major greenhouse gas, by 70% by 2050 from the level in 1990 while satisfying the required amount of energy services in either of the two possible socioeconomic scenarios (Scenario A: active / Scenario B: slow).

Further investigations were conducted for the purpose of setting reduction goals, formulating methods for designing low-carbon society scenarios, and estimating roles of technologies related to energy, city design, transportation and ICT. In February 2008 a part of the results was published under the title "Vision and achieving scenarios of a low-carbon society (in Japanese)" (Global Environment, Vol. 12, No. 2, 2007, Association of International Research Initiatives for Environmental Studies), and others[1][2][3].

In Scenarios A and B, in 2050 the GDP per capita is estimated to increase by 2.7 and 1.6 fold, while the population will decrease by factors of 0.74 and 0.8, leading the GDP to increase by 2.0 and 1.3 fold, respectively, from the corresponding levels in 2000. There are several factors that will reduce energy service demands such as shifts to service industries, saturation of number of vehicles, change of industrial structure, and decrease of investment in social infrastructure. Thus, the total

energy demand for services in 2050 will be almost equal to that in 2000.

Various innovations, such as well insulated buildings, city structures where people can live within walking distance, and the development and spread of energy-saving devices, will reduce energy demand by about 40% while satisfying the service demands. It is estimated that CO_2 emissions can be reduced by 70% from the emission level in 1990 by implementing low-carbon measures by energy suppliers, such as increasing the share of solar, wind power and other renewables, and appropriate use of nuclear power and carbon capture and storage.

In order to achieve the goal of 70% reduction by 2050, innovations such as technologies and reform programs have been studied from the viewpoint of when and how such innovations should be implemented and what kind of measures and policies are effective to realize them. A dozen actions are proposed and their effectiveness has been studied[4].

Measures and policies undertaken in a particular sector for achieving a low-carbon society do not only affect that sector but also induce carbon reduction in other sectors. For example, well insulated houses and the use of solar energy are direct and effective low-carbon measures for the residential and commercial sectors. Low-carbon measures taken by primary energy suppliers, such as increased use of renewables, will also contribute to the CO_2 reduction in the building sector. To expand the use of renewables it is also necessary to encourage their use in the end-use sectors. Wide publicity and environmental education underpin all measures. There are various technological and social barriers to achieving reduction goals, and it takes time to remove these barriers. Therefore proper steps must be taken in a due sequence. In this report, an action denotes a set of technological measures, social system reform programs and stimulatory policies that are combined appropriately by considering relevant inter-relationships.

The model studies indicate the reduction potential in each sector. The effective measures and policies to realize such reduction potential are summarized as actions. A dozen actions are formulated by taking into account the model results and expert interviews.

(2) Multi criteria on evaluating long-term scenario and policy on climate change

This research project addresses issues on medium to long term target-setting on climate change policy. In order to mitigate climate change, it is important to clarify a goal for the mitigation activities. We observed that the negotiators expected the Article 2 of UNFCCC to be a kind of indication of the collective will of countries that climate change is a serious global problem. In order for international society to reach the ultimate goal, it is necessary to agree on a short-term emission reduction target that is in line with the desired global trajectory. As for Japan's long-term target, it became clear that 60-90% reduction of GHG emissions in 2050 from 1990 level is necessary in order to avoid a dangerous level of climate change. The calculation is made taking into account three scientific uncertainties, namely the level of temperature increase, climate sensitivity in the model, and global differentiation scheme. In order to achieve such level of GHG reduction, both civil society participation and technology development are needed. The policies supporting the former seem to be lacking at this moment. There is a need for creation of diffused energy use structure.

In 2007 and 2008, G8 summit mentioned a possibility of setting a global GHG reduction target as 50% reduction in 2050. We tried to identify the level and emission paths that can be implied by this target. We also draw implications of such level of target for Japan. We found that all cases showed that there is no room to increase GHG emissions after 2010, and that emission path leading to 2050 changes the level of temperature increase in 2100. Even in the case of halving global emissions in 2050, additional 1.5 degree temperature increase is unavoidable. Therefore, adaptation is equally important as mitigation. In our cases of global differentiation, Japan needs to reduce emissions in 2050 by 72-92% from 1990 level in order to halve emissions in 2050.

(3) Effects of introducing countermeasures for carbon dioxide emission reduction in urban areas

1) Urban scenario and integrated evaluation

This research enabled quantitative analysis of the effect of urban condition on the CO_2 emission reduction by implementing various countermeasures in urban areas. The research provided basic information and methods of utilizing various types of geographical information systems. Advantage of compact city was demonstrated in this research. These findings are novel in the research on urban activity in the context of CO_2 emissions.

2) Innovation in energy supply to urban areas

The output of Photovoltaics in the Kanto region was estimated from the time series data of every ten minutes over a period of one year obtained from meteorological observation. The simulation result of the optimal power generation mix model indicated that the expected load following capability of fuel fired power plants has a possibility to eliminate the necessity of large-scale power storage plants, and to lessen the economical cost to introduce PV extensively in the power system.

3) Energy saving in building sector

We developed a prediction model for CO_2 emissions related to operation, construction, renovation and dismantlement of all buildings (houses, offices, commercial buildings, medical facilities, educational facilities, accommodations and others) in Japan up to 2050. It is now possible to provide information to policy makers for achieving the national target of CO_2 emissions up to 2050 in the building sector.

4) Introduction of photovoltaic systems in cities

Power generation from photovoltaic cell was accurately evaluated for each prefecture which has a specific solar radiation and temperature. Power generation cost, cost pay-back time and energy pay-back time were evaluated for each prefecture. Effectiveness of battery system was demonstrated to minimize life cycle cost.

5) Urban mobility

Simulation model of area-based road pricing system was developed and applied to Okinawa city. Economic aspect as well as transportation control was examined in the road pricing system. The developed model was more sophisticated than the conventional ones.

6) Biomass and heat recovery in urban areas

A realistic projection was done for potential of biomass and waste heat use by developing the simulation models. For example, the material flow model of wooden resources, incorporating

building, paper production and energy sectors, was developed for integrated assessment of policy scenarios in these sectors. The combined sewage heat transfer and district heating and cooling systems model was developed for sophisticated estimation of the potential of sewage heat utilization.

7) CO_2 emission change in interregional physical distribution

A novel method of the input-output analysis for physical distribution is proposed in this study. Using "Physical Distribution Census" published by National Land and Transportation Ministry in Japan, we developed the method to calculate the physical distribution induced by a unit of final demand and the physical distribution derived by a unit of production. Induced and/or derived CO_2 emissions were directly calculated from induced and/or derived physical distribution.

8) Contribution of CGS, DHC and HP to the potential CO_2 emission reduction in the urban areas

The models were developed to estimate the contribution of distributed power system. Although our study could have dealt with the limited number of regions, we have proposed a new method and assessed the contributions of CGS (Cogeneration System), DHC (District Heating and Cooling), HP (Heat Pump) to reduce carbon emissions from the macro viewpoint, considering the micro level properties on both the demand pattern and the energy equipments in a consistent manner.

9) Development of integration tools for sharing knowledge between various actors

We have constructed a "web-based collaboration platform" for using the Internet to support more effective sharing of the knowledge of experts. Based on that platform, we used the DOME (Distributed Object-based Modeling Environment) model integration software to develop a method for integrating and evaluating individual computational models created for each of the different technologies and policies. Specifically, we carried out the integration of a “power planning and dispatch” model developed in Matlab with models developed in MS Excel for reducing energy in the construction and operation of commercial and residential buildings. Although each of the individual models had been developed independently by different researchers in the urban countermeasures subgroup without any special consideration to integration, by using DOME we were able to build an integrated model that was capable of evaluating interactive and time-dependent effects that could not be obtained through the separate models. Finally, in order to enable the integration of an even wider range of related knowledge, we used a method for creating computer-interpretable semantic statements together with several advanced information technologies to develop a web-based platform for sharing, discovery and integration of expert knowledge related to the achievement of a Low-Carbon Society.

(4) Integrated Measures of Technologies and Lifestyles against Global Warming

- Ecodesign of ICT (Information and Communication Technology) Society -

Discussed here is ICT impact on industrial structure in 2050, using a macroscopic long-term simulation model and microscopic LCA based model. The total energy consumption in Japan reduced to 13,376 Peta-Joule (PJ) in 2050 from 15,982 PJ in 2000, and the ratio of industry sector reduced to 41% in 2050 from 47% in 2000.These results reveal that ICT impact on Industry in 2050

accelerates economic growth in service sector, which results in reducing energy consumption in Japanese industry. On the contrary, from a global viewpoint, the improvement of ICT means the off-shoring will dramatically increase. This leads to the radical increase of China's and India's economy, as well as to an increase in global energy consumption.

(5) Long-term CO_2 reduction strategy of transport sector in view of technological innovation and travel demand change

1) According to a survey of the automotive technology, by 2020, the diffusion of the gasoline HV to the passenger car and the small freight vehicle is highly probable. The improvement of the average fuel consumption of freight vehicles is difficult because of the new long-term emission regulation. The BEV is suitable for the personal use over short distance. By 2050, the combination of the engine and the liquid fuel is left as a power-train for the vehicles, the average fuel consumption improves due to hybridization and the biomass fuel is introduced. If the lithium ion battery technology improves, there can be diffusion of the small-sized BEV in the urban area. The 30 to 40 percent weight reduction of vehicle leads to 20 to 30 percent emission reduction.
2) Long-term plans with backcasting approach were reviewed to find the feasibility of large reduction. It was found that such feasibility could improve by the combination of multiple means including travel demand changes, instead of exclusive reliance on technological innovations.
3) The current automotive CO_2 emissions in all cities in Japan were calculated by regional categories. A low carbon regional passenger transport vision in 2050 was built to achieve 70% CO_2 reduction which consists of various countermeasures suitable to each regional category.
4) A low carbon freight transport vision and an inter-regional passenger transport vision were developed for achieving 70% CO_2 emissions reduction.
5) The long-term forecasting model of passenger transport demand was simplified to obtain the outlook of 40% emissions decrease from BAU in 2050, by improvement of fuel consumption and enhancement of railways. It was shown that modal-shift plan which made aviation cut CO_2 by half was required to achieve 70% reduction.
6) The long-term forecasting model of freight transport demand was simplified to obtain the outlook of 70% emissions decrease in 2050, by the combination of the various policies.

III. Contribution to policy on global environmental issues for decision makers

1） Contribution to formulating domestic policy toward low-carbon society

We released "Japan Scenarios towards Low-Carbon Society(LCS) -Feasibility study for 70% CO_2 emission reduction by 2050 below 1990 level" in Feb 2007. It became the fundamental scientific finding for former Prime Minister Abe's policy "Invitation to Cool Earth 50" that aims to halve global GHG emissions by 2050 as compared to current emissions level. And it supported the former Prime Minister Fukuda's policy that emphasized the importance of Low-Carbon Society and set Japanese CO_2 emissions target for 2050 at 60-80% reduction.

2) Low-Carbon Society (LCS) as a common phrase in Japan and the world

We are one of the first groups to use the word “Low-Carbon Society” and spread it out by showing our scientific findings since around March 2005. It has become a common phrase since around May 2007 and supports to develop national and global climate policy. We released our Interim Report “Dozen Actions towards LCSs” on May 2008. Then the Japanese government set “Action Plan for Achieving a Low-carbon Society” in July 2008.

3) Development of international climate policy

We launched Japan-UK joint LCS research project in Feb 2006 in the process of Gleneagles Plan of Action. We conducted three series of workshops in Tokyo and London and developed “Call for Action” and “Executive Summary”. These results were delivered to G20 in Chiba, March 2008 and G8 Environmental Ministerial Meeting on May 2008, and led to the launch of new international research network on Low-Carbon Society (LCS-RNet). “Transition to Low Carbon Society” was recognized as one of the important trends at Hokkaido Toyako G8 Summit in July 2008.

4) International research collaboration

We introduced our Japanese LCS scenarios at UNFCCC/COP since 2005 and received good response. We have collaborated with several Asian and some major developing countries’ research institutes and started to develop scenarios for their Low-Carbon Societies. This has culminated in the launch of our new research project “Low-Carbon Asia Scenario Development” (S-6, funded by GREF, MOEJ).

5) Promoting research activities on Low-Carbon Society

Many research groups tend to link with Low-Carbon Society. "Japan Low-Carbon Society Scenario" delivers the fundamental concept of Low-Carbon Society and supports to make these research trends towards the right direction of LCS. Researchers who joined our research project become main contributors to launch these research programs in their research field. GERF (MOEJ) set new research items as special study on Low-Carbon Society and now 9 research programs are going on.

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