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 Final Report)

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I. Overview

This study (S-3-1) consists of two components, 1) middle/long term low-carbon society scenario development team and 2) policy options for global warming team.

National Institute for Environmental Studies (NIES) coordinates S-3-1 and S-3 overall, and has developed visions and scenarios towards Japan Low-Carbon Society (LCS) by 2050. Kyoto University has developed key component models to simulate LCS scenarios. Ritsumeikan University has developed local scenarios, such as Shiga Prefecture scenario and Mizuho Information and Research Institute has developed main Asian and other countries' LCS scenarios in collaboration with researchers in China, India, Thailand, Korea, Brazil, South Africa and others. After three years research we identified that energy supply, forest management, and bioenergy trade are important issues to consider for Japan LCS scenarios. Then Japan Institute of Energy assessed energy supply, Forestry and Forest Products Research Institute analyzed long-term forest management, and JKL cooperation operated long-term global energy model to evaluate the role of bioenergy.

As for policy options for global warming, IGES studied the social aspects and Shiga University analyzed the effect of induced technological change. Then Bunkyo University and Kobe University investigated the possible pathways of industrial structure changes and IGES has started the study on the industrial and commercial impacts of trades between Japan and Asian countries.

Besides Japan LCS scenario development, S-3-1 covers local and Asian scenario development, and analyzes key issues for LCS such as energy supply, industrial structure, technological development, relationships between Asian countries, forest management, and bioenergy.

II. Scientific outcome

(1) middle/long term low-carbon society scenario development (S-3-1 (1))

1) Japan Low-Carbon Society Scenarios[1)]

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) (Table 1).

Table 1 Two socioeconomic scenarios (Scenarios A and B)

Scenario A: Vivid	Scenario B: Slow
Technology-driven	Nature-oriented
Urban/Personal	Decentralized/Community
Technology breakthrough Centralized production /recycle	Self-sufficient Produce locally, consume locally
Comfortable and Convenient	Social and Cultural Values
2%/yr GDP per capita growth	1%/yr GDP per capita growth
	

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 (Table 1, Figure 1).

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 (Figures 1 and 2).

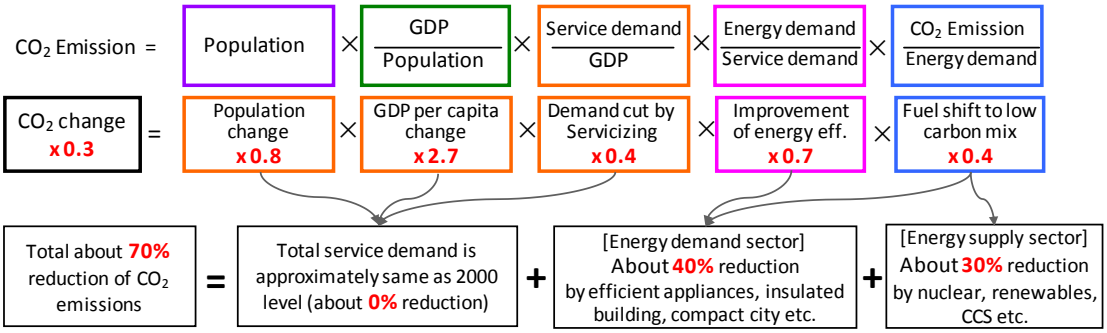

Figure 1 Relationships among components for achieving 70% CO_2 emission reduction from the 1990 level (The ratio indicates the approximate value in 2050 to the value in 2000, Scenario A)

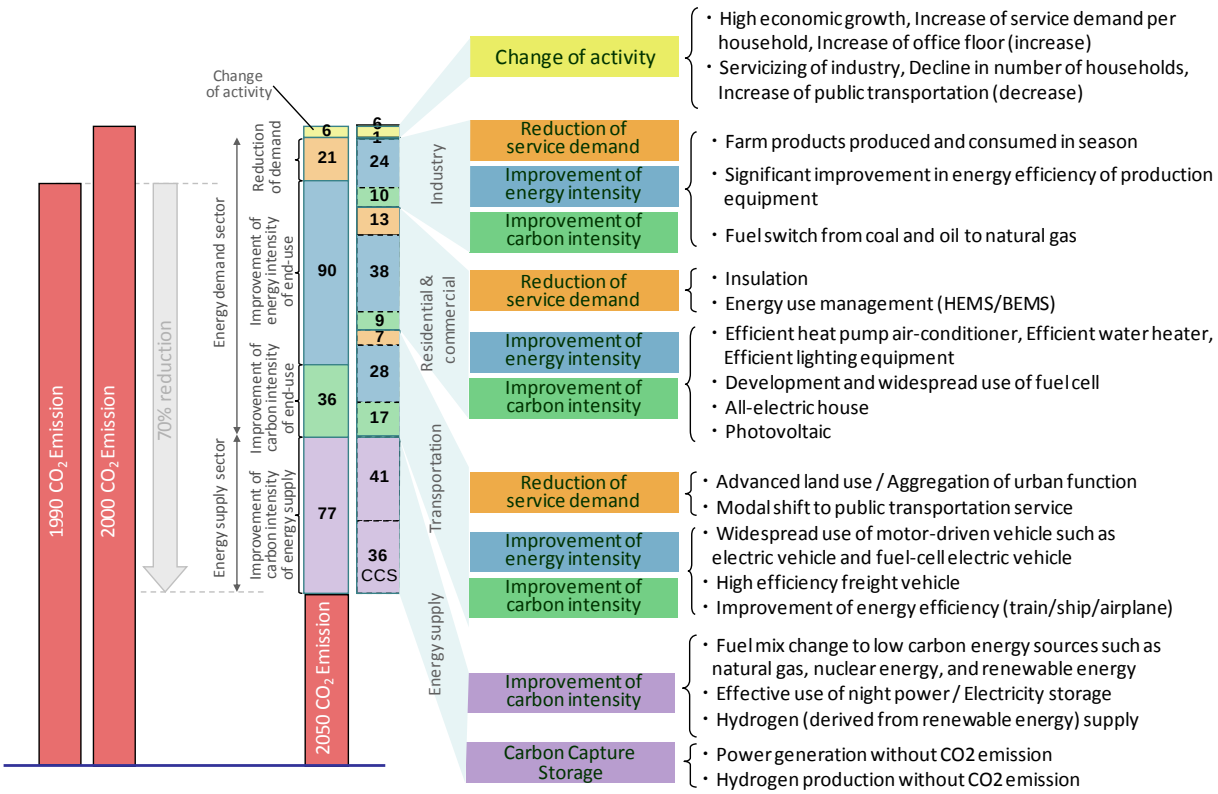

Figure 2 Combinations of actions for achieving 70% reduction by 2050 (Scenario A)

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 (Figure 3). A dozen actions are proposed and their effectiveness has been studied.

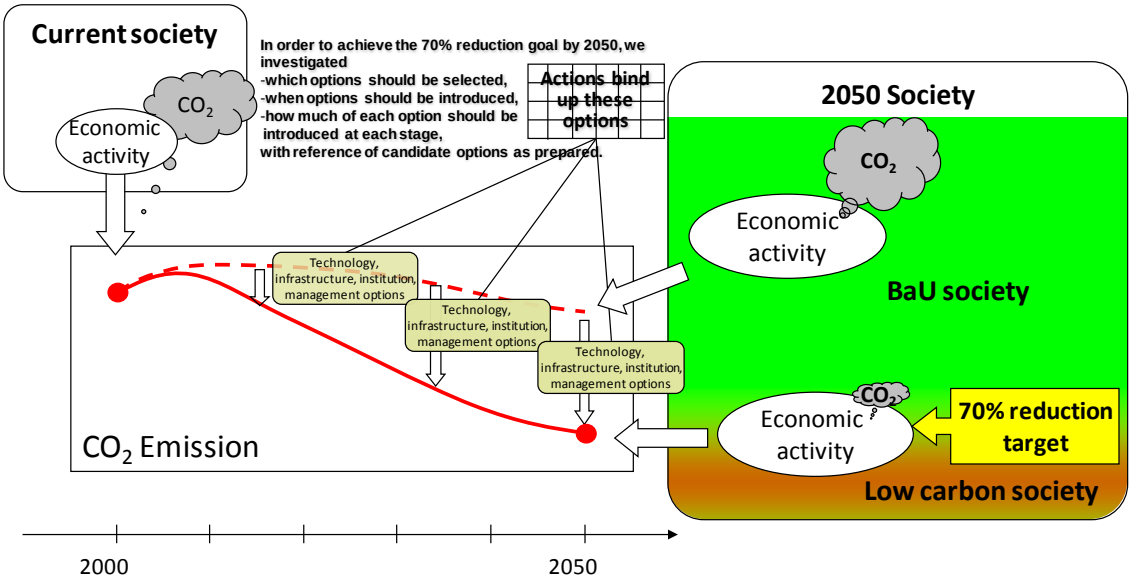

Figure 3 The role of actions towards low-carbon societies in 2050

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 (Figure 3).

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 (Table 1).

Principal domains of the actions are residential and commercial sectors (1 and 2), agriculture and forestry (3 and 4), industries (5), transportation sector (6 and 7), and energy (8, 9 and 10). Actions 11 and 12 are cross-sectoral actions.

In this report, economic instruments that are cross-sectorally effective, such as carbon tax and emissions trading, are not included as independent actions. The addition of such economic instruments will add value and enhance the effect of the dozen actions. Social infrastructure, such as public works and the capital market, were assumed to be properly in place and improved.

Table 2 Dozen Actions towards Low-Carbon Societies

	Name of Action	Explanation	Expected CO_2 reductions
1	Comfortable and Green Built Environment	Efficiently use of sunlight and energy efficient built environment design. Intelligent buildings.	Residential sector: 205~176MtCO_2 (56~48 MtC)
2	Anytime, Anywhere Appropriate Appliances	Use of Top-runner and Appropriate appliances. Initial cost reduction by rent and release system resulting in improved availability.	
3	Promoting Seasonal Local Food	Supply of seasonal and safe low carbon local foods for local cuisine	Industrial sector: 110~128MtCO_2 (30~35 MtC)
4	Sustainable Building Materials	Using local and renewable buildings materials and products.	
5	Environmentally Enlightened Business and Industry	Businesses aiming at creating and operating in low carbon market. Supplying low carbon and high value-added goods and services through energy efficient production systems.	
6	Swift and Smooth Logistics	Networking seamless logistics systems with supply chain management, using both transportation and ICT infrastructure	Transportation sector: 161~165 MtCO_2 (44~45 MtC)
7	Pedestrian Friendly City Design	City design requiring short trips and pedestrian (and bicycle) friendly transport, augmented by efficient public transport	
8	Low-Carbon Electricity	Supplying low carbon electricity by large-scale renewables, nuclear power and CCS-equipped fossil (and biomass) fired plants	Energy conversion sector: 348~297 MtCO_2 (95~81 MtC)
9	Local Renewable Resources for Local Demand	Enhancing local renewables use, such as solar, wind, biomass and others.	
10	Next Generation Fuels	Development of carbon free hydrogen- and/or biomass-based energy supply system with required infrastructure	
11	Labeling to Encourage Smart and rational Choices	Publicizing of energy use and CO_2 costs information for smart choices of low carbon goods and service by consumers, and public acknowledgement of such consumers	Cross-sectional
12	Low Carbon Society Leadership	Human resource development for building “Low-Carbon Society” and recognizing extraordinary contributions.	

The reductions in each sector are based on Scenario A and Scenario B, respectively.

2) Local Low-Carbon Society Scenarios[2)]

The long term objective of building a society that emits half the amount of greenhouse gases (low-carbon society) by 2050 is facing less and less opposition both scientifically and politically. In the short-to-mid term, however, many countries and regions are still hesitant to make any drastic policy changes. The back-casting type thought experiment is attracting attention as it is expected to help overcome such indecision.

After reviewing trends in the formation of low-carbon municipalities in Japan and overseas, this study will look at the Shiga Prefecture study result, conducted using the back-casting approach, and discuss the kind of policy changes needed for the prefecture's transport and land/residential housing sectors in a mid-to-long term perspective.

Measures targeting the industrial/commerce sector and the freight transport sector are also essential in reducing the prefecture's overall CO_2 emissions; however, in view of their relationship to prefectural policies, we will focus on the passenger transport sector and the land/residential housing sector.

At the city/district level, in addition to the long-term reduction plans/frameworks formulated in Shiga Prefecture and Toyonaka City in FY 2007 for reducing greenhouse gas emissions, the Tokyo Metropolitan Area, Kyoto City, and Tsukuba City are also working to formulate similar plans.

Shimada et al. [3)] participated in the formulation of a scenario to halve the emissions of Shiga Prefecture by 2030 (hereafter "Shiga Scenario"). An overview of the result is shown in Figure 4. While the measures at the national level, such as lowering the carbon contents of power supply and improving the gas mileage of automobiles, contribute to the emissions reduction considerably, the significant contribution that can be made from local measures, including environmentally conscious behaviors and reform of the transportation structure, should not be overlooked.

The discussion carried out for the formation of low-carbon municipalities in this article can be summarized as follows:

① In order to substantially reduce the local demand for passenger transport by automobile in the long term, we need to reduce both the automobile's share and trip length. To that end, it is important to increase the population density of inhabitable land and to maintain or increase the commuting ratio inside the municipality (and to attract industries by providing sites for development).

② Actually, the population in densely inhabited districts of some Shiga cities increased 20% in the five years between 2000 and 2005; therefore, it is not unreasonable to set up population density targets and adopt drastic policies to attract population.

③ Cities that have a high percentage of population in the densely inhabited districts and do not rely on automobile transport have high residential land prices. Such residential land has good potential for maintaining its asset value.

④ Residents of densely populated areas or apartment houses are dissatisfied with the small living space and the lack of contact with nature. Policies to promote population concentration by

increasing access to the natural environment, constructing and attracting development of apartment houses with adequate living space and amenities are effective not only from the perspective of reducing greenhouse gas emissions but also from the perspective of securing revenues for the municipalities.

⑤ Compared to the -0.43 long-term price elasticity value of overall gasoline consumption in Japan, Shiga's value is high at -0.91. Thus, revising the automobile fuel tax system in some areas can drastically reduce fuel consumption.

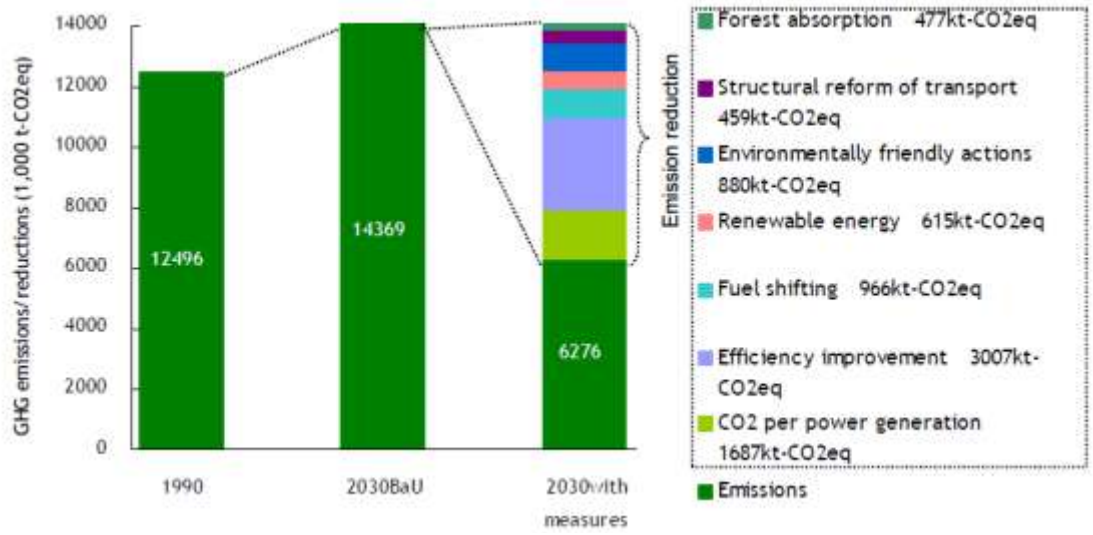

Figure 4 Contribution by mitigation measures in the Shiga GHG-half scenario

(2) Policy options for global warming (S-3-1 (2))

Since 1990s, reduction in GHG emissions in Japan has been mainly induced by changes in industrial structure, not by efficiency improvement such as energy saving that was main driver at the time of oil crisis. Contrary to Japan where industrial policy towards low carbon society is not well developed, EU explicitly aims to realize new industrial structure under good governance scheme, and social coordination system towards low carbon society has started functioning in EU. We proposed alternative models of social coordination system that is unique to Japan, and examined the conditions and governance scheme under which technological innovation and decoupling can occur. Concerning trade structure analysis, we developed an analytical tool suitable to assess the impacts of Japanese low carbon society scenarios on industrial and trade structure, based on a widely used multiregional computable general equilibrium model, the GTAP-E model. It was found that low carbon policy could have positive impacts on economic growth, as the macroeconomic impacts are determined by the balance between positive impacts due to energy efficiency improvement due to low carbon policy and negative impacts due to productivity loss associated with abatement activities.

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

(1) middle/long term low-carbon society scenario development (S-3-1 (1))

1）Contribution to formulate 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 the first group 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. GREF (MOEJ) set new research items as special study on Low-Carbon Society and now 9 research programs are going on.

(2) Policy options for global warming (S-3-1 (2))

The developed analytical tool for low carbon scenario development, which takes into account the influence of international trade, is expected to contribute to formulation of global environmental policies at the regional and international level that reflect not only potential impacts on Japanese industry but also international impacts through trades. Moreover, stakeholder consultation dialogues targeting the Japanese business sector has promoted better communication between business sector, decision makers and researchers, which is expected to indirectly contribute to

policy formulation reflecting reality of the business sector.

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