Systems Analysis Group

Synthetic Scenario Development for Climate Change Control and Sustainable Development

1. Introduction

RITE has been working on a synthetic scenario development for climate change control and sustainable development in a project called ALternative Pathways toward Sustainable development and climate stabilization (ALPS) since FY 2007. A variety of mitigation scenarios has been developed so far, and made a due contribution to policy making in the context of climate change control. The conventional approaches in modeling exercises for scenario development, however, tend to describe a simplified world in which most cost-effective mitigation measures in the world as a whole are taken. The reality is more complex: different actors have different policy priorities based on their economic levels, natural circumstances and other constraints, which leads to a difficulty in creating a coordinated uniform policy, as observed in the COP15 negotiations and in the domestic policy making process. Climate change is not the only issue on the global agenda, so it should be addressed in a balanced manner under multiple dimensions. Conventional global abatement scenarios may be too simplified to capture richness of detail and context of the real world situation. The results reveal that climate policy with the highly-idealized premises sometimes does not deliver relevant outcomes, or rather causes unduly confusion to the society.

The ALPS project aims at providing alternative plausible future scenarios and through quantification of multiple aspects of society on the assumptions that the real-world society consists of a wide range of values. This approach allows us to inform decision makers of more appropriate strategies toward sustainable development and climate stabilization from longer and wider perspectives. Another focus is to gain a clearer understanding of CO_2 emissions structure on a national, sectoral and technological basis in order to deal with short and mid-term climate challenges. The scenarios on combinations of macro and micro views would generate further insights into climate change mitigation and sustainable development.

This report presents a part of our system development which aims to be implemented in FY2011.

2. Approach

Modeling simulations are powerful tools to support decision making even though they tend to assume perfect information or perfectly rational behavior. At the same time, it is important to bear in mind that the real world is full of variety and complex. The gap between the

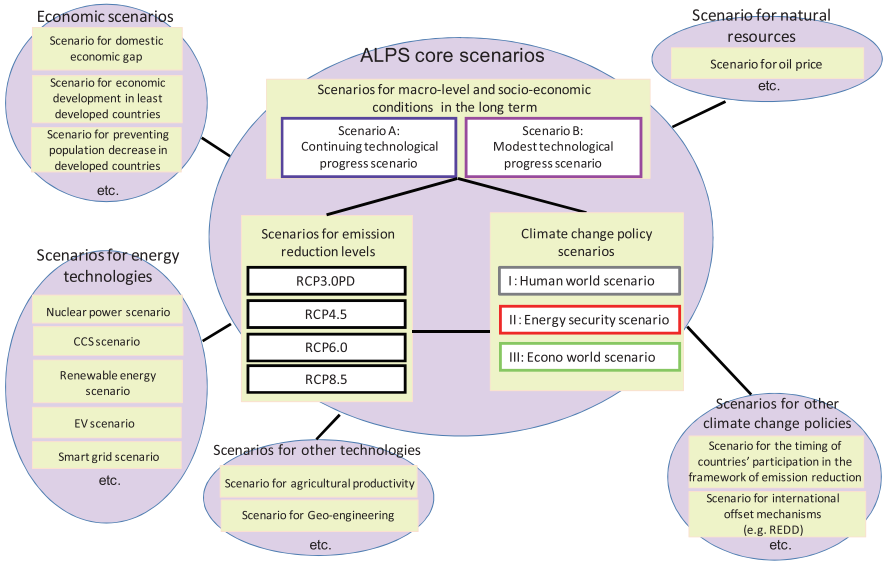

Figure 1 Scenarios to be developed in the ALPS project

Note:
The RCP for scenarios of emission reduction levels are representative concentration pathways, which are emission pathways considered by IPCC. These scenarios are:
RCP3.0PD Radiative forcing peaks at 3W/m^2 then declines to 2.6W/m^2 in 2100 (equivalent to 450ppm-CO_2eq.).
RCP4.5 Radiative forcing reaches 4.5W/m^2 in 2100 (equivalent to 600-650ppm-CO_2eq.).
RCP6.0 Radiative forcing reaches 6.0W/m^2 in 2100 (equivalent to 700-750ppm-CO_2eq.).
RCP8.5 Radiative forcing reaches 8.5W/m^2 in 2100.

real world and virtual model world creates a risk of sending a wrong message. Therefore this ALPS project starts from a deep understanding of the current world situation and historical trends in order to avoid such trap. Based on the insights gained from the socio-economic analysis above, narrative storylines with great details are worked out from broader perspectives.

Three different types of qualitative scenarios are developed: 1) Socio-economic scenarios, 2) Climate Change Policy scenarios, and 3) Representative Concentration Pathways (RCP) scenarios. Furthermore sub-scenarios focus on the subject matter of development and diffusion of climate friendly technologies (Figure1).

1) Socio-economic scenarios focusing on uncertainty of technological progress are divided into two scenarios: A) Continuing technological progress scenario and B) Modest technological progress scenario. A new approach is taken for the 2) Climate Change Policy scenarios to reflect various social situations in different climate change context, digging into three categories: I) Human World Scenario, II) Energy Security Scenario, and III) Econo World Scenario.

I) Human World Scenario assumes that human society is built up on the multiple values and diverse communities in nature. A multi-value society usually does not fit well with a uniform framework on climate change while all kinds of economic, social and political barriers exist in the diffusion of climate-friendly technologies. Under the II) Energy Security Scenario each country puts the highest priority on national security, and efforts are made to address climate change in the context of energy security. III) Econo World Scenario is a scenario under which people are rational, and measures against global warming are taken in a cost effective way. This assumption was implicitly adopted by most of the conventional climate change assessment. Given these different natures of the scenarios, mitigation measures and especially their costs may vary significantly even though the same economic conditions are assumed and the same concentration level is pursued. Referring to a range of sustainable development indices, the ALPS project intends to yield deep insights about these scenarios in order to make a contribution to a thorough discussion on climate change.

As for 3) Representative Concentration Pathways (RCP) scenarios, four scenarios (RCP3.0PD, RCP 4.5, RCP 6.0 and RCP 8.5) will be considered as targeted concentration stabilization levels in our analysis.

3. Future socio-economic scenario

CO_2 emissions are closely related to the use of energy. It is important to decouple CO_2 emissions from economic growth, however, it has been shown that there is a statistically significant positive relationship between CO_2 emissions, population and economic growth. For a synthetic scenario development of climate change control and sustainable development, therefore, a careful treatment for projections of population and economic growth is required. This project aims to analyze various indices comprehensively and to develop future scenarios such as about population and economic growth, taking impacts of world financial crisis into consideration. Figure 2 shows global GDP projections in our scenarios A) Continuing technological progress scenario (high scenario) and B) Modest technological progress scenario (medium scenario). Figure 3 shows projections for the share of global GDP by county in Scenario B. The global average of real GDP annual growth assumed to be 2.9% in Scenario A and 2.8% in Scenario B between 2005 and 2020, and 2.7% and 2.4% between 2020 and 2050, respectively. GDP in emerging economies such as China and India will grow significantly and its share of global GDP will further expand toward 2050.

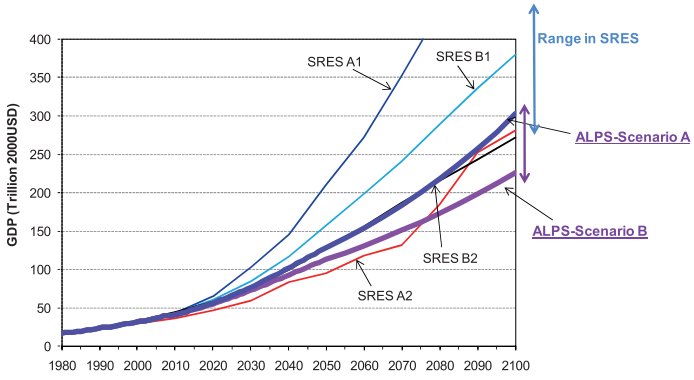

Figure 2 Global GDP scenarios

Note: SRES stands for the scenarios described in IPCC special report on emissions scenarios (2000).

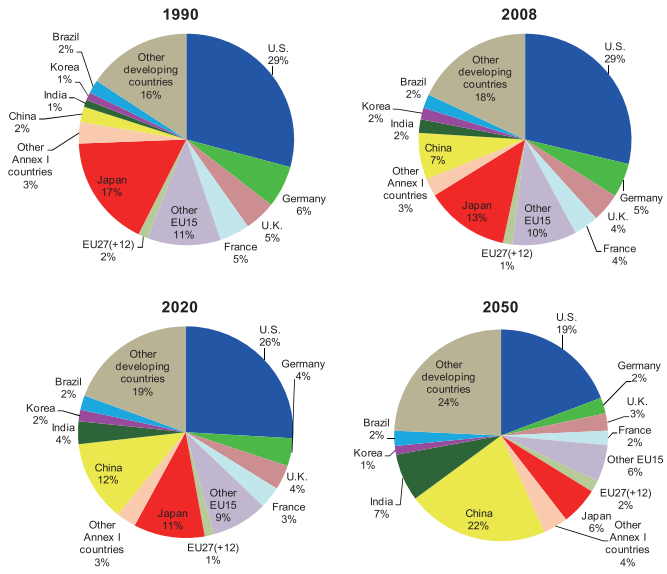

Figure 3 Share of global GDP by county in ALPS Scenario B

4. Global CO_2 emissions projection

Figure 4 shows a projection of CO_2 emissions estimated by the world's most advanced assessment model of GHGs mitigation (DNE21+) developed by RITE on the basis of CO_2 emissions statistics until 2008, economic trends by country and future prospects of economic growth until 2010. This is the projection of business-as-usual CO_2 emissions without additional climate policy, in which B) Modest technological progress scenario (medium scenario) and I) Human World Scenario (in line with a real society) are considered.

Global CO_2 emissions from fuel combustion amount to 2.8 billion tons in 2008, and are expected to reach 3.4 billion tons in 2030 and 5.3 billion tons in 2050. CO_2 emissions in developed countries decreased substantially due to the world financial crisis, however, the trend of increase in emissions in the world as a whole will not change significantly. Furthermore, the share of global emissions by country has largely changed since 1990 and it will continue to change toward 2050. Specifically, the ratio of total emissions of Annex I countries with their reduction targets under the Kyoto Protocol will account for below one-fourth of global emissions (23%) in 2020. It is crucial to pursue the framework of the Copenhagen Accord with participations from major emitting countries in order to achieve an effective CO_2 emission control.

5. Synthetic assessment of socio-economic scenarios for climate change control and sustainable development

Given the diversity in society, a scenario assessment only with indices related to GHGs emissions and mitigation cots is insufficient. The ALPS project develops quantitative scenarios which are consistent with narrative scenarios by using existing models developed by RITE with consistent data among these models. This enables us to conduct an assessment of indices widely related to sustainable development such as not only energy, climate change, but also economic society (see Table 1). An integrated index of the scenarios will be presented, taking into consideration of different priorities for each scenario by weighting key indices.

6. Expected Outcome

Synthetic scenarios toward sustainable development and climate stabilization will be implemented by FY2011 in a consistent and quantitative manner based on the narrative scenarios and group of assessment models. This study provides substantial insight into alternative pathways and catches the implied meaning from the quantitative assessment in order to guide our future actions. Findings and lessons learnt from this research project, including scenario analysis, are returned to society. The results of this study are expected to not only make scientific contribution to the IPCC but also to serve as fundamental information for decision making on global and domestic climate change policy.

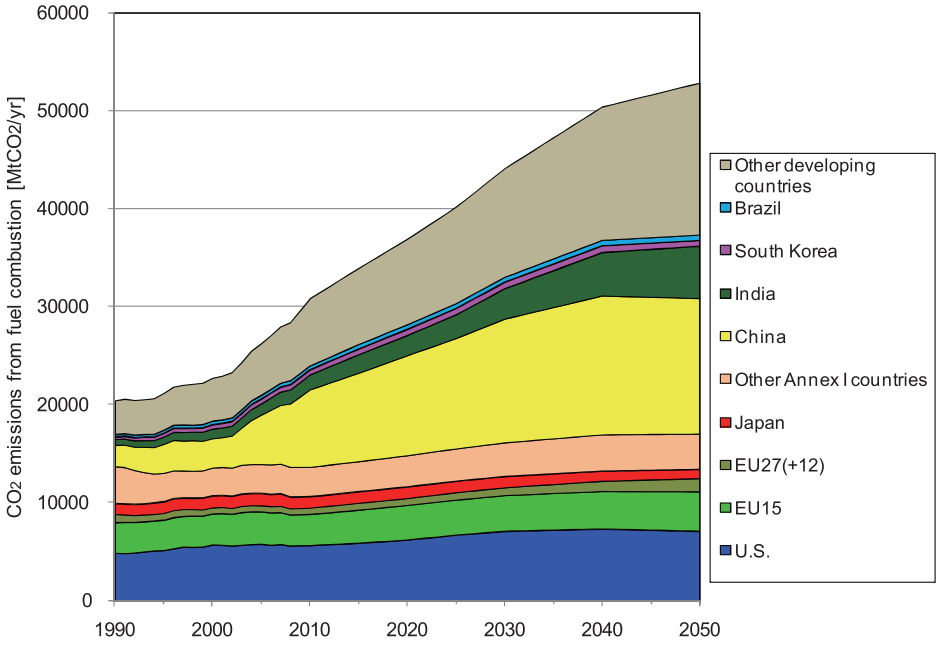

Figure 4 Projection of CO_2 emissions from fuel combustion in major countries and regions in ALPS Scenario B-I

Note: IEA statistics are used until 2008. Other Annex I countries refer to "Other Annex B countries" with reduction targets under the Kyoto Protocol.

Table 1 Key socio-economic indices for synthetic scenario assessments of alternative pathways toward sustainable development and climate stabilization

Items		Variables
Human capital	Working-age population	Ratio of working-age population (between the ages of 15 and 64)
	Education	Literacy rate, (Primary, secondary and tertiary education) Enrollment rate , Investment in education
Economy	Average income	GDP per capita
	Poverty	Proportion of population living in poverty
Global warming	Concentration of GHGs	CO_2 emissions and atmospheric concentrations of CO_2, GHGs emissions and atmospheric concentrations of GHGs, temperature
	Costs of climate change control	Mitigation costs, marginal abatement costs
Basic needs and infrastructure	Nutrition intake	Proportion of population below minimum level of nutrition intake
	Access to water	Proportion of population with sustainable access to an improved water source
	Access to energy	Proportion of population with access to modern forms of energy (electricity and gas)
	Health	Under-five mortality rate
Security	Food security	Ratio of food self-sufficiency
	Energy security	Energy security indicators
	Water security	Proportion of population above certain ratio of water demand and supply
Nature conservation	Land use	Area of land use change, change in the number of species