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ANALYSIS

Assessment of the emission reduction target of halving CO_2 emissions by 2050: Macro-factors analysis and model analysis under newly developed socio-economic scenarios

Keigo Akimoto [a,b,*], Fuminori Sano [a], Takashi Homma [a], Kohko Tokushige [a], Miyuki Nagashima [a], Toshimasa Tomoda [a]

[a] Systems Analysis Group, Research Institute of Innovative Technology for the Earth (RITE), 9-2 Kizugawadai, Kizugawa-shi, Kyoto 619-0292, Japan
[b] Graduate School of Art and Science, The University of Tokyo, 3-8-1, Komaba, Meguro-ku, Tokyo 153-8902, Japan

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ABSTRACT

This paper assesses the global emission reduction target of halving CO_2 emissions by 2050. First, future GDPs with specific uncertainty ranges were developed. The Kaya identity and the developed GDP outlook indicate that halving global CO_2 emissions by 2050, which corresponds to almost 450 ppm-CO_2eq. stabilization, requires an improvement approximately four times as large as the historical CO_2 intensity improvement rate on average up to 2050, if GDP loss should remain within a few percent of potential baseline GDP. In addition, the global energy-related CO_2 emission reductions were assessed by using an energy systems model. Marginal abatement cost of CO_2 is over 470 \$/tCO_2 for halving global CO_2 emissions by 2050 relative to 2005 even under the lower GDP scenario and technology improvements. Great challenges will have to be met for achieving the 450 ppm-CO_2eq. Realistic alternative emission reduction scenarios should be explored in two ways; 1) more innovative technological development than any present imaginable development, and/or drastic social innovations are needed for cheaper carbon costs, e.g., within a few tens of US\$ per tonne of CO_2, and 2) more modest emission reduction targets, e.g., 550 ppm-CO_2eq., and adaptation measures are considered.

1. Introduction

The climate change issue has become one of the top agenda items of international concern in the world. For example, G8 leaders at the Muskoka G8 Summit in 2010 "recognize the scientific view that the increase in global temperature should not exceed 2 °C compared to pre-industrial levels," and declared their "willingness to share with all countries the goal of achieving at least a 50% reduction of global emissions by 2050, recognizing that this implies that global emissions need to peak as soon as possible and decline thereafter." A similar declaration was also made at the sixteenth session of the Conference of the Parties (COP16) to the United Nations Framework Convention on Climate Change (UNFCCC) in Cancun in 2010.

The Intergovernmental Panel on Climate Change (IPCC) summarizes global emission pathways for six levels of atmospheric CO_2 concentration stabilization and the corresponding global mean temperatures in the Fourth Assessment Report (AR4) published in 2007 [22]. According to the IPCC AR4, the lowest level of category I whose CO_2-eq. concentration is 445–490 ppm corresponds to 2.0–2.4 °C of global mean temperature increase above pre-industrial at equilibrium and to 85 to 50% reductions of global CO_2 in 2050 relative to 2000. However, the IPCC is not a body that makes recommendations regarding the targets for atmospheric concentration stabilization or temperature change limits. For example, the IPCC Third Assessment Report (TAR) states: "Natural, technical, and social sciences can provide essential information and evidence needed for decisions on what constitutes 'dangerous anthropogenic interference with the climate system.' At the same time, such decisions are value judgments to be determined through socio-political processes, taking into account considerations such as development, equity, and sustainability, as well as uncertainties and risk" [21].

* Corresponding author. Systems Analysis Group, Research Institute of Innovative Technology for the Earth (RITE), 9-2 Kizugawadai, Kizugawa-shi, Kyoto 619-0292, Japan.
E-mail address: aki@rite.or.jp (K. Akimoto).

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Before the G8 mentioned the 2 °C target, EU proposed it, firstly at the Council Meeting in 1996. However, Tol [33] provides criticism to the effect that the EU target of 2 °C above pre-industrial levels is not based on scientific findings, and insists that deep cuts in emissions will only be achieved if alternative energy technologies become available at reasonable prices. Anderson and Bows [6] indicate that the 2 °C target does not have a scientific basis, and that it is likely to lead to dangerously misguided policies. Then, they concluded that achieving stabilization not only at 450 ppm-CO_2eq., which corresponds to the 2° increase, but also at 550 ppm-CO_2eq. will be unlikely from the current emission trends. Akimoto et al. [2] tried to evaluate the desirable level of atmospheric stabilization with scientific estimates of mitigation costs and global warming impacts on several sectors, and finally with the judgments of experts based on their scientific estimates. The conclusion did not support the 2° target, but did support 550 ppm-CO_2 (corresponding to approximately 650 ppm-CO_2eq.). On the other hand, Stern [30] mentioned that the risks of the worst impacts of climate change can be substantially reduced if greenhouse gas levels in the atmosphere can be stabilized between 450 and 550 ppm-CO_2eq. (Mitigation costs estimated by the Stern are mentioned below.)

While the 2 °C target of halving global emissions by 2050 is not a scientific requirement but a political target, both the current actual international policy on climate change and national policies in many developed countries pursue this ambitious target of 2 °C. On the other hand, deciding specific, concrete and deep emission reduction targets for the short term and taking the accompanying specific actions are too difficult to be achieved [29], and such a situation will not largely improve for most of the countries and under the UNFCCC process. Large gaps between the declared political vision for the long term and the difficulties in short-term targets and actions exist in real politics. As

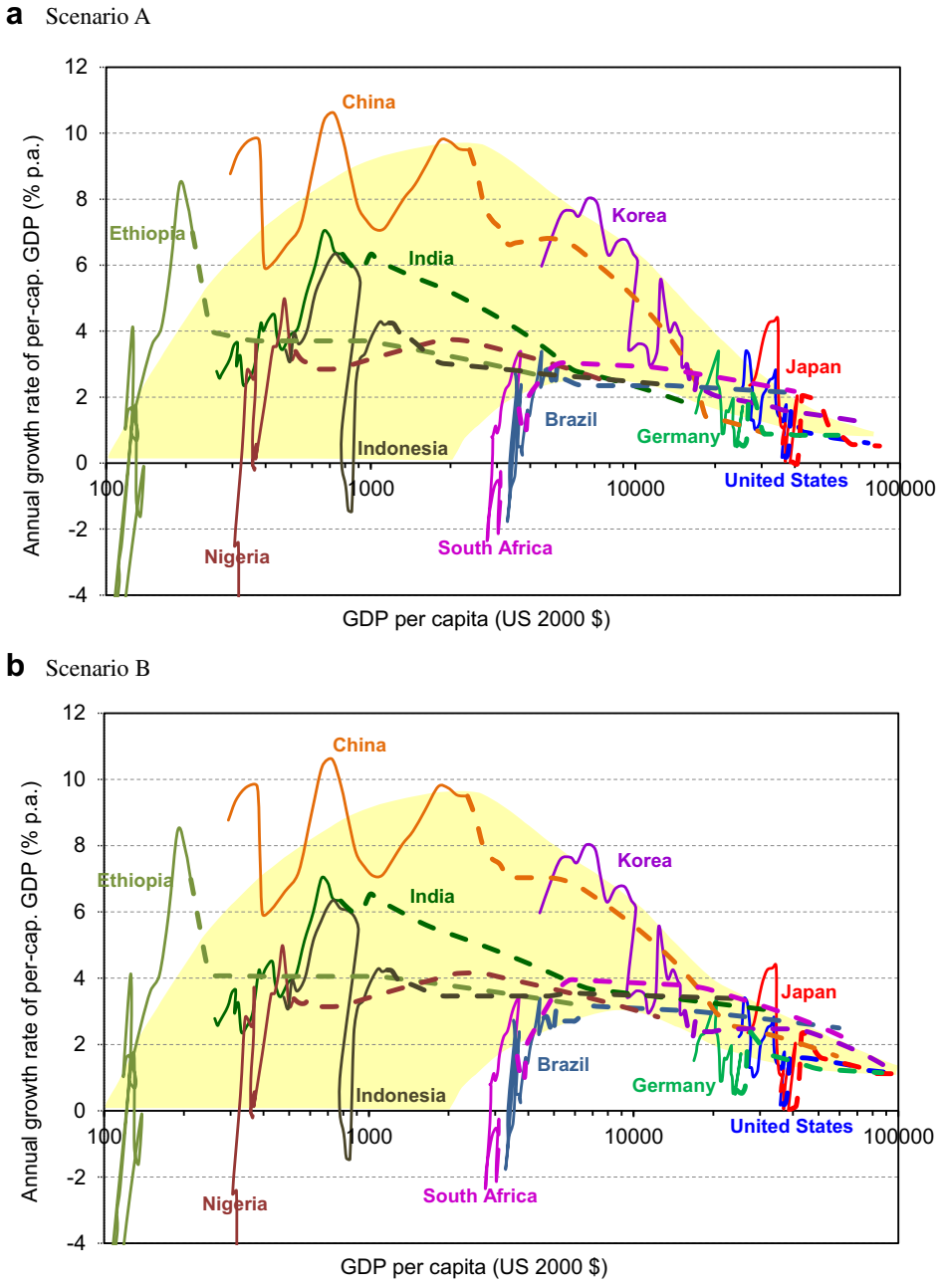

Fig. 1. Historical trend (solid line) and outlook (dashed line) of per capita GDP for several selected countries under Scenarios A and B.