Issues for Carbon Neutrality (Science and Policy)

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In my contribution titled “Is It Possible to Achieve Global-Scale Net-Zero Emissions by 2050” to a special issue of the IEEJ Journal in February 2021, I concluded that “achieving net-zero emissions by 2050 appears to be extremely difficult, if not impossible.” Later, the European Union and the United Kingdom increased their emission reduction targets for 2030. Japan and the United States followed suit. In May 2021, the Group of Seven industrial democracies in their climate and environment ministers’ meeting communique vowed to “lead by example and each commit to achieve net-zero greenhouse gas (GHG) emissions as soon as possible and by 2050 at the latest.” This means that G7 and other advanced economies clarified their initiative to limit the increase in the global average temperature from pre-industrial levels to 1.5℃ instead of 2℃ as agreed by all Paris Agreement parties including developing economies and to move up the deadline for achieving net zero GHG emissions to 2050 from “as soon as possible in the second half of this century” under the Paris Agreement. The issue is whether the initiative could be used to persuade emerging market economies, including China, and developing ones to enhance emission reductions. Developing economies for their part may assert that they have agreed to the 2℃ target rather than the 1.5℃ target and that it would be absolutely impossible to achieve net zero GHG emissions by 2050. As a result, climate negotiations between advanced and developing economies could be stalled. This is because China and other emerging market economies, as well as Asian and other developing economies continuing economic development, may give less priority to climate change countermeasures than advanced economies. In the following, this paper considers essential issues regarding the target of Net Zero GHG emissions by 2050. Based on the consideration and without prejudice, we should discuss targets that would satisfy emerging and developing economies.

Issue 1: Net Zero – GHG or CO_2 emissions?

As noted above, the Paris Agreement calls for limiting the increase in the global average temperature to 2℃ and achieving net-zero GHG emissions in the second half of this century. After the Intergovernmental Panel on Climate Change released a special report (IPCC/SR1.5) in 2018 concluding that net-zero emissions would have to be achieved by 2050 to limit the temperature increase to 1.5℃[1], however, the UK and EU rapidly shifted priority to the 1.5℃ target and net-zero GHG emissions in 2050, followed by the G7 members including Japan. However, the IPCC/SR1.5 report called for net-zero CO_2 emissions instead of net-zero GHG emissions.

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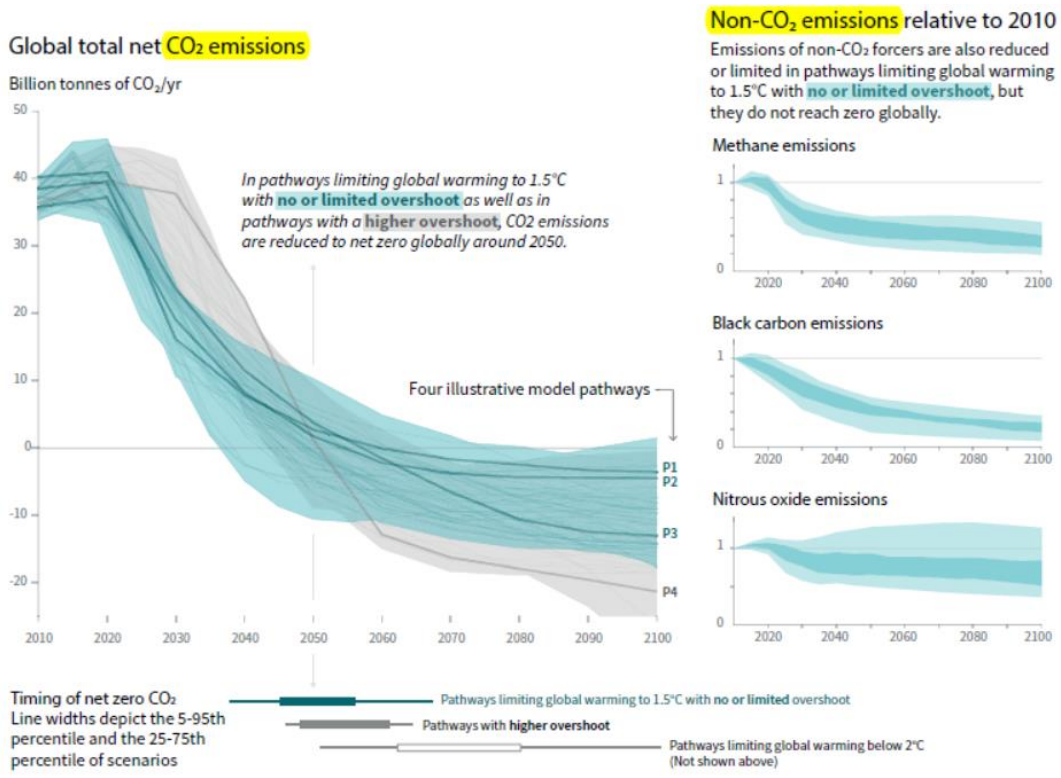
[1] More accurately, the report discussed a case in which global warming would be limited to 1.5°C with no or limited (less than 0.1°C) overshoot.

Fig. 1 indicates emissions pathways limiting global warming to 1.5℃ in the IPCC/SR1.5 report. Left pathways are for CO_2 and right ones for other GHGs. Approximately, CO_2 emissions would have to reach net zero around 2050 if we allow no or limited overshoot in global warming. However, other GHG emissions including methane would not have to do so. This is because CO_2, once emitted, will remain in the atmosphere over a very long time and surely contribute to boosting temperatures, while other GHGs stay over a shorter time (e.g., 12 years for methane). Other GHG emissions, as far as staying stable, would not contribute to boosting temperatures. However, the Paris Agreement and the G7 have stuck to net-zero GHG emissions instead of net-zero CO_2 emissions. Any clear reason for this is uncertain. One possible reason may be that the UK became the first country in the world in 2008 to set a statutory target of cutting GHG emissions by 80% from 1990 by 2050 and raised the target cut to 100% in 2019, remaining influential in negotiations at the Conference of Parties to the United Nations Framework Convention on Climate Change.

This means that net-zero GHG emissions would be excessive for the target of limiting global warming to 1.5℃ and would not have to be reached by 2050 from the scientific viewpoint.

Fig. 1 CO_2 and Other GHG Emission Pathways toward Achieving the Target of Limiting Global Warming to 1.5℃



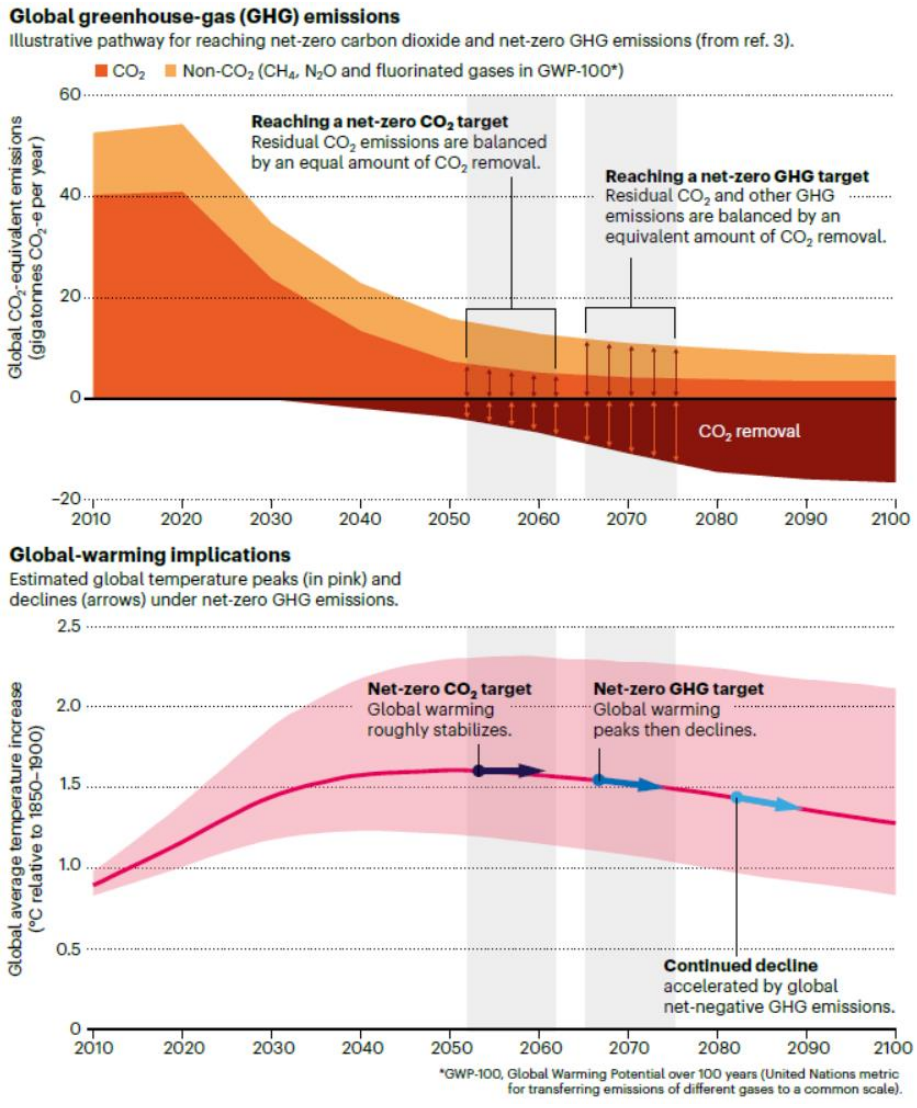
Source: IPCC/SR1.5/SPM p.15 Yellow highlights were given by the author.

Issue 2: Meaning of the Temperature Target – How long net negative CO_2 emissions would continue to extend?

Fig. 2 represents excerpts from a paper that was authored mainly by key contributors to the IPCC/SR1.5 report based on scenarios in the report and published in the refereed journal *Nature*.

The figure's upper half represents an illustrative pathway for reaching net-zero CO_2 and net-zero GHG emissions based on the IPCC/SR1.5 report, indicating CO_2 (red) and other GHG (brown) emission cuts and CO_2 removal (dark brown) through BECCS (bioenergy with carbon capture and storage), DACCS (direct air carbon capture and storage), afforestation and other measures for negative emissions. This shows that CO_2 emissions would become net zero (emissions offset by negative emissions) in the 2050s and total GHG emissions including CO_2 would become so around 2070.

Fig. 2 Global GHG Emission Cuts (upper) and Temperature Trend (lower)



Source: J. Rogelj et al. Three ways to improve net-zero emissions targets, Nature 591, 365-368

The lower half shows temperature changes from pre-industrial levels as a result of the above emission cuts. As temperatures are stabilized after CO_2 emissions reach net zero as noted above, the global average temperature increase would follow a trend indicated by the black arrow. Although other GHG emission cuts would make little progress towards 2100, the gap between CO_2 removal and emissions would expand in a manner to increase net negative CO_2 emissions. In line with such change, the global average temperature increase from pre-industrial levels (red line) would continue to fall, reaching some 1.3℃ in 2100. If the target limit is 1.5℃, the increase from pre-industrial levels should be stabilized at the target level. The ultimate goal of climate change countermeasures is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (Article 2 of the 1992 UNFCCC, underlined by the author) while ensuring sustainable economic growth. As the real objective is to limit losses from temperature rises to some extent, the goal should be the stabilization of temperatures. Given great uncertainties about the relationship between GHG concentrations and temperature rises, or the climate sensitivity, however, the stabilization of GHG concentrations might have been chosen for the convention. The temperature increase would slightly exceed 1.5℃ when CO_2 emissions reach net zero. Later, temperatures would stabilize with CO_2 emissions remaining net zero[2]. In the IPCC 1.5℃ scenario as indicated by the figure, however, the temperature increase from pre-industrial levels would continue to fall below 1.5℃ with net negative emissions expanding. It is doubtful if the IPCC 1.5℃ scenario meets the objective of the convention.

Issue 3: Uncertainties

Uncertainties over the science of climate change were discussed in detail in Chapter 8 of a recommendation[3] by the UK Committee on Climate Change to the government in December 2020. This paper briefly discusses the carbon budget in this regard. The carbon budget is a concept paying attention to a proportional relationship between cumulative CO_2 emissions and a temperature increase. The fifth IPCC assessment report on climate change published in 2013/2014 became the first IPCC report to discuss the carbon budget. In the report, the carbon budget (cumulative CO_2 emissions) to stabilize global warming at a given level (e.g., 1.5℃ at the probability of 50%) was estimated at 2,250 gigatons. The 2018 IPCC/SR1.5, released four to five years after the fifth report, gave cumulative CO_2 emissions through 2017 at 2,200 Gt, meaning that the remainder in the carbon budget was 50 Gt, less than two years' global CO_2 emissions. In the IPCC/SR1.5 report, however, the carbon budget estimate was raised to 2,780 Gt, indicating that the remaining carbon budget (allowable future emissions to achieve the target) would be 580 Gt (2,780 Gt – 2,200 Gt), up more than 10-fold from 50 Gt based on the fifth IPCC report. This change is attributable to the development of scientific knowledge and methodology. If the global mean surface temperature (GMST) is used

[2] As the temperature increase slightly exceeds 1.5℃, some additional CO_2 (or GHG) emission cuts would be required to push the increase down to 1.5℃. Here, however, I would like to refrain from discussing details. The essential question is if a long-term decrease in temperatures would be the objective that we should attain.

[3] The Sixth Carbon Budget, The UK's path to Net Zero, Committee on Climate Change, December 2020

instead of the traditional near surface air temperature (SAT) to measure temperatures, the carbon budget would increase further. The carbon budget, particularly the remaining carbon budget, is an important indicator to project future emissions pathways to reaching targets and the timing for net zero emissions and to consider the feasibility of targets. This important indicator is so uncertain. Research may be making progress towards the sixth IPCC report. If the carbon budget increases in the sixth report, climate targets may become easier to achieve. If it decreases, however, they may become more difficult to attain[4].

The above discussed typical uncertainties about the science of climate change. The Paris Agreement has failed to specify any long-term target year for limiting the temperature increase or to discuss whether overshoot is allowable and to what extent. These points are susceptible to the carbon budget. Given the above, it must be noted that the 1.5℃ target and the net-zero CO_2 emissions in 2050 are not necessarily linked to each other. This is the same case with the net-zero GHG emissions.

In the above, I cited the three issues. What I would like to emphasize here is that scientific grounds are not solid enough for the 1.5℃ target and the net-zero GHG emissions by 2050 for which G7 is pursuing. Given its significance, climate change is a challenge that should be addressed immediately and globally. For the future, however, I hope that world-leading policymakers would have the courage to verify the adequacy of climate targets from scientific and policy viewpoints without any prejudice and formulate new international agreements as necessary.

Writer's Profile

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Mr. Yamaguchi's previous position include Visiting Professor/Project Professor, University of Tokyo (2006–2015), Professor of Economics, Keio University (1996-2004), and Former Special Advisor, Research Institute of Innovative Technology for the Earth (RITE). Prior to this, he was Senior General Manager at Tokio Marine & Fire Insurance Co., Ltd. He served in numerous positions on committees and councils related Climate Change and Environmental issues such as a Lead Author of IPCC Working Group III and Chief Japanese Delegate and vice chair at Joint working party of Trade and Environment, Organisation for Economic Co-operation and Development (OECD).

[4] In the Working Group 1 report of the IPCC 6th assessment report released in August 9, 2021, carbon budget of achieving, for example. 1.5 degree C target at 50% probability is estimated as 2890GtCO_2 and, as 2390GtCO_2 has already been emitted by the end of 2019, remaining carbon budget from 2020 onward as 500GtCO_2.