Paradigm Shift in Climate Strategies

－From temperature target to emissions target－

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1. From Stabilization of Concentration to Temperature Target

The ultimate objective for climate change countermeasures is set out in Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC) adopted in 1992. The goal is "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". In the European Union (EU), the ministerial council held in 1996 established a target of limiting global warming to no more than 2°C above the temperature in pre-industrial levels, and encouraged the world to set this to tackle climate change. At the COP21 held in Paris in 2015, an international agreement (Paris Agreement) was reached on the 2°C-target (more accurately, well below 2°C above pre-industrial levels, referred as the 2°C-target in this essay). The concentration target has shifted toward a temperature target. The Paris Agreement not only sets out the 2°C-target, but also includes the aspirational target of limiting the rise in global temperatures to 1.5°C. Currently, countries around the world are coming up with a wide range of countermeasures toward achieving either the 2°C or 1.5°C target. In reality, will this temperature target work? If not, what should we do? These are the themes of this essay.

2. Gap between Reality and the Targets

In fact, the contents agreed upon in Paris comprise two elements. The first is the abovementioned temperature target (Article 2), and the second is a GHG (Greenhouse Gas) emissions reduction target aimed at realizing the first target. This latter target is aimed at balancing the emissions and absorption of greenhouse gases (net zero emissions) by the second half of this century (Article 4), i.e. emissions target. It is important to note here that the Paris Agreement states clearly that the deadline for achieving the emissions target is the second half of this century.

Fig. 1 is reproduced from the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), prepared by Working Group III in 2014, the year prior to the Paris Agreement. Of the scenarios shown, the scenarios with the lowest emissions at 430-480ppmCO_2eq (area shown in light blue) marks the pathway toward achieving the 2°C-target. Based on this figure, we can make the following two points. Firstly, there is a range in the emissions scenario for achieving the 2°C-target. Secondly, to achieve the 2°C-target, net CO_2 emissions (Emissions – Absorption) have to fall to zero or close to zero by 2080, after which it becomes net negative emissions (NNEs)

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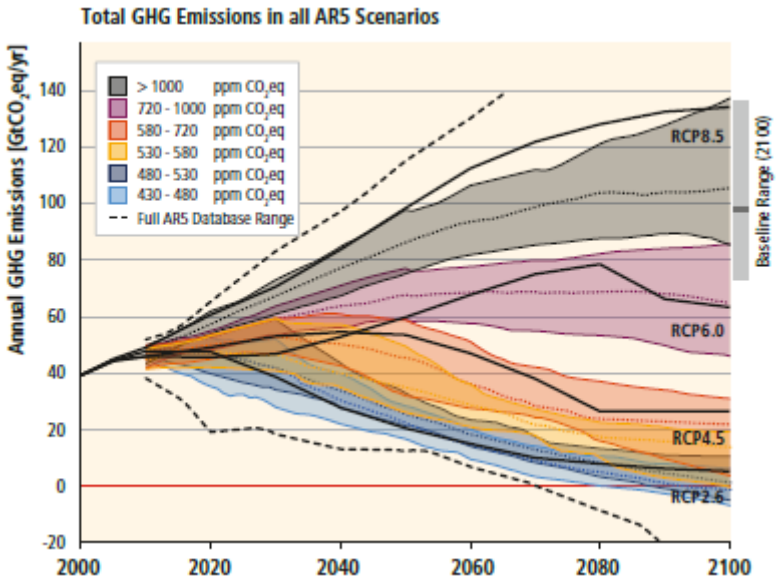
by 2100. The temperature and emissions targets set out in the Paris Agreement are based on this figure.

Fig. 1　GHG Emissions Pathways toward Achieving Various Concentration (temperature) Target



Source: Extracted partially from IPCC /AR5/WG3 Figure 6.7 (p. 432)

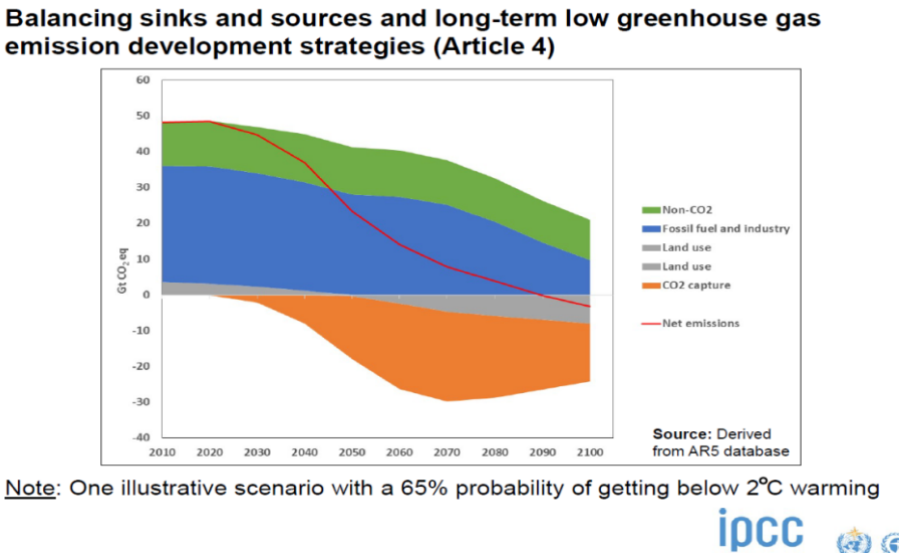
The Paris Agreement sets out the aspirational target of limiting global warming to 1.5°C, but there were no IPCC scenarios at that point which were aimed toward the realization of this target. As such UNFCCC requested IPCC for the provision of the impact in the event that temperature rises by 1.5°C above pre-industrial levels as well as the emissions pathways toward achieving this target. The response to this request came in the form of the IPCC Special Report on Global Warming of 1.5°C (SR1.5) completed in 2018. According to SR1.5, to achieve the 1.5°C target, it is necessary to reduce CO_2 emissions by about 45% compared to 2010 levels by 2030, and to reach net zero levels around 2050.[1] To begin with, global emissions are still increasing even now, especially in developing countries, so anyone can see that it is far too unrealistic to reduce emissions by 45% against 2010 levels in a little over 10 years.

The abovementioned relates to the global situation. However, the Paris Agreement asks countries to submit nationally determined contributions (NDCs), which are voluntary reduction targets, for 2030 (2025 for the United States), toward the achievement of the global emissions target. Most models estimate a temperature rise of 3°C or more by 2100 based on the premise of these targets. Going forward, it will be impossible to achieve the 2°C-target without the introduction of unproven technologies, and this will be even more difficult for the 1.5°C-target. In short, the gap between NDCs and the targets is simply too wide.

[1] GHG other than CO_2 will not reach net zero level even by 2100 (SR1.5 Figure SPM.3a).

If we were to consider negative emissions (NEs), this gap would be even wider. Please refer to Fig. 2.

Fig. 2　Structure of Net Negative Emissions



Source: Professor Jim Skea's presentation at IPCC Workshop held in Tokyo in November 14, 2017

This is extracted from the materials presented in Tokyo by Professor Jim Skea, Co-chair of Working Group III for the Sixth Assessment Report of the IPCC. It presents one of the illustrative scenarios from the database of the IPCC Fifth Assessment Report, and shows that the net emissions corresponding to achieve 2°C-target with a 65% probability (red line) becomes net negative by 2100. However, gross CO_2 emissions for 2100 is the sum of the blue (CO_2 generated through fossil fuels) and green (GHG emissions other than CO_2) areas, the grey area represents GHG emissions generated through land use (there are + and – in this sector, but the balance is negative), and the orange area represents CO_2 absorption (typically known as BECCS (bioenergy with carbon capture and storage), this is a form of technology that recovers CO_2 emissions using bioenergy and stores it underground). In short, looking at 2100, we can see that while the net figure is negative of several Gt, the gross figure shows that massive (several tens of Gt of) NEs is needed in order to offset CO_2 and non-CO_2 emissions at that point to achieve a net negative figure. (Incidentally, current CO_2 emissions worldwide is more than 40 Gt). Many academic papers published in professional journals have raised the concern about whether or not such a high volume of BECCS is physically achievable. Their contents mainly cover factors such as the limitations of biofuels (land availability, competition with food production), and the trade-off with the diversity of species. Naturally, this gap will increasingly expand under the 1.5°C-target.

3. Toward Actionable Target (from temperature to emissions)

As explained above, while the 2°C and 1.5°C targets are both too ambitious, a temperature target in itself, to begin with, may be unsuitable as a common target for the world. There are several reasons for this.

Firstly, there is no scientific basis for setting either the 2°C or the 1.5°C targets. Much literature has been produced concerning the level of concentration that is deemed "non-dangerous" under the article 2 of the UNFCCC. However, there is a consensus that these are not determined based on science, but are ultimately based on a value judgement based partly on science. The same could be said for the temperature targets.

The second point is the uncertainty of equilibrium climate sensitivity. Under existing knowledge, temperature is said to increase by a range of 1.5°C - 4.5°C, which is in fact about three times, when CO_2 concentration doubles. Moreover, there is no agreement among experts concerning the best estimate. Conversely, this means that in the moment that a certain temperature target is set, there is an infinite number of scenarios toward achieving it.

The third reason is the probability of achieving the temperature target. If we were to look closely at the IPCC report, we can see that there are frequent descriptions about the probability of achieving the 2°C-target as 66% or higher (likely) or 50% or higher (more likely than not). If 2°C were a "dangerous" temperature rise according to political assessments, the probability of achieving the goal must then be 100%. However, the scenarios for achieving the 2°C-target presented by IPCC basically take the premise of a 66% or higher probability of achieving the goal. In this situation, the probability of temperature rise exceeding 2°C is as high as one-third, so a temperature target that seeks to avoid danger has already failed in this sense.

Fourthly, the temperature target does not serve as a guide for action for each country. It has already been explained above that it is impossible to achieve the 2°C-target based on the cumulative efforts of the NDCs set by each country. However, even if a temperature target (for example, 2°C) were established and there were just one emissions pathway toward achieving that target, hypothetically speaking, the top-down approach of assigning a tolerable emissions level to each country up till 2100 would already not function, even without needing to wait for the example of the Kyoto Protocol. In addition, it is overwhelming just to think about how to distribute and assign a high level of negative emissions (BECCS) to member countries. In other words, based on a temperature target, each country does not know what action to take; furthermore, it is far too abstract for emissions entities including corporations and consumers, and cannot be described as an "actionable" target at all.

4. Proposal of Net Zero CO_2 Emissions without Relying on Massive NEs

On the other hand, particularly unusual weather conditions have been occurring around the world recently, and the risks of temperature rise are increasingly becoming visible. The IPCC Special Report on The Ocean and Cryosphere in a Changing Climate published in September this year also sounds the alarm on this point. It is well known that CO_2 has an extremely long retention period

among the GHGs (it is not completely absorbed even after 1,000 years or 10,000 years). In other words, the emission of an additional ton of CO_2 will definitely advance global warming by the same degree. Temperatures will continue to rise infinitely as long as there is no end to this. We have to prevent this somehow.

In light of this, the author's proposal is to make a paradigm shift from setting a temperature target to zero emissions for CO_2. However, as there is a need to avoid dependence on a high level of BECCS through various factors, our proposal is to achieve net zero CO_2 emissions without relying on massive NEs. This would be an actionable target for all entities. To that end, it is necessary to develop technology to reduce CO_2 emissions to zero, and we are already taking a step toward that[2]. Of course, it is also important for those on the demand side to understand the importance of zero emissions and take action to contribute to this goal. There is no deadline for our proposal. This is because the deadline (2100) for achieving the temperature target indicates clearly that the target is far too unrealistic. Of course, it is needless to say that it would be desirable to achieve the net zero CO_2 emissions target as soon as possible.

Writer's Profile

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Mr. Yamaguchi's previous position include Visiting Professor/Project Professor, University of Tokyo (2006–2015) and Professor of Economics, Keio University (1996-2004). 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.

[2] "Towards net zero CO_2 emissions without relying on massive carbon dioxide removal", Yoichi Kaya, Mitsutsune Yamaguchi, Oliver Geden, *Sustainability Science*, March 2019.