Research Institute of Innovative Technology for the Earth (RITE)

Submission to the Talanoa Dialogue of the UNFCCC

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Title

Toward globally effective climate change countermeasures: total risk management recognizing the difficulties in the real world

Summary

Where are we?

Global CO_2 emissions have been increasing. While the global GDP grew during the period from 2013 to 2016, CO_2 emissions stalled largely due to steel and cement production adjustment in emerging countries, especially China, and the expansion of shale gas production in the US. Given the potential economic growth of developing countries in the future, global CO_2 emissions will likely continue to increase during the 21st century. It should be recognized that the gap between the 2°C/1.5°C targets and the current emission trends in the real world is continuously widening. In addition to the deviation of current policies from the submitted NDCs, even if all the NDCs are realized, we are not on track for the 2°C target. As for the NDCs, the CO_2 marginal abatement cost varies widely across countries, and it is estimated that global mitigation costs could be more than six times higher than the cost of the least-cost measures with an equal marginal cost across countries. Furthermore, domestic mitigation actions are not necessarily implemented at the lowest cost. The difficulties in meeting the climate target must be re-examined in light of different national circumstances. If we stick to a far-reaching target, we may be gripped by a sense of helplessness and abandon even easy mitigation measures.

Where do we want to go?

Achieving Sustainable Development Goals (SDGs) through climate action is crucial. Mitigation options are associated with multiple synergies and tradeoffs across the SDGs. Mitigating climate change can reduce its impact and aid sustainable economic growth over the long term, and possibly create synergies with SDGs. However, if the cost for mitigating climate change is too high, there is a possibility that the economy will weaken over the long term, resulting in tradeoffs with eradicating poverty and hunger. Well-balanced climate actions should be taken in the context of SDGs. Meanwhile, in the very long term, we should aim at net zero CO_2 emissions globally, whatever the target level of temperature increase will be.

How do we get there?

We should address various uncertainties, including scientific, economic, and political issues, and consider a total risk management strategy with a wide portfolio of mitigation and adaptation options. Flexibility of the strategy is important. National or sectoral CO_2 emission accounts can differ, depending on consumption-based or production-based CO_2 emissions. Therefore, we should pay due attention to an LCA-like viewpoint rather than placing too much emphasis on reducing process-base CO_2 emissions, focusing more on the wide-ranging deployment of new low-carbon products and services beyond national borders. The one thing more important than anything else is innovation. Innovative technologies that seemingly, at a glance, do not lead to CO_2 emission reductions could change society and bring significant CO_2 emission reduction opportunities. For example, the sharing economy enabled by advanced technologies, such as IT and AI, is autonomously induced in the economic evolution regardless of the emission reduction constraints; however, CO_2 emissions may be reduced as a result. If food loss and waste throughout the food supply chain are reduced by the use of IT and AI, it could be a significant GHG emission reduction opportunity as well as the creation of synergies with SDGs. Needless to say, we need to take whatever climate action at hand. Simultaneously, we should develop enduring strategies towards future large emissions cuts. Innovative technologies, such as IT, AI, and biotechnology, may not be directly relevant to emission reduction, but their wider application brings not only huge benefits to society, but also opportunities to mitigate climate change.

1. Where are we?

Global CO_2 emissions have been increasing. While global GDP grew during the period from 2013 to 2016, CO_2 emissions stalled (the increase in global CO_2 emissions from 2009 to 2013 was steeper). This is estimated to be largely due to the production adjustment of steel and cement in emerging countries, especially China, and the expansion of shale gas production in the US. Given the future potential economic growth in developing countries, global CO_2 emissions are highly likely to continue increasing throughout the 21st century. The current emissions profile should not be seen optimistically. We need to face up to the fact that the gap between the current profile and the targets of 2°C and 1.5°C is becoming larger. Adherence to difficult targets may cause resignation, which may jeopardize achievable targets.

Consumption-based CO_2 emissions

In some developed countries, GDP is on an upward trend while CO_2 emissions decrease and even electricity consumption is on a downward trend. However, the estimated consumption-based CO_2 emissions show that they do not decrease as much as the production-based CO_2 emissions and that the downward trend in CO_2 is mainly caused by the shifting of industries occurring across nations, especially in the energy-consuming manufacturing industry. In many cases, GDP growth is achieved by growth in the service sector, such as finance and insurance. However, as a result, at the global level, a cut in CO_2 emissions is not being achieved. Partial understanding of the superficial figures does not enable us to find truly necessary measures.

Figure 1 shows the transitional change of the production-based and consumption-based CO_2 emissions in Europe, the US, and Japan. The production-based CO_2 emissions have steadily been decreasing, especially in Europe, however, in terms of consumption-based CO_2 emissions, it has not decreased that much. Figure 2 shows the transitional change of the production-based and consumption-based CO_2 emissions per GDP in the US, Japan, UK, and Sweden. In terms of the production-based CO_2 emissions per GDP, the degree of improvement of the four countries differs greatly, however, concerning the consumption-based emissions, the improvement rate of the four countries does not differ that much when excluding the impact of Japan's emission increase due to the shutdown of nuclear power generation after the Fukushima Daiichi nuclear accident during the Great East Japan Earthquake.

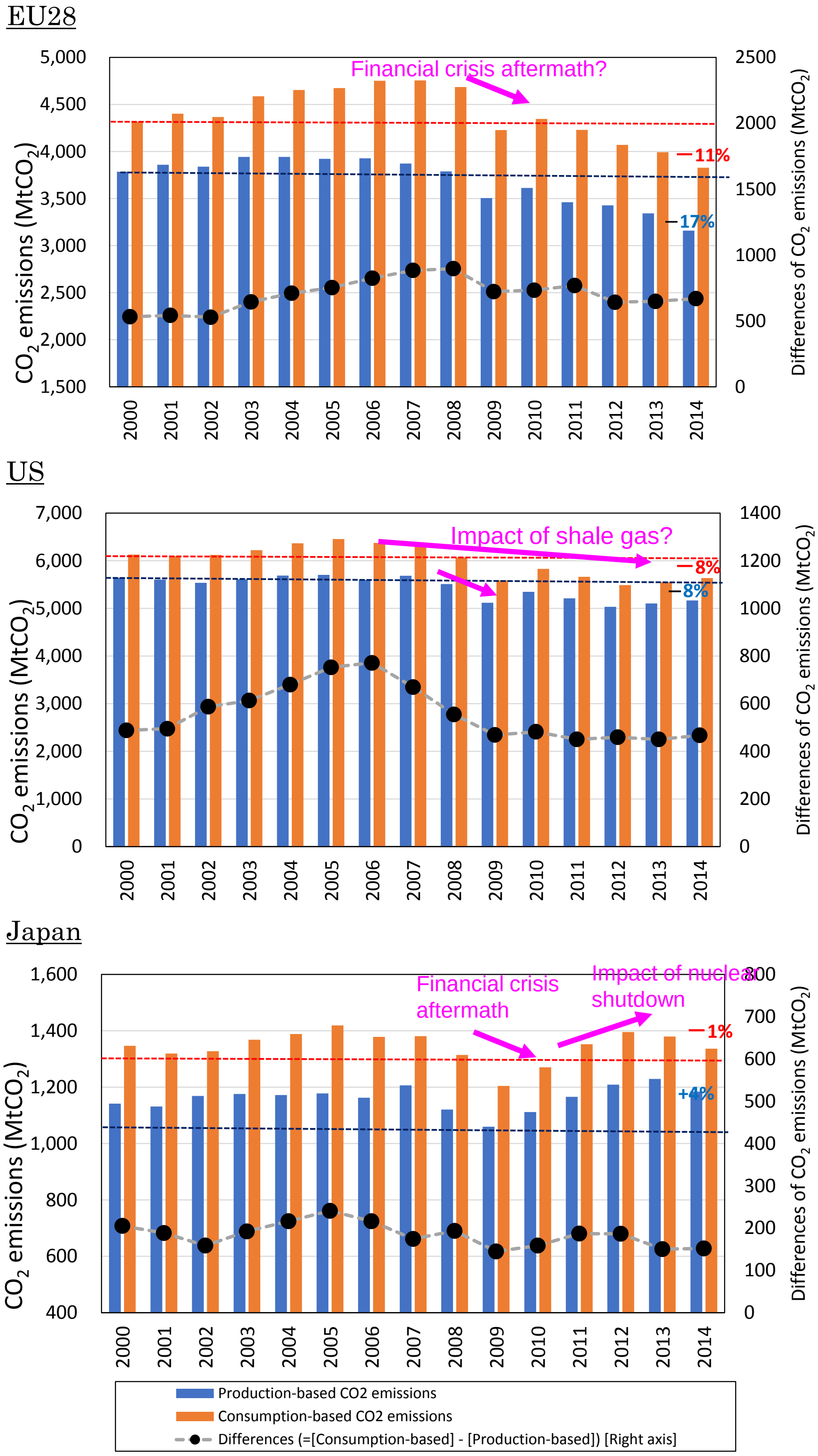

Figure 1. Transitional change of the production-based and consumption-based CO_2 emissions in Europe, the US, and Japan (2000-2014) (Source: RITE, 2018)

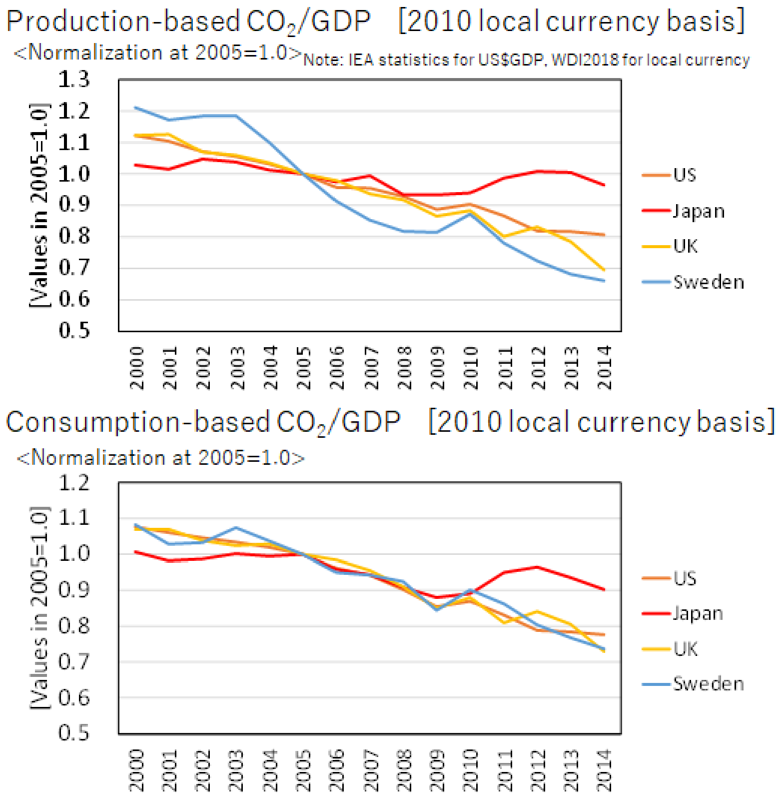

Figure 2. Transitional change of the production-based and consumption-based CO_2 emissions per GDP in the US, Japan, UK, and Sweden (Source: RITE, 2018)

National difference in the emission abatement cost for achieving the NDCs and gap from 2°C target

The RITE, in collaboration with the Resources for the Future (RFF) in the US and the FEEM in Italy, performed analyses and evaluations by adopting multiple metrics in order to evaluate the emission reduction efforts of the emission reduction targets documented in the NDCs (Aldy et al., 2017; Akimoto et al., 2017; Aldy et al., 2016; Akimoto et al., 2018).

For example, Figure 3 shows the GHG emissions per GDP (MER) and Figure 4 shows the CO_2 marginal abatement cost, both of which are the assessment results of the NDCs' emission reduction efforts (both conducted by the RITE). As shown in Figure 4, the CO_2 marginal abatement costs of achieving the NDCs of Switzerland, Japan, and EU28 were estimated at more than 200\$/tCO_2, while those of many developing countries were estimated at 0\$/tCO_2 or nearly equal to the same level. The marginal abatement costs of the NDCs are estimated to vary considerably by country. As for the global total abatement cost in this case, it is projected to be around 0.38% per GDP. Meanwhile, the global marginal abatement cost and the total abatement cost per GDP were estimated at 6$/t$CO_2$ and 0.06%, respectively, if the global emission reductions expected from each country's NDCs are achieved globally in the most cost-efficient manner (which leads to an emission reduction sharing where the marginal abatement costs of all countries are equalized). As shown in this result, the global total abatement cost of 0.38% when each country achieves the NDCs is estimated at around 6.5 times, which is considerably large, the cost of 0.06% achieved by the most cost-efficient emission reduction sharing.

Firstly, we need to recognize that much greater costs are inevitable than a cost-minimum case, because thorough equalization of the worldwide marginal abatement costs is difficult in reality. Meanwhile, if marginal abatement costs differ greatly, the international leakage of CO_2 is more likely to be induced, thereby preventing countermeasures from being carried out sustainably. Therefore, it is important to harmonize the emission reduction targets across nations as much as possible in the future.

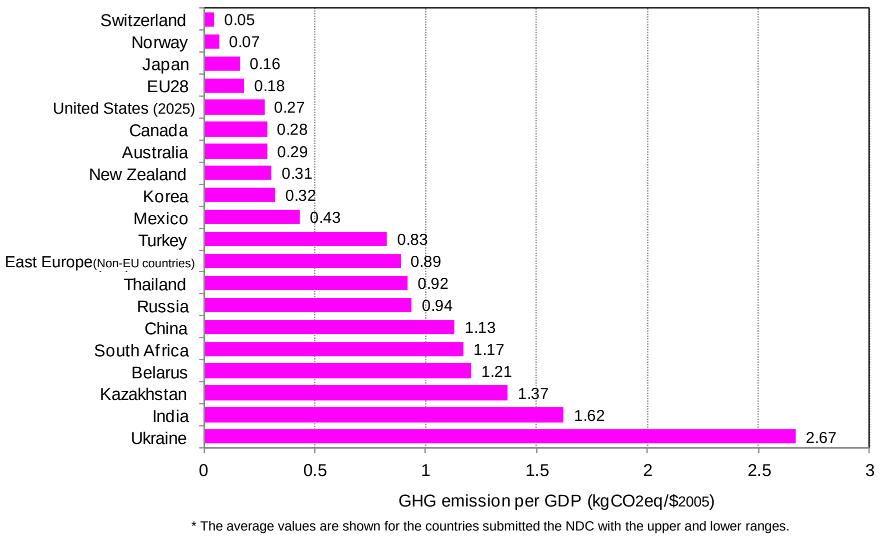

Figure 3. International comparison of GHG emissions per GDP (MER) in 2030 (Source: Akimoto et al., 2017)

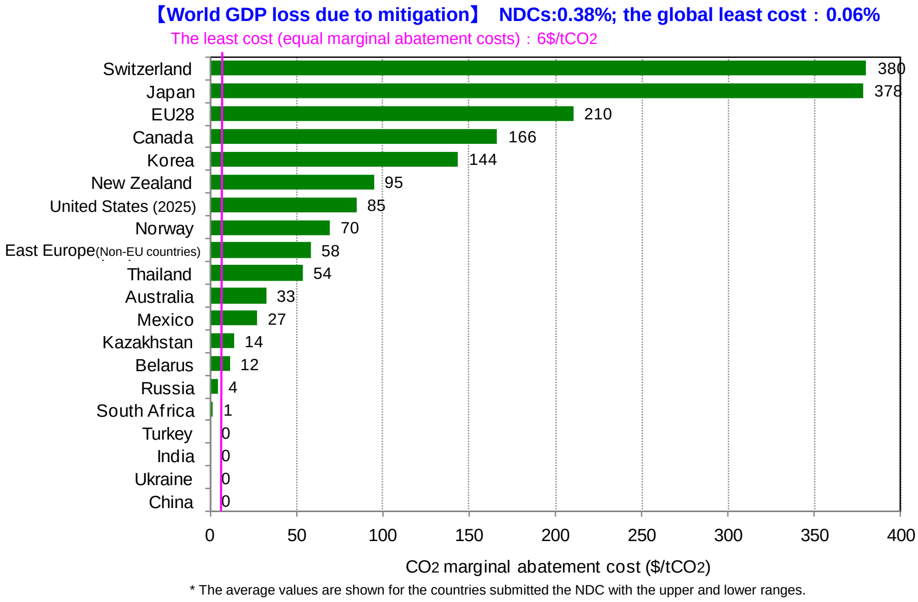

Figure 4. International comparison of CO_2 marginal abatement costs in 2030 (2000US$) (Source: modification of Akimoto et al., 2017)

We performed an estimation by means of the world's four models because the estimation of emission abatement costs using models is accompanied by large uncertainty (Figure 5). Overall, the trends are not much different to those in Figure 3, although each model has different assumptions with regards to the costs of each measure and the existence of constraints of nuclear power generation, and the breadth of concrete estimates becomes large. The marginal abatement costs of developed countries are consistent with those estimated by the IPCC to be necessary when achieving globally the 2°C target at a minimum cost, while those of developing countries are not (the difference is large). Therefore, in terms of the marginal abatement cost, there also exists a gap between the NDCs and the 2°C target at the global level. The marginal abatement costs are estimated at 7–28 US$(2015)/$tCO_2$ for achieving the global emission reductions expected from the NDCs with a minimum cost (world's marginal abatement costs are equalized). The difference from the marginal abatement costs for achieving the 2°C target is large. Figure 5 also shows the comparison between the social cost of carbon (SCC) and the NDCs. As for the SCC, there is a debate as to how large its uncertainty is, and whether it can adequately consider climate change damage costs. Aside from this debate, there is a gap between the SCC and the marginal abatement costs of the NDCs, however, the gap is not as large as the one from the 2°C target, which only requires a little more effort into emission reductions.

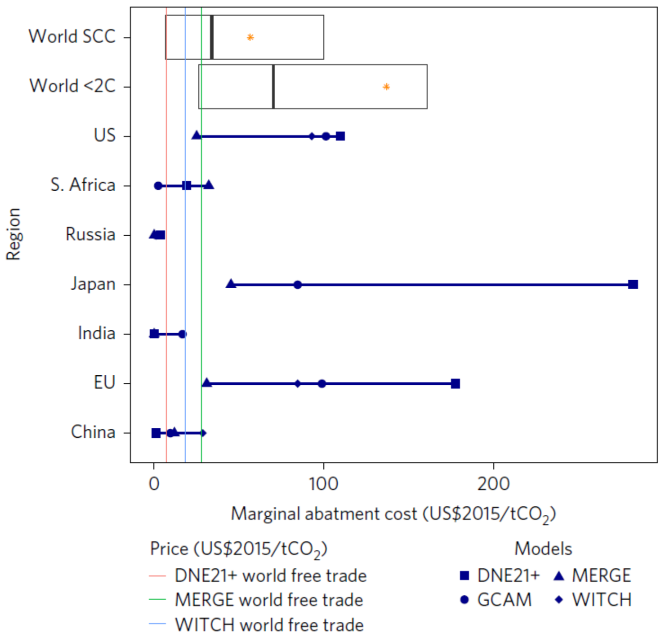

Figure 5. Average 2025–2030 marginal abatement costs for achieving the NDCs for the four models (Source: Aldy et al. 2016)

Current status in major-developed nations towards achievement of NDCs

Evaluations stated in the previous section are based on the condition that NDCs are to be achieved as pledged. However, the current status of major-developed nations show that achieving NDCs requires enormous challenges and is not easy (Victor et al., 2017). Figure 6 shows the emission reduction projections in BAU cases (and current policy cases) as well as emission reduction targets in NDCs of the US, EU, and Japan. Significant gaps between projections and NDCs are seen in all of these nations, indicating that achievement of their targets may not be easy.

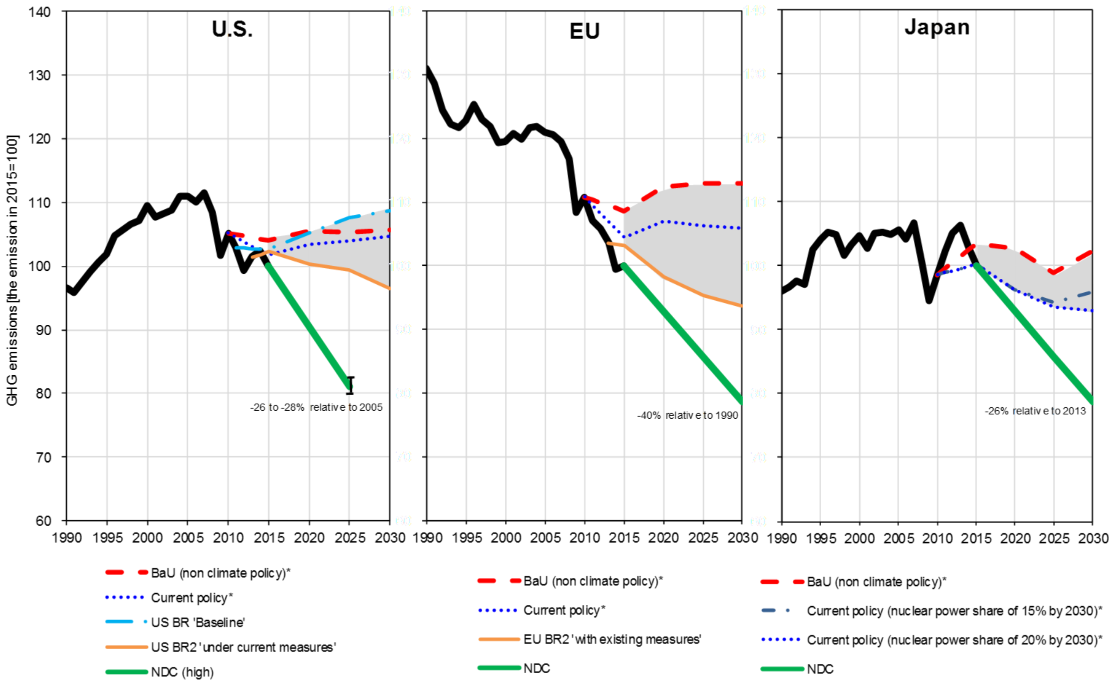

Figure 6. Emission reduction targets in NDCs of the US, EU, and Japan (and gaps between the targets and BAU emission projections) (Akimoto et al. 2018, modification of Victor et al. 2017)

As unleveled global CO_2 abatement costs are expected to increase mitigation costs considerably, domestic policies in each nation will not achieve minimization of the costs. Therefore, achieving NDCs may actually require more cost. Figure 7 indicates the estimated CO_2 marginal abatement cost of NDCs in the US, EU, and Japan, considering several domestic policies or social constraints. The results show that even the considering factors listed here may triple the marginal abatement costs compared to that of the assumed least-cost achievement of NDCs with domestic policies. In the light of actual policies or social constraints, emission reduction costs would be calculated to be much higher, thus indicating that NDCs is too difficult to achieve.

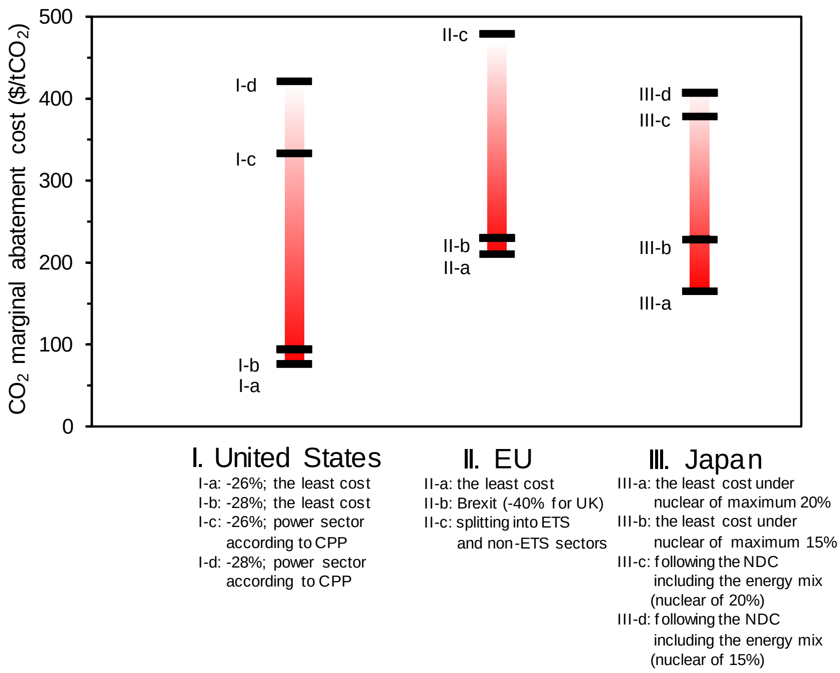

Figure 7. CO_2 marginal abatement costs in NDCs and differences by various constraints in the US, EU, and Japan (Akimoto et al., 2018)

2. Where do we want to go?

Achieving SDGs simultaneously

Achieving SDGs simultaneously is important. Many synergies are indicated to exist between climate change mitigation and SDGs. However, we need to recognize many tradeoffs coexisting between them. Climate change mitigation delivers a reduction in damage effect, sustainable economic growth in the long term, and a potential to yield many synergies with SDGs. Meanwhile, too much mitigation costs may rather deteriorate the economy in the long term, negatively effecting the eradication of poverty or famine. Although acknowledging that climate change issues are extremely crucial, achievement of SDGs is a superordinate concept, and we must consider climate change countermeasures to achieve targets of both climate change and SDGs in a balanced manner.

That is to say, in order to achieve SDGs simultaneously, significant emission reductions shall be realized with countermeasures with mitigation cost levels that all nations can address coordinately. In some cases, implications from integrated assessment models (IAM) analyses are interpreted as meaning that the price of carbon must increase to achieve temperature targets such as 2°C. However, these implications shall be interpreted as meaning that a 2°C target is difficult. Raising global carbon price levels to several hundred dollars/tCO_2 under global cooperation is just a description in the IAM world, and, in the real world under realistic international regimes, this is a fantasy. We should neither pursue a fantasy nor waste time. We must develop a society where CO_2 emissions decrease autonomously, even if the carbon price does not increase (Figure 8). For this purpose, innovations are extremely important.

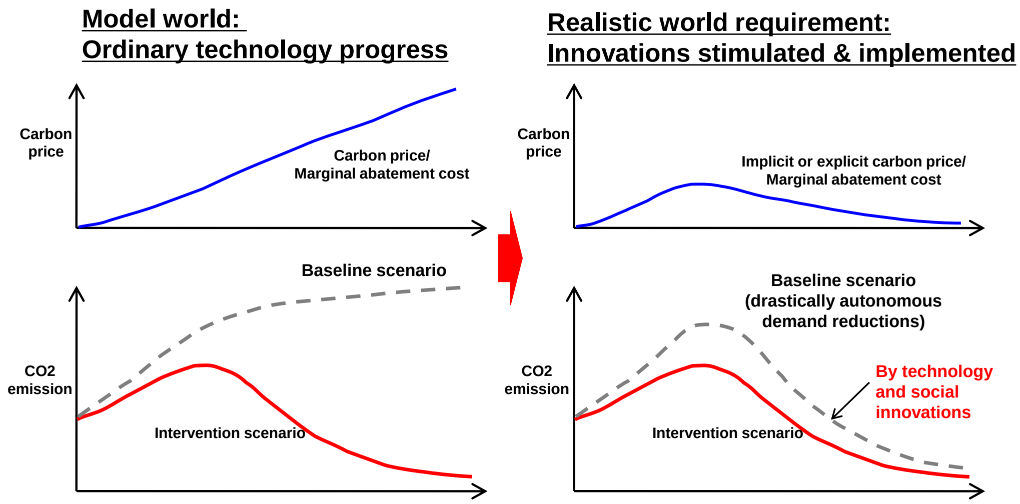

Figure 8. Graphs of large emission reductions such as the 2°C target in the real world

Net zero CO_2 emissions in the long term

There is almost a linear relationship between cumulative CO_2 emission and an increase in temperature. This indicates that temperature will continue to increase as long as CO_2 is emitted globally. Therefore, stabilizing the temperature at any level requires net zero emissions of global CO_2 at that point. Measures for net zero emissions of global CO_2 do exist from a technical point of view, however, measures with economically-available costs do not currently exist in the world. It is vital to recognize the importance of proceeding toward zero CO_2 emissions, or decarbonization.

3. How do we get there?

Total risk management required

As for how much the temperature would increase if CO_2 emissions were doubled, there exists a large range of uncertainty. The IPCC Fifth Assessment Report (AR5) estimates that equilibrium climate sensitivity (ECS) is likely in the range of 1.5°C to 4.5°C. Although it depends on the level of temperature stabilization, in the case of a 2°C target, the uncertainty will lead to large differences in global allowable emissions in 2050, which would result in large differences in mitigation costs (Kaya et al., 2016).

As for mitigation measures, it is important to focus on the development of technology, its actual deployment, and the development of backstop technology as the risk management by understanding the unit mitigation costs of each mitigation measure and the role of each technology. The large-scale deployment of expensive technologies would not lead to sustainable responses and the achievement of SDGs at the same time. It is important to consider flexible risk management strategies, which minimize the risks in total, by incorporating not only adaptation measures but also climate engineering methods such as CO_2 Direct Air Capture and Storage (DACS) and Solar Radiation Management (SRM). Technology development of the DACS which aims at reducing mitigation measures, and technology development of the SRM which clarifies the degree of its adverse effects and aims at reducing its adverse effects, would be required.

Development and deployment of environment-conscious products and services required

Addressing CO_2 emission mitigation at the whole supply chain and at a global level is of importance. Focusing on the emission reductions in a production process of a country would lead to the wrong interpretation. Achievement of emission reductions in a country does not necessarily result in global CO_2 emission reduction, as we can see the analysis of consumption-based CO_2 emissions. In order to reduce CO_2 emissions at the whole supply chain and at a global level, we need to focus not only on CO_2 emission reductions at the processing stage but also on CO_2 emission reductions by products and services. It is important to compete in the development and deployment of improved environmentally-conscious products on a commercial basis.

Inducing innovation widely

Inducing innovation widely is the most important. Technologies that will not directly lead to emission reductions have the potential to change society and to achieve large CO_2 emission reductions. For example, the sharing economy enabled by the advanced technologies, such as IT and AI, is autonomously induced in the economic evolution regardless of the emission reduction constraints, which has the potential to reduce CO_2 emissions. In addition, a large amount of food is wasted in the whole food supply chain, and if new technology innovation such as IT and AI can reduce food waste, it will become an opportunity of large GHG emission reductions at the whole supply chain. Furthermore, synergies with SDGs will also be expected. Instead of focusing too much on emission reductions in the near-term, we should explore strategies with patience towards larger emission reduction in the future. These strategies focus on advanced technologies such as AI and biotechnology which will not directly lead to emission reductions but are extensively applicable.

4. Conclusion

The Paris Agreement is a significant progressive step as it promotes the emission reductions of all countries. However, there exists a gap between the current responses/achievements and long-term targets, such as the 2°C target. We should not discuss idealism, but face realities. We should prioritize current mitigation measures which can be steadily implemented.

There are large uncertainties in the degree of temperature increase, climate damage, and mitigation costs. Although a comprehensive risk management assuming the uncertainties is important, social benefits would be large by reducing these uncertainties. The global society should focus on the further advancement of research on reducing various uncertainties related to climate change.

Although the global society should strongly recognize concerns about damage driven by climate change, strategies with patience towards a large emission reduction in the future are of importance, which focuses advanced technologies such as AI and biotechnology that will not directly lead to emission reductions but are extensively applicable. The development of a wide range of technology, which is not considered a direct mitigation measure at first glance, has the potential to achieve significant emission reductions in the end. While aiming at a low-carbon and decarbonized society, responses to climate change with a comprehensive risk management having a certain degree of flexibility concerning a long-term target is required. This will largely contribute to the simultaneous achievement of reducing emissions and of harmonization with global SDGs.

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About RITE

The Research Institute of Innovative Technology for the Earth (RITE) was established in 1990 as a center of excellence to work internationally toward developing innovative environmental technologies based on the Earth Regeneration Plan "the New Earth 21" compiled by the Government of Japan. RITE is located in Kyoto prefecture, and has been carrying out R&D activities particularly for the mitigation of global warming, including R&D on carbon dioxide capture and storage, biorefinery technologies and the integrated analysis on the strategy for mitigating global warming.
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