

Research Perspectives on Future Scenarios toward Achievement of the 2 Degree Target

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Abstract

The Paris Agreement entered into force in 2016, with the world rushing to realize the 2°C target for holding the increase in the global average temperature to well below 2°C above pre-industrial levels. On the other hand, there is a big gap between the aggregate of existing mitigation targets of each country after 2020 and emission pathways that would achieve the 2°C target, and this means that more ambitious GHG reductions will be needed toward 2050 and later. Some countries have already submitted their long-term low greenhouse gas emission development strategies. Although Japan proposes a 26% reduction of its GHG emissions by 2030 compared to those in 2013 and an 80% reduction by 2050, it has yet to engage in thorough discussions of its long-term strategy and roadmap. The existing analyses indicate an 80% GHG emission reduction is technologically feasible, but there are many challenges to realizing it. This paper introduces discussions in Japan toward achieving the 2°C target, and considers what will be needed in Japan to realize the 2°C target.

Key words: long-term low GHG emission development strategy, mitigation target, Paris Agreement, 2°C target

1. Introduction: Paris Agreement and Greenhouse Gas Emission Reduction Target

The Paris Agreement was adopted at the 21st Conference of Party (COP21) of United Nations Framework Convention on Climate Change (UNFCCC) in Paris in 2015 (UN, 2015). In November 2016, the Paris Agreement entered into force after the threshold for that of the Paris Agreement was achieved, which was for at least 55 Parties to the Convention, accounting in total for at least an estimated 55% of the total global greenhouse gas (GHG) emissions, to have deposited their instruments of ratification, acceptance, approval or accession with the depositary.

It is said that climate policies and actions have moved to a new phase by the Paris Agreement. Now the United States has announced its withdrawal from the Paris Agreement, but many states and private companies in the USA have indicated their intention to remain in the Paris Agreement. Recently in many areas, climate change impacts have become obvious. The movement to realize the Paris Agreement will not be stopped but will accelerate in the future.

Article 2 of the Paris Agreement describes the global average temperature target as follows: “Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-

industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.”

Article 4 of the Paris Agreement mentions the global emission pathways as follows: “In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty.” Moreover, that “All Parties should strive to formulate and communicate long-term low greenhouse gas emission development strategies, mindful of Article 2, taking into account their common but differentiated responsibilities and respective capabilities, in the light of different national circumstances” is also mentioned (COP, by decision 1/CP 21, paragraph 35, invited the Parties to communicate by 2020 to the secretariat, mid-century, long-term low greenhouse gas emission development strategies in accordance with Article 4, paragraph 19, of the agreement). That is to say, in order to achieve climate targets such as the 2°C target, global GHG emissions will need to peak-out as soon as possible, and show a negative trend during the latter half of the 21st century.

2. The 2 Degree Target and INDCs

Prior to COP21, all countries had to submit their own intended nationally determined contributions (INDCs) to the UNFCCC. All the submitted documents are listed on the UNFCCC's website (<http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx>). The INDCs cover not only the targets for GHG mitigation reductions but also the targets for adaptation in each country. Some developing countries focus on climate change impacts and adaptation rather than GHG reduction targets.

Table 1 shows the mitigation targets of major

countries and regions of the world. From Table 1, it can be seen that the GHG mitigation targets reflect the situation of each country. Most of the developed countries have adopted absolute targets for GHG emissions. On the other hand, many developing countries have adopted intensity targets or relative reduction of their emissions in a BaU (business as usual) case. Moreover, some developing countries such as Indonesia and Thailand have adopted two types of targets: one unconditional target and a separate conditional target contingent on other countries' support.

The UNFCCC (2016) has summarized the all

Table 1 Emission reduction targets of major countries and regions.

Country	Target
China	To reduce carbon intensity by 60% to 65% by 2030 below 2005 levels.
India	To lower emission intensity of GDP by 33% to 35% by 2030 below 2005 levels.
Indonesia	An unconditional 2030 GHG emission reduction target of 29% below BaU including land use, land-use change and forestry (LULUCF) emissions, and a conditional 41% reduction below BaU by 2030 (with sufficient international support).
Japan	To reduce emissions by 26% below 2013 emission levels by 2030.
Korea	To reduce GHG emissions by 37% below BaU by 2030.
Malaysia	To reduce GHG emission intensity of GDP by 45% by 2030 relative to the emissions intensity of GDP in 2005.
Thailand	An unconditional 20% reduction in emissions by 2030 compared to BaU levels. This could increase to 25%, conditional upon international support.
Vietnam	An 8% reduction in emissions by 2030, compared to BaU. This could be increased to 25% conditional upon international support.
USA	To reduce economy-wide emissions by 26% to 28% below 2005 domestically.
EU	To reduce GHG emissions by at least 40% domestically below 1990 levels by 2030.
Russia	Limiting anthropogenic GHG to 70–75% of 1990 levels by 2030.
Brazil	To reduce GHG emissions by 37% below 2005 levels by 2025.

Source: UNFCCC (2015)

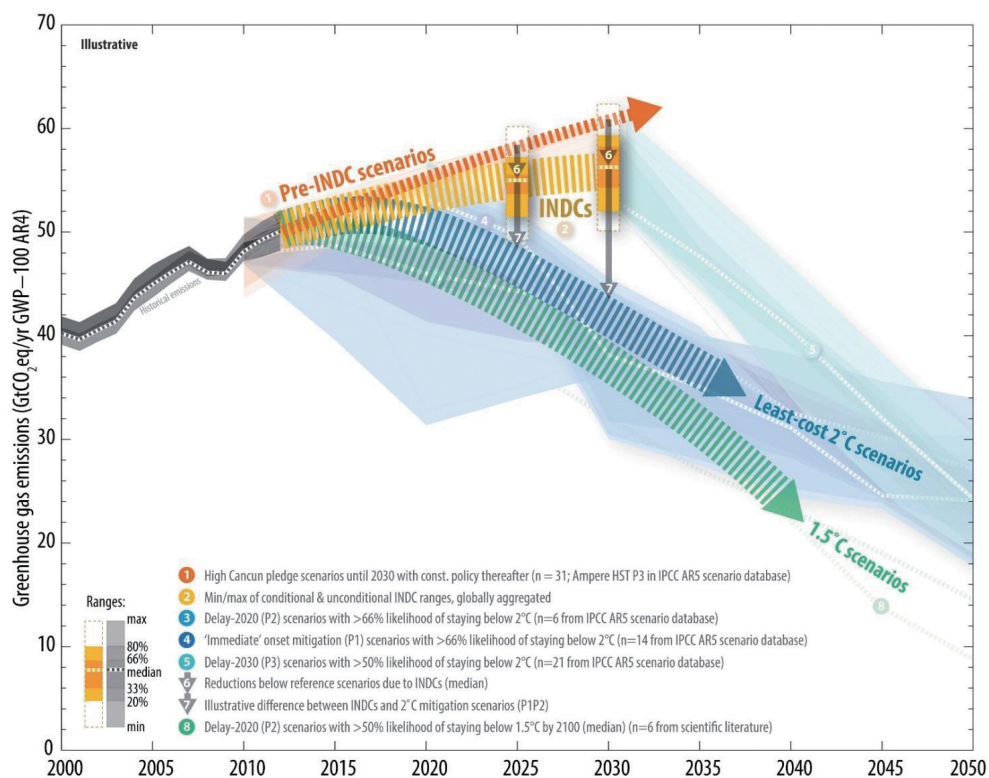


Fig. 1 Comparison of global emission levels in 2025 and 2030 resulting from the implementation of the INDCs and under other scenarios. Source: UNFCCC (2016)

proposed GHG reduction targets. Figure 1 shows the various global GHG emission pathways, including emissions upon achieving the INDCs. This figure shows that the INDCs can reduce GHG emissions compared to no GHG reductions in the world by 2025 and 2030, but very large gaps remain in GHG emissions between the INDCs and the 1.5°C / 2°C scenarios. In order to achieve the 2°C target after following the INDCs, very steep GHG emission reductions will be needed after 2030. That is to say, more ambitious targets in 2030 will be needed to achieve the 2°C target according to this figure. The Paris Agreement mentions the “global stocktake” which assesses collective progress towards achieving the purpose of the Paris Agreement and its long-term goals. For each country, “Each Party’s successive nationally determined contribution will represent a progression beyond the Party’s then current nationally determined contribution and reflect its highest possible ambition, reflecting its common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.”

3. Long-term Low Greenhouse Gas Emission Development Strategies

The Paris Agreement requests each Party to submit a

“long-term low greenhouse gas emission development strategy” by 2020. As of the end of June 2017, a total of six countries had submitted their own strategies: the USA, Mexico, Canada, Germany, France and Benin. Among these countries, the USA, Mexico, Canada, Germany and France have indicated long-term GHG emission reduction targets, as shown in Table 2. Although the benchmark years are different, many countries have indicated GHG reductions of more than 75% by 2050. In particular, Germany mentions a 95% reduction by 2050 compared to its emissions in 1990.

4. Discussion on Japan’s Long-term Strategy

The Government of Japan (2015) approved Japan’s INDC at a Cabinet meeting on July 17, 2015. The GHG reduction target for 2030 was set at a 26% reduction compared to the 2013 level. After that, Japan also approved a Climate Action Plan at a Cabinet meeting on May 13, 2016. The Climate Action Plan stipulates an 80% reduction of GHG emissions in Japan by 2050. Figure 2 shows previous trends and future targets for GHG emissions in Japan. Although Japan achieved its GHG mitigation target during the 1st commitment period (2008 – 2012) by using carbon sinks and credits, no sharp GHG reduction could be observed from 1990 to 2015. In order

Table 2 GHG emission reduction targets under long-term low GHG emission development strategies.

Country	Date submitted	GHG reduction target
USA	Nov. 16, 2016	80% reduction of GHG in 2050 compared to 2005 level
Mexico	Nov. 16, 2016	50% reduction of GHG in 2050 compared to 2000 level
Canada	Nov. 17, 2016	80% reduction of GHG in 2050 compared to 2005 level
Germany	Nov. 17, 2016	80 – 95% reduction of GHG in 2050 compared to 1990 level
France	Dec. 28, 2016	75% reduction of GHG in 2050 compared to 1990 level

Source: UNFCCC (2017)

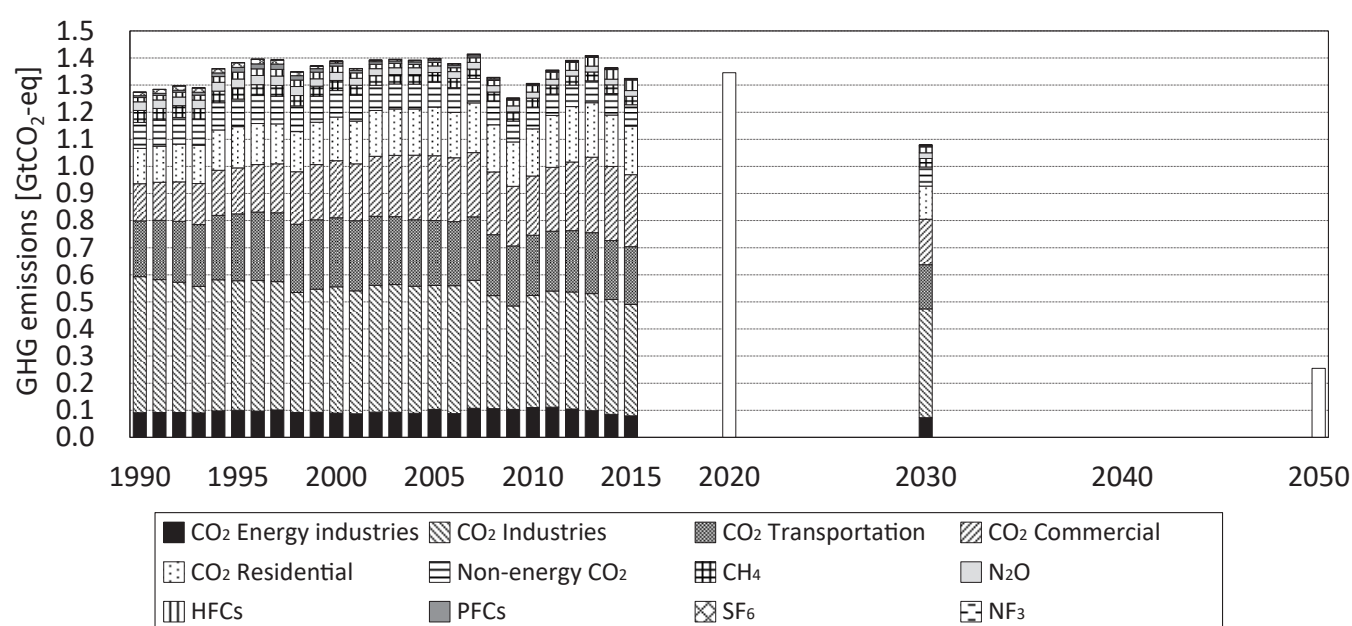


Fig. 2 GHG emission trends through 2015 and future emission targets in Japan.

Source: Greenhouse Gas Inventory Office of Japan (2017) and Government of Japan (2015)

to achieve the GHG emission targets for 2030 and 2050, a real break in this trend will be needed from now on.

Although the Climate Action Plan mentions an 80% reduction of GHG emissions in Japan by 2050, a detailed concrete roadmap to achieve the 80% reduction target has yet to be quantified. To discuss the long-term target for Japan, the Sub-committee on Long-term Low-Carbon Vision was organized under the Central Environment Council in July 2016. In March 2017, the sub-committee presented its long-term low-carbon vision (2017). In this vision, “simultaneous solution” of economic and social problems such as aging of society and climate change is regarded as a background issue. The long-term GHG reduction target for 2050 is clearly set at 80%, and in order to achieve this target, the vision stresses improved energy efficiency, increased low-carbon energy supply, and a switch to low-carbon energies in end-use. In addition to that, the “carbon budget” concept is introduced, in which the global mean temperature change is related to cumulative GHG emissions from the pre-industrial level, and it gives the clear message that the time to act is “Now.” If infrastructure and large-scale facilities including coal thermal power plants, which have long life times, are introduced now, the CO₂ emissions may remain high over time. Such “lock-in” effects will have to be avoided to keep the GHG mitigation opportunity as high as possible. The vision points out that development and deployment of new innovations are key to long-term significant GHG emission reductions. Not only innovation in technology, but also innovations in economic and social systems and lifestyles will be needed to realize drastic GHG emission reductions. The transformation will contribute to emission reductions both in Japan and worldwide. To support the various actions toward a low-carbon society, the role of “carbon pricing” will be very important. Carbon pricing will provide the necessary information and a good incentive to reduce the GHG emissions.

5. Is an 80% Reduction of GHG emissions in Japan by 2050 Achievable?

There have been several studies assessing 80% reduction of GHG emissions in Japan by 2050. The first of these was the Japan Low Carbon Society (LCS) Scenarios toward 2050 Project (2050 Japan Low-Carbon Society Scenario Team, 2008). This was a research project of the Global Environmental Research Fund (S-3) of the Ministry of the Environment, Japan. In this project, two types of socio-economic scenarios were proposed, and by using the Asia-Pacific Integrated Model (AIM), it found quantitatively that a target of 70% reduction of CO₂ emissions by 2050 compared to the 1990 level in both scenarios would be achievable. Later the GHG mitigation target for 2050 was changed from 70% to 80%, and the new target was also found to be realizable.

The Deep Decarbonization Pathways Project (DDPP) is another example of a quantitative analysis. The Sustainable Development Solutions Network (SDSN)

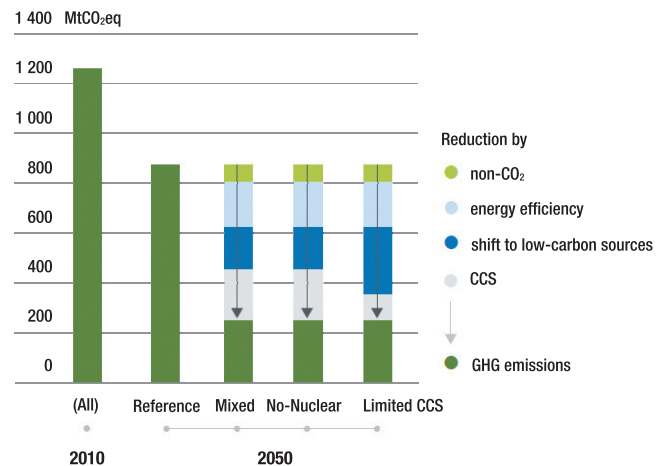


Fig. 3 CO₂ emissions by case and decarbonization wedges for the three scenarios.

and the Institute for Sustainable Development and International Relations (IDDRI) initiated it to demonstrate how countries could transform their energy systems by 2050 to achieve a low-carbon economy and significantly reduce the global risk of catastrophic climate change. The project currently comprises 16 country research teams, composed of leading research institutions from countries representing about 70% of global GHG emissions and at very different stages of development.

From Japan, the AIM project team is participating in this project, and by using the AIM/Enduse [Japan] (a dynamic recursive technology selection model for mid-to long-term mitigation policy assessment in Japan), it assesses GHG emission pathways in Japan through 2050 (Kainuma *et al.*, 2015). It has prepared three scenarios to assess 80% GHG emission reduction in Japan by 2050: a mixed scenario in which all technology options are available; no nuclear scenario; and limited carbon capture and storage (CCS) scenario, in which 100 MtCO₂/year of CCS is allowed, i.e., half the amount considered in the mixed scenario.

Figure 3 shows the CO₂ emission reductions for these three scenarios in 2050. The DDPP shows the three pillars of decarbonization as a whole: energy efficiency, decarbonization of electricity and electrification of end-uses. In the case of Japan, these pillars are also important, and the report concludes that “With large-scale diffusion of low-carbon technologies, Japan’s long-term GHG emission reduction target is technically feasible, even if the availability of nuclear power and/or CCS is limited.” Although the marginal costs of CO₂ reduction in the no-nuclear and limited CCS scenarios are more expensive than that in mixed scenario, these three scenarios can achieve the 80% reduction of GHG emission by 2050.

6. How can Japan Contribute to the 2°C Target?

From the existing quantitative analyses, the 80% GHG emission reduction in Japan by 2050 is a

technologically feasible target, but to realize this target, we face many challenges. From Fig. 2, no sharp GHG emission reduction can be observed in Japan from 1990 to 2015. This means that the general level of engagement with climate change mitigation is still slow.

To ensure the 2°C target is reached, an 80% reduction in Japan by 2050 is inevitable. From the existing studies, the 80% reduction target can be achieved using the existing and forecasted technologies. Various innovations of technologies and socio-economic systems can help implement the mitigation actions.

It is important to show how to support implementation of the mitigation technologies in the actual world. For example, if the payback period can be considered long, that is to say, decision making with a long-term viewpoint can be realized, the mitigation costs decrease, and more mitigation technologies including energy saving technologies and renewable energies will be able to be introduced.

Climate change measures to achieve the 2°C target will have to continue more than 100 years, and strengthen year by year. On the other hand, the year 2050 is not the distant future. The target of 80% reduction will have to be realized before high school students at this moment reach 60 years of age. A long-term perspective during the decision making process can help avoid lock-in effects. The research also will have to contribute to implementation of GHG mitigation technologies in the real world to provide a concrete roadmap. For that purpose, in addition to mitigation technologies, socio-economic activities in the future will have to be discussed, and more detailed analyses taking into account the local circumstances and stakeholders' conditions will be needed in addition to macroscopic analyses.

References

- 2050 Japan Low-Carbon Society Scenario Team (2008) *Japan Scenarios and Actions towards Low-Carbon Societies (LCSs)*. <http://2050.nies.go.jp/report/file/lcs_japan/2050_LCS_Scenarios_Actions_English_080715.pdf> (accessed on 1 October 2017)
- Central Environment Council (2017) *Outline of Long-term Low-carbon Vision*. <<http://www.env.go.jp/press/103822/713.pdf>> (accessed on 1 October 2017)
- Government of Japan (2015) *Submission of Japan's Intended Nationally Determined Contribution (INDC)*. <http://www4.unfccc.int/Submissions/INDC/Published%20Documents/Japan/1/20150717_Japan's%20INDC.pdf> (accessed on 1 October 2017)
- Greenhouse Gas Inventory Office of Japan (2017) <<http://www-gio.nies.go.jp/index.html>> (accessed on 1 October 2017)
- Kainuma, M. *et al.* (2015) *Pathways to Deep Decarbonization in Japan, SDSN-IDDRI*. <http://deepdecarbonization.org/wp-content/uploads/2015/09/DDPP_JPN.pdf> (accessed on 1 October 2017)
- UN (United Nations) (2015) Paris Agreement. <http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf> (accessed on 1 October 2017)
- UNFCCC (United Nations Framework Convention on Climate Change) (2015) INDCs as communicated by Parties. <<http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx>> (accessed on 1 October 2017)
- UNFCCC (United Nations Framework Convention on Climate Change) (2016) *Aggregate Effect of the Intended Nationally Determined Contributions: An Update*. <<http://unfccc.int/resource/docs/2016/cop22/eng/02.pdf>> (accessed on 1 October 2017)
- UNFCCC (United Nations Framework Convention on Climate Change) (2017) Communication of long-term strategies. <http://unfccc.int/focus/long-term_strategies/items/9971.php> (accessed on 1 October 2017)



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