Japan's Greenhouse Gas Emission Reductions in Light of Global Stocktake

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Purpose of this paper

The Paris Agreement, adopted in 2015, incorporates a mechanism to assess global progress in countermeasures against climate change every five years and encourage countries to increase ambition of national greenhouse gas (GHG) emission reduction targets. That is intended as a key to achieve the goal of the agreement which is to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C.

The Global Stocktake conducted at the 28th Conference of the Parties (COP28) of the United Nations Framework Convention on Climate Change (UNFCCC) in 2023 was the first assessment of the global progress. In its outcome document[1], it was recognised that four-fifth of the carbon budget for the 1.5°C target, which represents the upper limit of cumulative CO2 emissions that may be emitted to achieve the temperature target, has been already consumed, that the global GHG emission pathway is not consistent with the Paris Agreement temperature target, and that the opportunities to increase ambition and implement existing commitments to achieve the Paris Agreement are rapidly narrowing. It then states that significant, rapid and sustained reductions in GHGs are needed and asks contributions to a global effort to achieve this (e.g., tripling global renewable energy capacity and doubling the rate of energy efficiency improvements by 2030, accelerating the phase-down of unabated coal-fired power plants, transition away from fossil fuels during this decisive decade). It also encourages all parties to ensure that their next national reduction targets (Nationally Determined Contributions: NDCs) are aligned with the 1.5°C target. Following this outcome of the first Global Stocktake, in the G7 Puglia Summit Leaders' Communiqué of 17 June 2024[2], G7 countries, including Japan, expressed their "commitment to submitting ambitious 1.5°C aligned NDCs ".

How, then, should Japan set its future emission reduction targets to be aligned with the 1.5°C target? This paper first reviews Japan's emission reduction performance to date and assesses progress towards the 2030 target, which is currently set by the Japanese Government as its NDC. It then examines the goal Japan should set towards the 1.5°C target in the light of international discussions.

Japan's GHG emission reduction performance and current reduction targets

We refer to the GHG emissions data from the 'Japan Greenhouse Gas Inventory Document' (NID)[3], published by the Greenhouse Gas Inventory Office of the National Institute for Environmental Studies (NIES).

In Figure 1, the black dots connected by black lines show net GHG emissions including land use, land use change and forestry (LULUCF). In Japan's NDCs, only emissions are calculated for the base year, not including removals, and a gross-net method (i.e. a method that includes absorption for the commitment year/period) is used for forest absorption. In Figure 1, except

[1] https://unfccc.int/event/cma-5#decisions_reports
[2] https://www.g7italy.it/wp-content/uploads/Apulia-G7-Leaders-Communique.pdf
[3] https://www.nies.go.jp/gio/en/aboutghg/index.html

for the base year emissions in 2013 (1,408 MtCO2e, shown as a red dot), all emissions include absorption by forests and other sink measures.

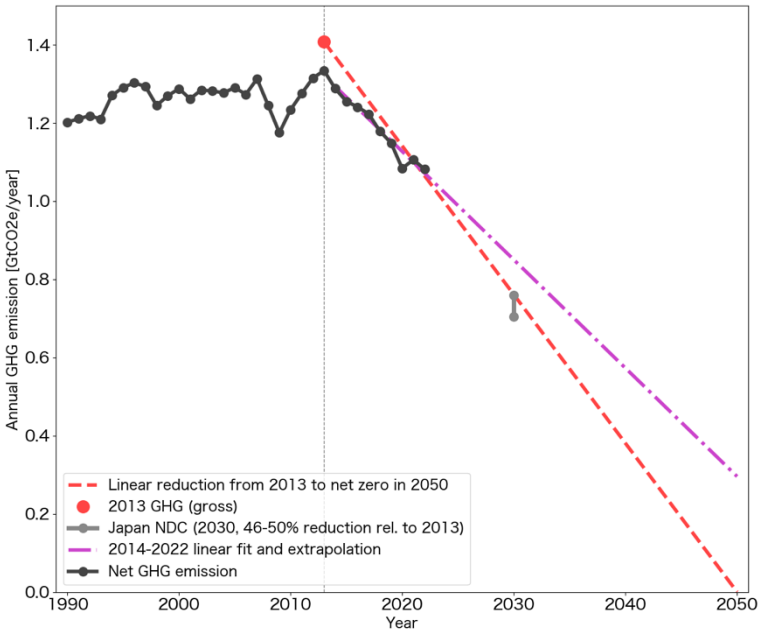

Figure 1. Past GHG emission data and emission reduction targets for Japan. See text for explanation of dots and lines.

Japan's NDC[4] at the time of writing, which was set in 2021, defines the target for 2030 as "to reduce GHG emissions by 46% in 2030 from 2013 levels. (snip) Furthermore, Japan will continue strenuous efforts in its challenge to meet the lofty goal of cutting its emission by 50%." A 46% reduction means a net GHG emission of 760 MtCO2e, including the amount absorbed by forests and other sink measures[5], compared to a gross GHG emission of 1,408 MtCO2e in 2013 (the base year). A red dashed straight line drawn from 1,408 MtCO2e in 2013 to zero in 2050 approximately passes through 760 MtCO2e in 2030.

Assessment of Japan's progress in reducing GHG emissions

One thing we should note when we compare Japan's actual emissions with its target is that Japan's NDC is based on gross GHG emissions in 2013, which do not include absorption by forests and other sources, while the 2030 target is set for net emissions, which take removals into account.[6] This procedure makes it difficult to see whether the pace of emission reductions after 2013 is on track to achieve the target to some extent (see Reference 2). In Figure 1, we show a straight line which represents a least-squares linear fit to the net GHG emissions for the period 2014-2022[7] as a magenta single-dotted line. In Figure 2, the 2010–2030 part of Figure 1 is shown enlarged. Extending this straight line gives emissions of 850 MtCO2e in 2030 and 296 MtCO2e in 2050[8]. In other words, to achieve the 2030 target and

[4] https://www.env.go.jp/earth/earth/ondanka/ndc.html

[5] In the NDC, activities related to 'forest management', 'new plantations and reforestation' and 'deforestation' from 2014 onwards are included in the calculation of absorption, which differs from the absorption in the NID, which covers all forest-related absorptions, by 1 to 7 Mt (varying from year to year). This difference is smaller than the thickness of the net emissions line in Figure 1 and is therefore not shown.

[6] Japan's way of calculating GHGs and setting a target follow international rules, and there is no problem with its procedure in itself.

[7] Net emissions in NDCs rather than NIDs were used for this approximation.

[8] The least-squares linear fit here includes the year 2020, when global emissions have dropped significantly due to COVID-19; if 2020 is removed from the fitting, the pace of reductions will be slower and the deviation from the target linear line (red dashed line) will be greater.

net zero emissions in 2050 it is necessary to further strengthen emission reduction measures, rather than extending the past pace of emission reductions after 2014. Specifically, the reduction pace for the period 2014–2022 (magenta single dotted line) is -1.97%/year, while the straight line from base emissions in 2013 to zero in 2050 (red dashed line) is -2.63%/year; Japan needs to enhance the pace by approximately -0.6%/year.

Reference 1 provides emission reduction progress since 1990 and targets for the UK, Germany, France and the USA. Similar to Japan, all countries except the UK will not achieve their targets if they extend their pace of emission reductions in recent years, and they need to strengthen their emission reduction measures.

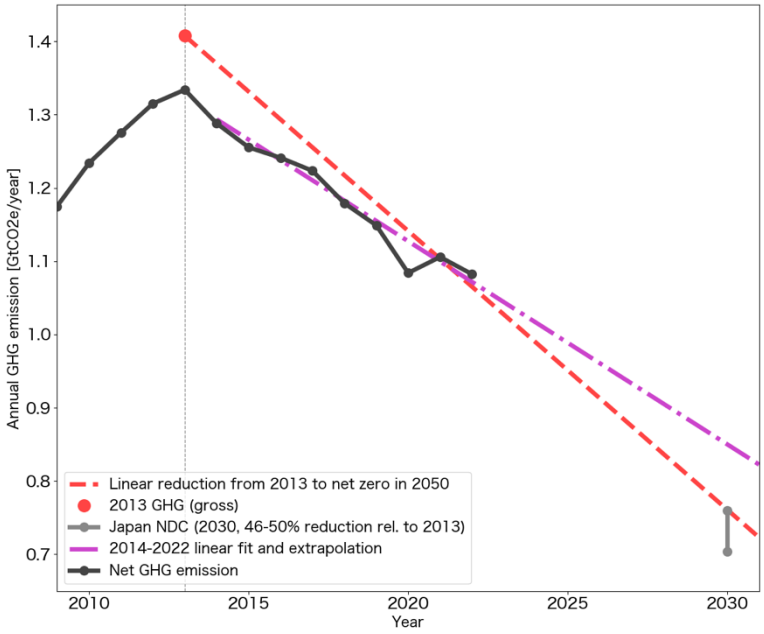

Figure 2. the 2010–2030 part of Figure 1 is enlarged.

Alignment of Japan's current 2030 target with the global 1.5°C emission reduction pathway

In the IPCC AR6 synthesis report[9], emission reductions required to limit warming to 1.5°C with no or limited overshoot from 2019 emission levels are presented, based on a database of scenarios using integrated assessment models which have been submitted by various research institutes around the world. Median GHG emission reductions in 2030 are 43% relative to 2019 levels, with 34–60% at the 5-95th percentile.[10] In Figure 3, the global emission reduction pathway presented by the IPCC synthesis report, simply scaled with Japan's 2019 emissions, is shown as a solid green line for the median and shaded green for the 5-95th percentile. With this pathway, the median GHG emission in 2030 are 667 MtCO2e and the 5-95th percentile range is 456-767 MtCO2e. The 2030 target of Japan in its NDC of 760 MtCO2e is located close to the upper end of this 5-95th percentile. The median value (667 MtCO2e) of the IPCC global 1.5°C pathway means a 53% reduction compared to 2013. This indicates that Japan's current 2030 target is somewhat short of the global 1.5°C-aligned emission reduction rate reported by the IPCC. A pathway aligned with the 1.5°C target would require emissions to be lowered at a faster pace than a linear emission reduction towards 2050 (i.e.,

[9] https://www.ipcc.ch/ar6-syr/
[10] AR6 Synthesis Report SPM Table SPM.1

the curve needs to be concave downwards).

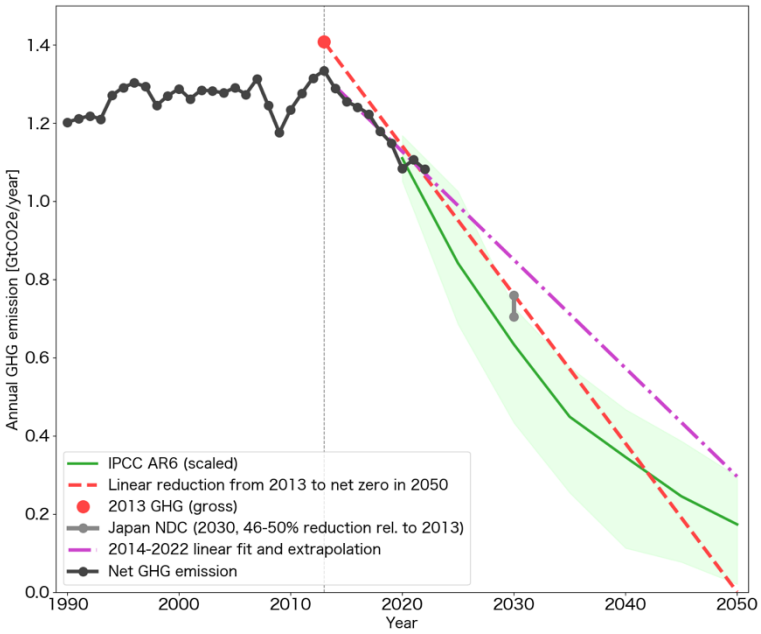

Figure 3. Same as Figure 1, but with the global 1.5°C emission pathway in the IPCC AR6 synthesis report, scaled based on 2019 emissions.

Figure 5 in Reference 1 summarises the emission reduction targets of the UK, Germany, France and the USA stated in their NDCs, along with emission reduction progress since 1990. The figure shows that the 2030 targets of these countries are roughly in line with the median IPCC global reduction percentage.

Could developed countries claim that their reduction targets be aligned with the 1.5°C target if they are equivalent to a reduction rate corresponding to the global 1.5°C pathway? We will examine this point in the light of past international discussions.

Japan's emission reduction targets in the light of previous international discussions

To examine the alignment of Japan's emission reduction target with the 1.5°C target, we should consider the past international discussions which are the premise for the global stocktake at COP28.

- In developing and emerging countries, energy consumption is expected to increase in future as their economy grows. In order to achieve rapid and deep global emission reductions aligned with the 1.5°C target, countries with mature industrial structure such as Japan have to reduce emissions at a relatively faster pace than the rest of the world.[11]
- Scenario analyses using the Integrated Assessment Models used in IPCC reports often assume uniform global carbon pricing and seek emission reduction pathways through cost minimisation. This tends to result in larger emission reductions in developing and emerging countries where emission reduction costs are relatively low.

[11] Article 4 of the Paris Agreement (https://unfccc.int/process-and-meetings/the-paris-agreement) states that it 'recognises that peaking will take longer for developing country Parties'.

Even in such scenario analyses most results show that, in order to limit global temperature increase within a certain amount, developed countries need to follow pathways with earlier emission reductions than the rest of the world.[12]

- There have been discussions from the perspective of equity about the emission reductions of countries and support for developing countries. The principle of equity is enshrined in the 1992 United Nations Framework Convention on Climate Change (UNFCCC),[13] and the Paris Agreement[14] calls for developed countries to continue to take the lead in emission reductions and financial support, while requiring all countries to respond. The outcome of the fifth Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA 5) at COP28 in 2023 also reaffirms the principle of equity and developed country initiative[15]. These statements reflect past discussions that countries such as Japan, which have achieved economic development with significant GHG emissions in the past, should reduce their own emissions quickly as well as should contribute to global emission reductions. The International Energy Agency's (IEA) 2050 Net Zero scenario [16] assumes that developed countries will achieve net zero CO2 emissions by around 2045, China by around 2050 and other emerging and developing countries after 2050, and the scenario is in line with the equity approach. Similarly, the UNEP Emissions Gap Report[17] also states that realising the 1.5°C target will require unprecedented action by all countries, and 'for high-income countries, this implies further accelerating domestic emissions reductions, committing to reaching net zero as soon as possible – and sooner than the global averages from the latest IPCC report implies'.

One reason which makes discussions on the consistency of individual countries' reduction targets with the 1.5°C target unclear is that there is no international agreement on how to allocate the total cumulative global CO2 emissions (carbon budget) to limit the warming to 1.5°C (or the cumulative GHG emissions obtained by integrating emissions pathway) to individual countries. Here we look at the Climate Action Tracker (CAT) calculations[18] as an example of attempts to allocate cumulative GHG emissions to individual countries.

In calculating country-specific emission pathways, CAT assembles the data of 1.5°C-aligned scenario pathways[19] from the IPCC 1.5°C Special Report database, and use the country's pathway if the scenario provides an individual pathway for the country, and if it is not available, calculate the pathways of individual countries within a region ('OECD countries' in the case of Japan) so that the emission intensities (emissions / GDP) of all countries in the

[12] The IPCC reports aggregate the results of scenario analyses using multi-agency integrated assessment models from institutes around the world to examine pathways to limit global temperature increase and atmospheric GHG concentrations to a certain level (see Chapter 3 of the IPCC AR6 WG3 report for a summary of roles of integrated assessment models). In Chapter 6 of the IPCC AR5 WG3 report (Section 6.3), general properties of those scenarios are summarised as follows.

- In the baseline scenario without any specific emission reduction measures, population and GDP growth in developing and emerging (non-OECD) countries is assumed to be relatively higher than in developed (OECD) countries.
- In many scenarios, global cost minimisation from the baseline scenario is applied to determine a pathway to limit the temperature increase to a certain level under ubiquitous price of carbon across the globe.
- In developed (OECD) countries emissions peak earlier than in the rest of the world where greater growth is assumed in the baseline scenario, although the change in emission intensity (rate of decline) in developing and emerging countries is assumed to be relatively faster than in developed countries.

[13] https://unfccc.int/resource/docs/convkp/conveng.pdf Article 3.

[14] Paris Agreement, Articles 4 and 9.

[15] CMA.5 Decision document (https://unfccc.int/sites/default/files/resource/cma5_auv_4_gst.pdf) Preamble and paragraph 38

[16] https://www.iea.org/reports/net-zero-roadmap-a-global-pathway-to-keep-the-15-0c-goal-in-reach Box 2.1

[17] https://www.unep.org/resources/emissions-gap-report-2023

[18] https://climateactiontracker.org/publications/1o5C-consistent-benchmarks-for-enhancing-Japans-2030-climate-target/

[19] CAT uses emissions pathways with less than 0.1°C overshoot and those rely on bioenergy with carbon capture and storage (BECCS) and land-use sinks up to the level defined in the IPCC special report on 1.5°C.

region converge to the same value in 2100. Then the country's emission pathway aligned with the 1.5°C target is derived by taking a median value of multiple scenarios. As a result, Japan's cumulative GHG emissions between 2020 and 2050 aligned with the 1.5°C target are calculated to be 14.3 GtCO2e. In contrast, if the global 1.5°C emissions pathway in the IPCC AR6 is simply scaled to Japan's emissions in 2019 (green line in Figure 3), the cumulative emissions from 2020 to 2050 are 16.6 GtCO2e, more than 10% larger than the CAT value.[20] This difference is due to the fact that, as mentioned earlier, in the integrated assessment models used in the IPCC reports (1.5°C Special Report and Sixth Assessment Report), developed countries are first to lower their emissions. In other words, even without taking into account the equity perspective, developed countries need to lower their emissions before the global pathway in order to achieve the 1.5°C target globally.

The 1.5°C Roadmap published by IGES[21] used the upper limit of Japan's cumulative GHG emissions after 2020 by CAT (14.3 GtCO2e) as a benchmark to consider the emission reduction pathways that Japan could contribute towards the 1.5°C target. In the 'Balanced Scenario' of the 1.5°C Roadmap Technical Report, GHG emission reductions in 2030 and 2035 are 57% and 76% (relative to 2013 levels), respectively, and these reductions are faster than the IPCC's global pathway (Figure 4). Furthermore, Reference 4 of the report examines how cumulative emissions would be allocated to countries, and shows that the cumulative emissions allocated to Japan would be smaller than 14.3 GtCO2e if we take considerations such as equality and responsibility into account. Such smaller allocations of cumulative emissions to developed countries have been noted in previous studies.[22]

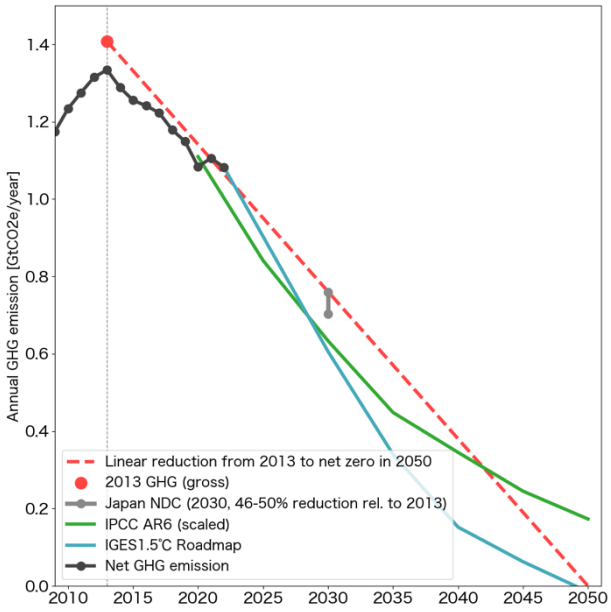

Figure 4: Japan's GHG emission pathways under the 1.5°C roadmap (balanced scenario)

These examinations tell us that, although there is no quantitative international agreement on the criteria to judge whether individual country targets are aligned with the 1.5°C target, given Japan's position as an industrialised country, it would be difficult to claim the alignment

[20] Note that the CAT calculation does not include LULUCF. If we assume a forest sink of about 50 MtCO2e/year, the same level as today, the cumulative emissions between 2020 and 2050 calculated by integrating the CAT's 1.5°C pathway would be about 12.8 GtCO2e, which is almost 30% smaller than 16.6 GtCO2e.

[21] https://www.iges.or.jp/jp/pub/onepointfive-roadmap-jp/ja

[22] See, for example, van den Berg, N. J. et al. Climatic Change 162, 1805-1822 (2020); Kuramochi, T. et al. Climate Policy, 16(8), 1029-1047 (2016)

with the 1.5°C target if Japan's future emission reduction target does not set more rapid and deep emission reductions compared to the IPCC's global reduction pathway (53% in 2030 and 67% in 2035, both relative to 2013 levels, scaled with the Japan's past GHG emissions). This is the case for all developed countries.

Conclusion

In this paper we examined progress of Japan's emission reduction and discussed the targets which Japan should set as NDCs to be aligned with the 1.5°C target, as required by the Global Stocktake, based on international discussions.

- In order to achieve the current Japanese Government target of a 46% to 50% reduction by 2030 (compared to 2013 levels) and the 2050 net zero target, further measures need to be taken to accelerate the pace of emission reductions compared to reductions made so far since 2013.
- A linear emissions reduction pathway from 2013 to 2050 Carbon Neutrality is not aligned with the 1.5°C target. To achieve the global 1.5°C-aligned pathway, economically mature developed countries will need to reduce at a faster pace than developing and emerging countries. Furthermore, for developed countries including Japan, it is difficult to claim the alignment with the 1.5°C target unless they set a target to reduce GHG emissions at a faster pace than the global 1.5°C-aligned pathway.
- When countries set their NDCs, in order to claim that their targets are aligned with the 1.5°C target as encouraged by the Global Stocktake, they need to clearly describe the basis of its consistency with the 1.5°C target.

Scientific findings compiled in previous IPCC reports and international agreements tell us that, Japan's emission reduction target aligned with the 1.5°C target should aim to reduce emissions at a faster pace than the global 1.5°C-aligned pathway, and it is appropriate for the 'leadership role' agreed by the G7. In this paper, we show a 76% reduction from 2013 levels by 2035 as one guidance.

There are some arguments that, because Japan's GHG emissions account for only 3% of the global total, it is more important to contribute to the reduction of the remaining 97%, rather than domestic reduction efforts. While it is important to contribute to global emission reductions, given the international discussions and scientific findings to date described in this paper, it is a prerequisite that Japan's domestic reductions should be accelerated and deepened. The 1.5°C Roadmap is designed to achieve rapid and deep emission reductions, while simultaneously building a sustainable and prosperous society. In order to further increase international recognition of Japan's sincere commitment to climate actions and to materialise its will to "become a leader in the global response to the climate crisis"[23], the Japanese Government is urged to take the conclusions of the Global Stocktake seriously, increase the level of ambition of the next NDC, and communicate clearly to the Japanese public that measures need to be strengthened, and build consensus to formulate and implement the necessary actions.

[23] United States – Japan Joint Leaders' Statement on 10 April 2024: https://www.mofa.go.jp/mofaj/na/na1/us/pageit_000001_00501.html

Reference 1: Comparison with emission reductions progress in other countries

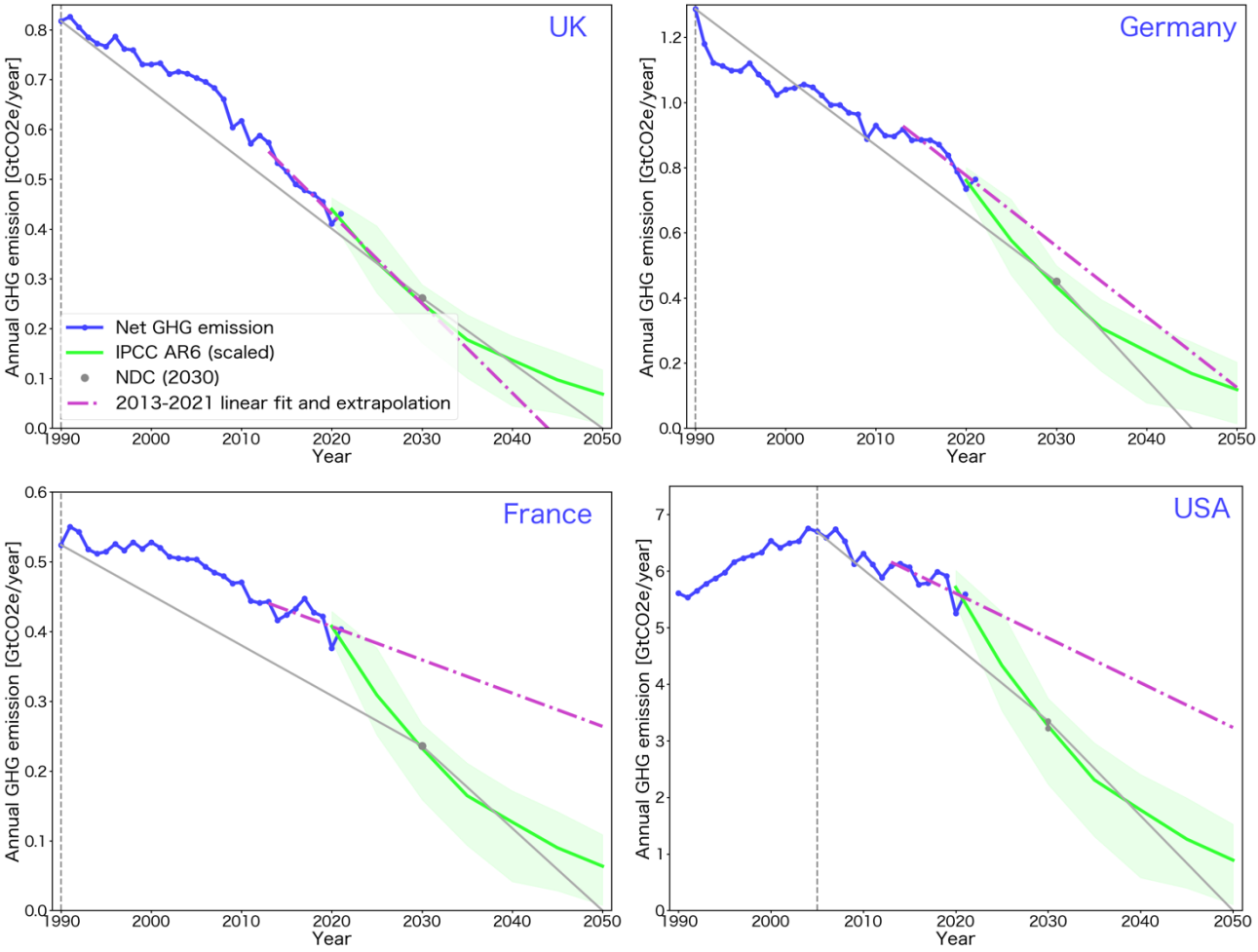

Figure 5. GHG emission trends for the UK, Germany, France and the USA. Blue dots and lines are net GHG emissions taking absorption into account. Grey dots in 2030 are the reduction targets in each country's NDC. Grey lines connect the base year to the 2030 target and the target year for achieving net zero (2045 for Germany, 2050 for the other countries). The green lines and shades (scaled IPCC 1.5°C emission pathway) and magenta lines (linear fit for 2013-2021) are shown in a same manner as in Figure 3.

In Figure 5, GHG emissions trends for the UK, Germany, France and the USA are shown, following the same procedure as for Japan. The emissions data from 1990 to 2021 published by the UNFCCC[24] were used here. In these countries, the treatment of absorption by forests and other sources differs from that in Japan, and they set a baseline and account for differences[25]. Here we plot net emissions including LULUCF published in the UNFCCC.[26] As in the case of Japan, the range of IPCC AR6 global emission pathways scaled by 2019 emissions (green line and shade) and the result of a least-squares linear fit to the 2013-2021 emissions (magenta chain line) are also shown.

[24] https://unfccc.int/topics/mitigation/resources/registry-and-data/ghg-data-from-unfccc

[25] For more information on the treatment of forest sinks, see the Ministry of the Environment document: https://www.env.go.jp/content/000148802.pdf (a Japanese document).

[26] France, like Japan, includes indirect CO_2 emissions while other countries do not publish figures including indirect CO_2. Net GHG emissions without indirect CO_2 are shown for them. Indirect CO_2 emissions in 2021 of Japan and France are less than 0.3% of total GHG emissions.

A comparison between the Japanese case in Figure 3 and the cases of other countries in Figure 5 indicates the following:[27]

- Japan's 2030 target is close to the upper end of the 90% range of the global 1.5°C-aligned pathway by the IPCC AR6, while the 2030 targets of other countries shown in Figure 5 are close to the median value in 2030 of IPCC's global 1.5°C-aligned pathway.
- If the pace of emission reductions since 2013 continues, the UK is on track to reach net zero by 2045. This is a faster pace of reduction than other countries, including Japan.
- If Germany maintains its emission reduction pace from 2013 onwards, the reduction rate in 2050 will be 90% of the 1990 level and 86% of the 2013 level, which is comparable to a similar calculation in Japan (83% of the 2013 level). In other words, the pace of emission reductions in Germany and Japan in recent years are comparable.
- France and the USA have reduced emissions at a slower pace since 2013 compared to Japan. It should be noted that for the US, the impact of the Inflation Reduction Act signed into law in 2022 is not included.
- Japan, Germany, France and the USA will not achieve their targets if they continue the paces of reductions from 2013 onwards. Their measures need to be strengthened.

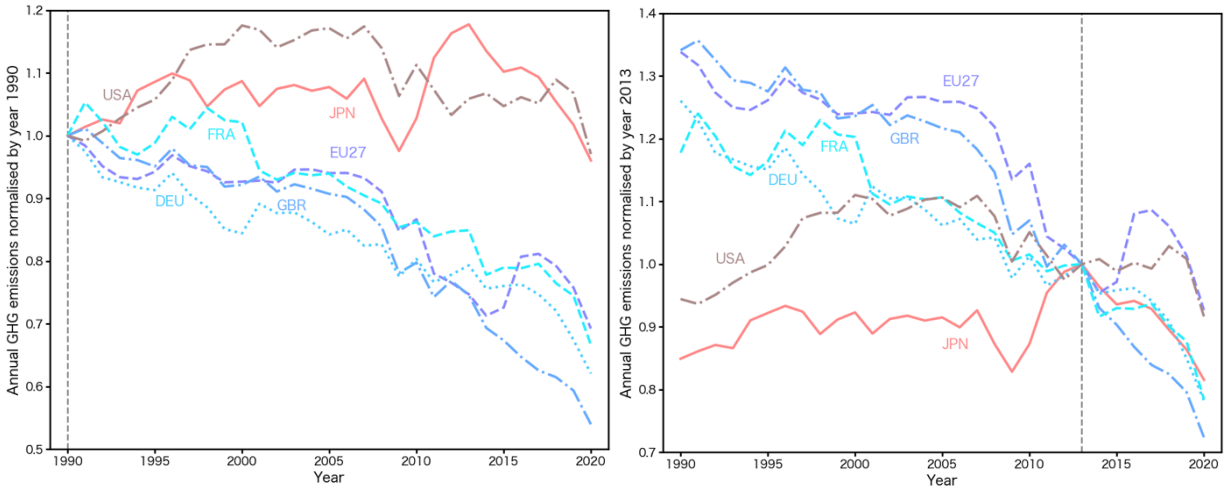

Figure 6. Comparison of emission trends for Japan (JPN), the UK (GBR), Germany (DEU), France (FRA), 27 EU countries and the USA (USA) normalised by GHG emissions in 1990 (left) and 2013 (right).

Figure 6 shows GHG emission trends of Japan, four countries shown in Figure 5, and 27 EU countries, normalised in the year 1990 (the reference year for European countries) and 2013 (the reference year for Japan).

- By looking at long-term variations since 1990, we can see that Japan and the USA have not been able to reduce emissions compared to European countries. Regarding the difference between Japan and Europe, it has been pointed out that while some European countries were able to improve their energy efficiency relatively easily by replacing old facilities in the former communist bloc and by converting power plant fuels from coal to natural gas, it was relatively difficult for Japan to reduce its energy

[27] In Figure 3, data up to 2022 from is used. The results of comparisons with other countries discussed here would not change if the Japanese data up to 2021 published by the UNFCCC were used.

intensity because Japanese industries had been promoting energy efficiency since the oil shock in 1970s.[28] The trend is also affected by the significant increase of the proportion of fossil fuel power generation in Japan following the big earthquake in 2011.

- Even if we compare countries by using 2013 values as a reference, it cannot be said that Japan is reducing emissions at a particularly faster pace than other countries.

Reference 2: Government data on emission reductions achieved by Japan and other countries

There are documents which represent the government's views on progress of Japan's emission reduction to date, including those presented at the Global Environment Subcommittee of the Central Environment Council of the Ministry of the Environment (MoE) on 26 June 2023[29], the Plan for Global Warming Countermeasures Follow-up Expert Committee of the Global Environment Subcommittee of the Central Environment Council on 17 August 2023[30], and the GX Implementation Council on 28 November 2023[31]. Figure 7 shows an extract from the MoE press release on 12 April 2024, "Japan's Greenhouse Gas Emissions and Removals in FY2022"[32].

For comparison with other countries, we show a viewgraph from the GX Implementation Council of 28 November 2023 (Figure 8). A similar figure was presented at the Global Environment Subcommittee of the Central Environment Council on 26 June 2023.

Figures 7 and 8 presented by the Government give the impression that Japan is on-track in GHG emissions reduction and the country has made a steadier reduction compared to other countries. The apparent differences between these figures and Figures 3, 5 and 6 would come from the following reasons.

- The treatment of forest absorption in Japan's NDC differs from that of other countries, and in Japan's figures the starting point at the base year 2013 does not include removals. This makes the line connecting the base year and the target (red line in Figures 1, 2, 3 and 7) appear above the actual net emissions which include removals. In figures for other countries the base year values include removals. Although Japan's procedure to treat forest absorption and other sinks follow the international rules, this causes a difference that in Japan's figure actual emissions are below the linear line while in figures for other countries actual emissions are mostly above the linear lines.
- Japan uses 2013 as the base year, whereas European countries use 1990 as the base year. Figures 7 and 8 by the Government do not show Japan's actual emissions between 1990 and 2013.

[28] For example, Seki, S. (2004), "The Establishment of the Kyoto Protocol and Negotiation Structure(京都議定書の成立と交渉構造)", in Sawa, A. and Seki, S. (eds.), Reexamination of the Global Warming Problem: How to Negotiate the Post-Kyoto Protocol, Toyo Keizai Inc, Global Warming and Environmental Diplomacy(地球温暖化と環境外交), T. Tanabe (1999) Jiji Press.

[29] https://www.env.go.jp/council/06earth/post_132_00003.html

[30] https://www.env.go.jp/council/06earth/yoshi06-23.html

[31] https://www.cas.go.jp/jp/seisaku/gx_jikkou_kaigi/dai9/siryou2.pdf Pages 3-4

[32] https://www.env.go.jp/press/press_03046.html

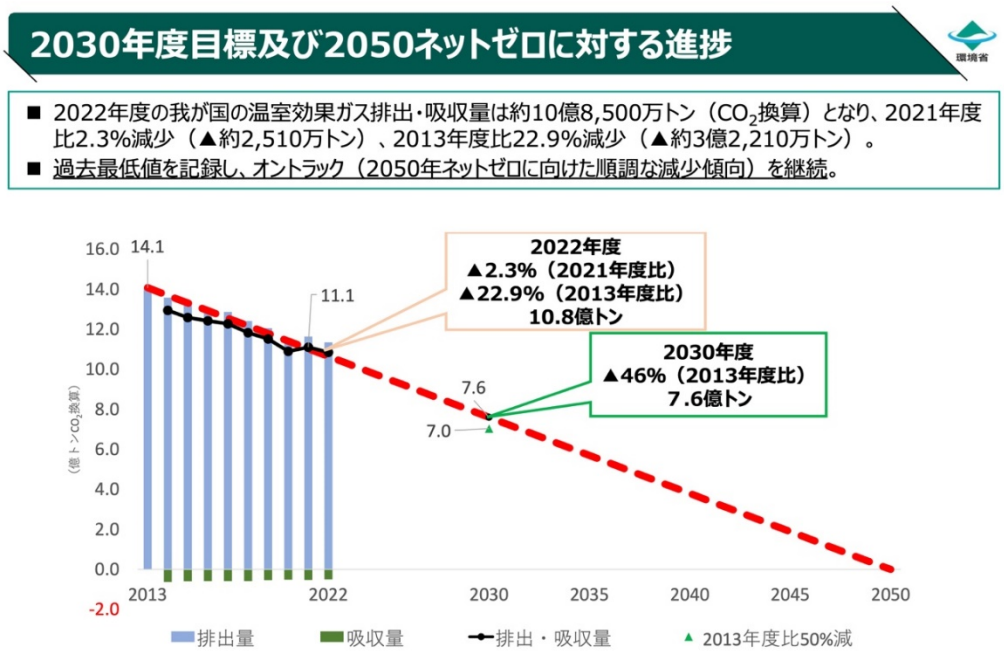

Figure 7. From Ministry of the Environment press release (12 April, 2024)

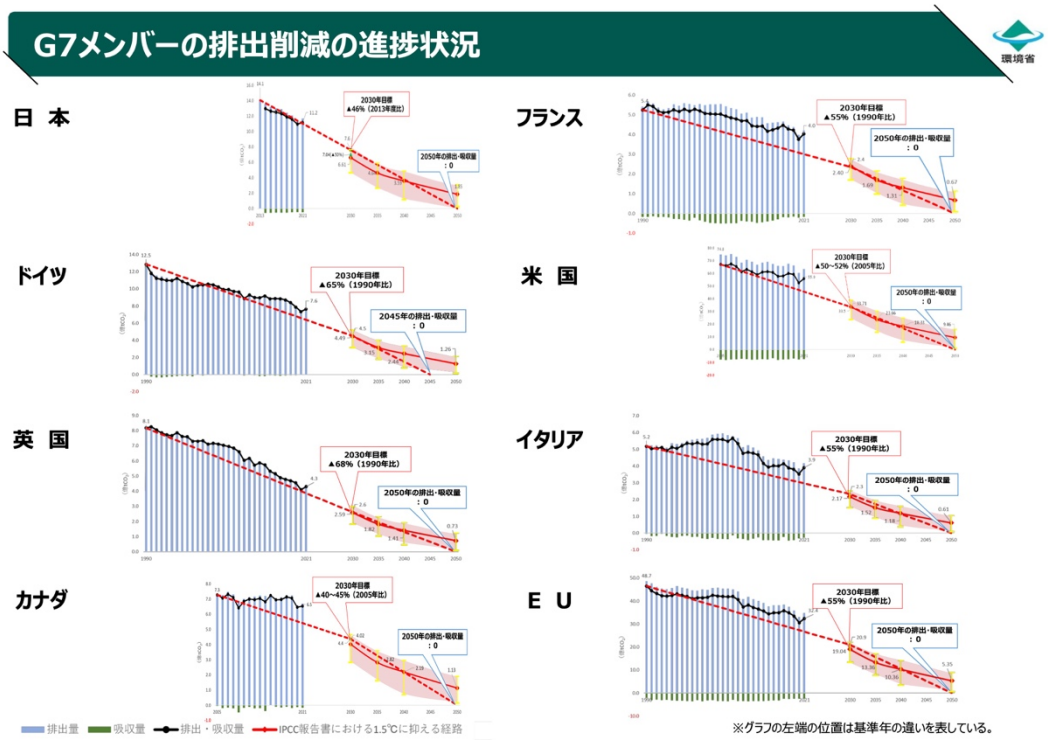

Figure 8. From a document for the 9th GX Implementation Council (28 November, 2023)

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