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1.5°C-consistent benchmarks for enhancing Japan's 2030 climate target

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Summary

This policy brief discusses economy-wide and sector-level benchmarks in 2030 and beyond for Japan to be consistent with the Paris Agreement's long-term 1.5°C warming limit, based on recent analyses by the Climate Action Tracker and its member organisations, NewClimate Institute and Climate Analytics. The benchmarks presented in this brief are set in such a way that the world would not have to rely excessively on unproven negative emission technologies in the second half of this century.

On an economy-wide level, we show that for Japan, a domestic greenhouse gas (GHG) reduction of more than 60% below 2013 levels by 2030 would be 1.5°C-consistent. While this is a challenging benchmark, the analysis of mitigation options and scenarios presented in this brief shows how this could be achieved. It is also in line with what would be necessary at a global level to be on a pathway consistent with 1.5°C. It is therefore essential for Japan to consider this range throughout the 2030 Paris Agreement target (Nationally Determined Contribution - or NDC) revision process.

On a sectoral level, transformational changes need to take place in all sectors by 2030. In the power sector, Japan would need to phase out unabated coal-fired power plants by 2030 and increase electricity generation from renewables to about 60% or more to avoid reliance on nuclear or fossil fuels with carbon capture, utilisation and storage (CCUS), and to increase its chance of achieving 100% renewable energy by 2050. It is equally important for Japan to drastically strengthen efforts to reduce energy demand by, for example, energy efficiency, energy service demand through infrastructural changes, and (induced) behavioural changes.

Electrification of end-use sectors is an additional key strategy. While this may lead to higher electricity generation, there are also additional options to further integrate variable renewable energy. Green (renewable energy-based) hydrogen will become another key to decarbonisation in a number of industrial processes, or some of the heavy-duty transport and aviation, where direct electrification is not viable. It is crucial, however, that the hydrogen consumed is produced from renewables and deployed only where alternatives are not available.

We stress that it is most important to deploy existing commercial technologies that are considered essential for 2050 net zero (e.g. existing wind – including offshore wind – and solar PV technologies, zero energy buildings and houses (ZEB/ZEH), electric vehicles (EVs)) as much as possible by 2030. Additional investment into the development of innovative technologies, as laid out in the Green Growth Strategy of December 2020, will facilitate Japan achieving net zero by 2050.

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1 Introduction

In October 2020, Prime Minister Yoshihide Suga declared that Japan aims to achieve net zero greenhouse gas (GHG) emissions by 2050 while emphasising that pursuing climate actions will bring strong benefits to the economy (Prime Minister of Japan and His Cabinet, 2020).

This declaration was an important step forward from the previous long-term goal of a 80% reduction from current levels and to achieve net zero GHG emissions "as early as possible in the second half of" the 21st century (Government of Japan, 2019). The government is now in the process of revising its 2030 Paris Agreement target (Nationally Determined Contribution - or NDC), which currently targets a 26% reduction below 2013 levels by 2030, a level of ambition that needs to be significantly strengthened to be consistent with the new 2050 net zero GHG emissions goal (MOEJ, 2020).[1]

This declaration was soon followed in December 2020 by the introduction of the "Green Growth Strategy towards 2050 Carbon Neutrality" (Government of Japan, 2020). The overall strategy puts much emphasis on innovative technologies such as hydrogen and ammonia fuels, so-called "carbon recycling" (including bioenergy combined with carbon capture and storage: BECCS), and next generation solar cells, and their roles in a carbon neutral economy. By contrast, there is comparatively limited description on the deployment strategies of existing low-carbon technologies and measures in the mid-term future (up to 2030–2040) to keep Japan's long-term GHG emissions trajectory on track towards net zero in 2050.

This policy brief discusses economy-wide and sector-level benchmarks in 2030 and beyond for Japan to be in consistent with the Paris Agreement long-term temperature goal. Our aim is to inform Japanese policymakers as they develop a revised NDC that is expected to be sufficiently ambitious in light of the Paris Agreement's long-term temperature goal and Japan's 2050 net zero goal.

Mainly based on recent analyses by the Climate Action Tracker project (2020d) and its member organisations, NewClimate Institute and Climate Analytics, we present a range of 1.5°C-consistent benchmarks set in terms of GHG emissions, energy and other technology-specific indicators that are commonly discussed by relevant stakeholders. The benchmarks presented in this brief are set in such a way that the world would not have to rely excessively on unproven negative emission technologies and land-use sinks in the second half of this century. We refer to Japan-specific assessment results where available.

1 Note that the Japanese government uses fiscal year (FY) for both the NDC target year and historical data years (GIO, 2020). A fiscal year in Japan starts in April of the reporting year and ends in March of the next year.

2 Japan's Paris Agreement-consistent GHG emission pathways

Japan's current NDC is not sufficiently ambitious to achieve the global warming limit of 1.5°C under the Paris Agreement, nor Japan's 2050 net zero emissions goal (Climate Action Tracker, 2020c). The Climate Action Tracker analysed national-level 1.5°C-consistent emissions trajectories (Climate Action Tracker, forthcoming) based on a subset of scenarios from integrated assessment models (IAMs) reported in the IPCC 1.5°C scenario database (Huppmann et al., 2019). See Appendix A1 for a summary of the methodology used. These scenarios are "global least-cost pathways", i.e. they apply uniform carbon pricing globally; therefore, they do not take into account equity principles nor Japan's relatively higher responsibility.

We considered 1.5°C emissions pathways with no or low overshoot, i.e. less than 0.1°C overshoot, and only include scenarios that rely on bioenergy with carbon capture and storage (BECCS) and land-use sinks up to the sustainable level defined in the IPCC special report on 1.5°C (SR15) (IPCC, 2018).

The analysis indicates that Japan's GHG emissions (excluding land use, land-use change and forestry) would need to decrease by 62% below 2013 levels by 2030 and 82% by 2040 (median estimates: Figure 1).[2] This is broadly in line with the reductions necessary at the global level: halving GHG emission from 2020 to 2030 to be in line with 1.5°C.

While Japan's emissions have been steadily decreasing since 2013, getting Japan onto a 1.5°C-consistent pathway requires significant and rapid accelerated emission reductions. The analysis also shows that Japan's current NDC is not consistent with domestic pathways that would be consistent with the former (Cancun Agreement) "stay below 2°C" objective that was superseded by the stronger Paris Agreement temperature goal (median estimate: 40% below 2013 levels) (Figure 1).

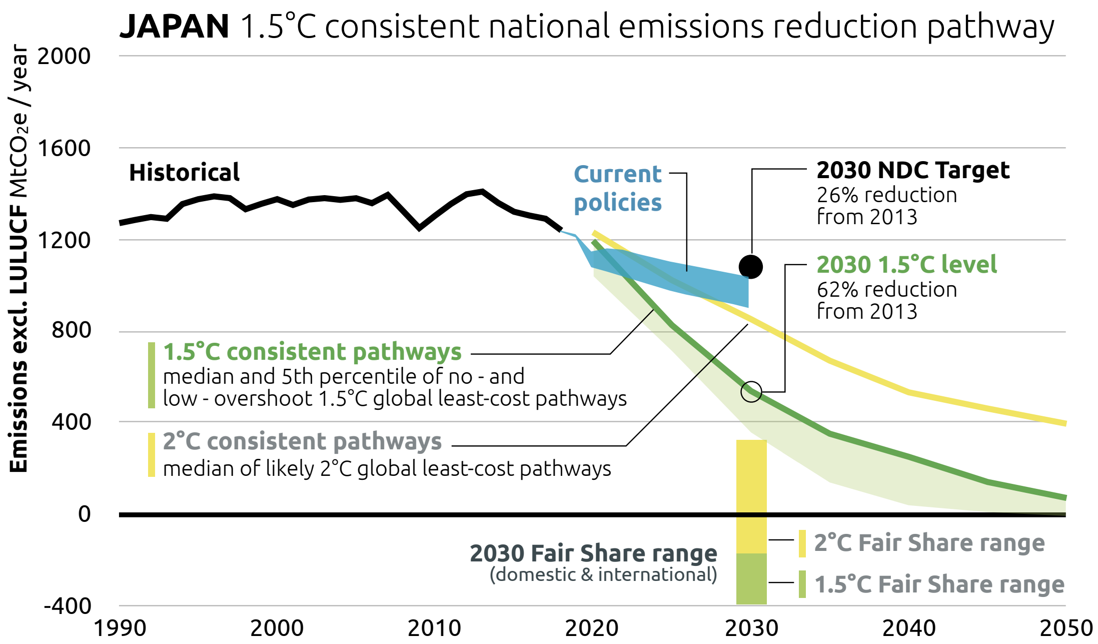

Figure 1: GHG emissions pathways for Japan that would be consistent with 1.5°C global least-cost scenarios (excluding land use, land-use change and forestry: LULUCF). Historical emissions data for 1990–2018 and NDC target emission level (excluding land-use sinks and overseas credits), current policy projections as well as 2°C-consistent emissions pathways are also presented. Source: Climate Action Tracker (forthcoming; 2020c). See Appendix A1 for a summary of the methodology used to derive 1.5°C pathways.

2 Compared to 1990 emissions, these values correspond to 58% and 80% reductions, respectively.

When various equity principles are considered, 2°C and 1.5°C-consistent emission allowances in 2030 would be considerably lower than those indicated in Figure 1 (Robiou du Pont et al., 2016; Climate Action Tracker, 2020c).[3] Thus, a fair contribution by Japan would include, on top of the aforementioned domestic GHG emissions reductions, either even faster reductions of domestic GHG emissions or additional financial support to emission reductions in developing countries.

3 1.5°C-consistent benchmarks and key considerations in the NDC revision - by sector

3.1 Power sector

Power generation accounted for 40% of Japan's total CO_2 emissions in 2018 (GIO, 2020). While the emissions in this sector decreased by 13.3% in 2018 compared to 2013, when emissions hit a record high in the aftermath of the Fukushima nuclear accident, they are still 30.9% higher than 1990 levels (GIO, 2020).

Japan's 2030 electricity mix target under its current NDC is based on the 2015 Long-Term Energy Supply and Demand Outlook, which outlines that in 2030 electricity will be supplied by 20–22% nuclear energy, 22–24% renewables and 56% fossil fuels (METI, 2015). These targets were reiterated in 2018 by the Basic Energy Plan and in the 2019 Long-Term Strategy under the Paris Agreement (METI, 2018a; Government of Japan, 2019).

For 2050, the "Green Growth Strategy towards 2050 Carbon Neutrality" suggested that the decarbonised electricity generation sector could be comprised of 50–60% renewables, 30–40% nuclear power and fossil fuel-fired power equipped with carbon capture, utilisation and storage (CCUS), and the other 10% from hydrogen and ammonia combustion (Government of Japan, 2020).

1.5°C-consistent benchmarks for 2030 and 2040

Rapid emissions reductions are required for the Japanese power sector under 1.5 °C-consistent pathways (Table 2). A recent Climate Analytics analysis, and its underlying dataset, indicates that the share of electricity from renewables and other zero/low-carbon energy sources (e.g. nuclear power, and fossil fuel-fired power with carbon capture and storage (CCUS) would need to reach 60% or higher by 2030 and above 80% by 2040 for Japan to be 1.5°C-consistent (Climate Analytics, 2021). These Japan-specific benchmarks are consistent with the global benchmarks for renewables only (Climate Action Tracker, 2020d).[4]

By contrast, unabated (i.e. without CCUS) coal-fired power generation needs to be almost entirely phased out by 2030 (based on the underlying data in Climate Analytics, 2021). This finding is consistent with an earlier global study also covering Japan (Climate Analytics and Renewable Energy Institute, 2018; Climate Action Tracker, 2020d). To achieve net zero GHG emissions, unabated gas-fired power would also need to be phased out by 2050.

The findings for 2030 from a 2050 net zero CO_2 emissions pathways for Japan investigated by Oshiro et al. (2018) lie on the lower side of the ranges presented in Table 2.[5] A bottom-up analysis commissioned by WWF Japan shows a lower share of renewables (about 45%) with little nuclear and no fossil with CCUS (Research Institute for Systems Technology, 2020).

3 Some stylised 2°C-consistent emission pathways under two equity-based effort sharing approaches in an earlier study (Kuramochi et al., 2016) show higher emission allowances than these two studies.

4 55–90% share in 2030 and 75–100% share in 2040, before reaching 98–100% in 2050.

5 The study used AIM/Enduse [Japan]. Here we refer to results for two 2050 net zero CO_2 scenarios without emission constraints for 2030; one without constraints on technology availability ("1.5deg") and the other with nuclear phase-out before 2050 ("1.5deg_NucPO"). CO_2 sequestration is assumed to be scale up to about 200 $MtCO_2$/year by 2050.

Table 1: 1.5°C-consistent levels for CO_2 emissions intensity, shares of electricity from renewables and other zero-/low-carbon energy sources and unabated coal-fired electricity in total generation in the Japanese power sector in 2030, 2040 and 2050 according to global least-cost scenarios. Source: based on the underlying data in (Climate Analytics, 2021), supplemented by Climate Analytics and Renewable Energy Institute (2018) on unabated coal-fired power generation figures.

Country	Year	CO_2 emission intensity gCO_2/kWh	Share of renewables, fossil fuel with CCUS, and nuclear in total electricity generation	Share of unabated coal-fired power in total generation
Japan	**2017** (historical)	520	20%	34%
	2030	90–200 [1)]	63–87% [2)]	<5%
	2040	10–110 [1)]	81–99% [2)]	0%
	2050	<0–40	94–100%	0%

[1)] The global benchmarks estimated by the Climate Action Tracker are lower at 50–125 gCO_2/kWh for 2030 and 5–25 gCO_2/kWh for 2040 (Climate Action Tracker, 2020d).

[2)] The global benchmarks estimated for renewables by the Climate Action Tracker are 55-90% for 2030 and 75–100% for 2040 (Climate Action Tracker, 2020d).

It is important to note that the composition of low-carbon electricity mix in 2030 varies widely across the scenarios reviewed by Climate Analytics (2021) and cited in this brief.[6] That said, it is unrealistic to expect significant contributions from nuclear power - and fossil fuel-fired power with CCUS - in the electricity mix in 2030 and beyond.

The future of nuclear power in Japan is highly uncertain considering current legal litigations (National network of legal teams for nuclear phase-out, 2020), multiple technical considerations – including safety regulations required for both existing and new plants (see for example Renewable Energy Institute, 2020), as well as the long, around 20-year, lead time required for new construction (Cabinet Secretariat of Japan, 2011). Fossil fuel-fired power with CCUS has not been operated commercially in Japan—there is only one in the world operating commercially (Global CCS Institute, 2021)[7] —while there are no concrete installation plans at plant-level as of end-2019 (Kiko Network, 2019).

Given these circumstances on other low-carbon options and the continually improving cost competitiveness of renewables, the most reasonable option for Japan would be to aim for achieving the 1.5°C-consistent shares of low-carbon electricity largely with renewables. This suggests that renewables would need to supply about 60% or more of the total electricity generation in 2030. Achieving such a renewables share by 2030 would increase the chance of Japan achieving 100% renewables by 2050 (Research Institute for Systems Technology, 2020).

These findings also suggest that most of the rest of electricity generation would be unabated natural gas-fired power, which would need to be phased out well before 2050. To minimise reliance on natural gas-fired generation, electricity demand needs to be minimised even as electrification of energy end-use sectors has to be enhanced simultaneously. Energy savings through both technological, infrastructural measures as well as behavioural changes would be crucial (see Section 3.5 for details).

Power sector decarbonisation in Japan could deliver significant economic benefits. For example, a recent study showed that it would lead to a net increase in domestic employment overall and increased stable jobs in rural areas compared to a fossil fuel-dependent baseline (Kuriyama and Abe, 2021). Combined with an early decision on retiring conventional fossil fuel-fired power plants and adequate policy support for surplus workers from these plants, power sector decarbonisation could revitalise local economies and improve inequality in the working-age population (Kuriyama and Abe, 2021).

6 Other model intercomparison studies such as Sugiyama et al. (2019) also show very different electricity mix as well as different electricity demand levels across models and scenarios.

7 The only commercially operating project, the Boundary Dam Unit #3 (SaskPower, 2020), is having economic and technical performance issues (Climate Action Tracker, 2020a).

3.2 Industry sector

Industry accounted for 39.5% of Japan's energy-related CO_2 emissions in 2018 when electricity-related emissions are also included (GIO, 2020). Energy-related CO_2 emissions from the industry sector have been decreasing; 2018 emissions were 14% lower than in 2013 and 21% lower than in 1990. Substantial non-CO_2 GHG emissions are also emitted from various industrial processes. The current NDC aims to reduce energy-related CO_2 emissions from this sector by 8.7% in 2030 below 2013 levels. According to the latest document by METI, this target has already been achieved (MOEJ and METI, 2021).

Some emission-intensive industries are starting to make a shift towards net zero emissions by 2050. For example, the Japanese Iron and Steel Federation (JISF), the largest steel industry group in Japan, recently announced that it will also aim for net-zero CO_2 emissions by 2050 (JISF, 2021).

1.5°C-consistent benchmarks for 2030 and 2040

Under 1.5 °C-consistent emission pathways, emission-intensive industries need to significantly reduce their emissions over the next few decades. Virtually all new industrial installations after 2020 would need to be low-carbon (Kuramochi et al., 2018). An important strategy to decarbonise the industry sector is electrification – either directly or indirectly through replacing fossil fuels – for heating and feedstock through the use of green (renewable energy based) hydrogen (Climate Action Tracker, 2020d).

A recent Climate Action Tracker analysis shows that, on a global level, CO_2 emissions intensity per unit of product would need to decrease by 25–30% by 2030 below 2015 levels for steel, and 40% by 2030 for cement, respectively (Table 2) (Climate Action Tracker, 2020d). In addition to electrification, deep decarbonisation of the Japanese industry sector by 2050 requires departure from the prevailing industrial policies (Ju et al., 2021).

Steep reductions in emissions intensity require rapid and extensive deployment of production technologies using decarbonised energy and feedstock (Climate Action Tracker, 2020d). Technological options in the iron and steel sub-sector include e.g. enhanced steel scrap recycling, switch to hydrogen-based iron production technologies using renewable energy-based hydrogen, and enhanced use of charcoal and biogas. For Japan, which is the second largest primary iron and steel producer in the world, the presented benchmarks suggest a need for a rapid shift toward CO_2-free (green) hydrogen-based production. The recent announcement by JISF is an important step forward (JISF, 2021).

Technological options in the cement sub-sector that would be key to a deep decarbonisation include reduced clinker-to-cement ratio, deployment of novel cements and decarbonisation of the thermal energy mix, and CCUS (65% to 80% of plants equipped by 2050) (Climate Action Tracker, 2020d), based on current knowledge. Our recommendation, including for Japanese cement producers, would be an aspirational benchmark of a 100% emissions intensity reduction, with additional research and development into innovative technologies.

Besides technological transformation, it is also important to consider possible transformation of the supply chain to achieve deep decarbonisation in some sub-sectors. For example, Japanese iron and steel producers import iron ore and coking coal mainly from Australia, where there is also large potential for low-cost renewable energy production. Gielen et al. (2020) assessed that CO_2 emissions could be reduced by a third at the relatively low cost of USD 67/tCO_2 by importing Australian-produced renewable hydrogen-based direct reduced iron (DRI) to produce steel products in Japan, instead of producing its primary iron domestically using the imported Australian iron ore and coking coal.

Additional important mitigation options not considered here are material substitution (replacing cement with other building materials) and material efficiency, such as in the building sector. Examples of studies on comparable economies, such as Australia (Climate Action Tracker, 2020a), show the industry sector can strive to reach net zero emissions by 2050. We have also set this as a global benchmark for cement and steel industries (Climate Action Tracker, 2020d).

Table 2: 1.5°C-consistent benchmarks for the global industry sector. Source: adapted from Climate Action Tracker (2020d).

Country	Year	Cement emissions intensity (vs.2015 level)	Steel emissions intensity (vs.2015 level)	Share of electricity in final energy consumption [1)]
Global	**2030**	40%	25–30%	35%
	2040	N/A	N/A	45–55%
	2050	85–90% (aspirational: 100%)	95–100%	50–55%

[1)] Japan in 2018: 36% (IEA, 2020a)

3.3 Transport sector

The transport sector represented 18% of total energy-related CO_2 emissions in Japan in 2018, both with and without electricity-related emissions (GIO, 2020). The sector's emissions have been on a decreasing trend since 2001, in stark contrast to the average 3% annual increase observed for Annex I countries as a whole (UNFCCC, 2020).

Under its current NDC, Japan aims to reduce transport sector emissions by 27% below 2013 levels by 2030 (Government of Japan, 2015). Before the announcement of the GHG neutrality target, Japan's targets were to achieve a 50–70% share of "next-generation vehicles"[8] in new passenger car sales by 2030 (METI, 2018d). For 2050, Japan aimed to reduce tank-to-wheel emissions by 90% below 2010 levels for all new passenger vehicles produced in Japan (METI, 2018c, 2018b).

Following the 2050 GHG neutrality announcement, Japan now aims to achieve 100% share of "electrified vehicles"—a category that includes non-plug-in hybrids (HV) and plug-in hybrid vehicles (PHV)— in new passenger car sales by 2035 at the latest (NHK, 2021). The governor of Tokyo has indicated an even earlier, 2030, target (Nikkei Asia, 2020).

1.5°C-consistent benchmarks for 2030 and 2040

Rapidly phasing out fossil fuel-powered vehicles is key to transitioning the Japanese transport sector to 1.5°C-consistent pathways. A 2018 Climate Action Tracker analysis (Kuramochi et al., 2018) showed such vehicles need to phase out from new passenger car sales by 2035 globally in order to achieve zero emissions in 2050.

A more recent analysis (Climate Action Tracker, 2020d) similarly concluded that EVs should represent 75–95% of new light-duty vehicle (LDV) sales globally in 2030 and 100% by 2040 (Table 3). The benchmark for the EU and USA is more ambitious with 95–100% sales in 2030. For the EU, this means that more than half of its LDV fleet would be composed of EVs by 2030 (Climate Action Tracker, 2020d). A benchmark for Japan would probably be in the same order but still needs to be developed.

Furthermore, the share of low-carbon fuels in the entire Japanese transport sector will need to increase dramatically in the coming decades where the key for achieving this would be electrification (Table 3) (Climate Action Tracker, 2020d). It is important to note that most, if not all, of the remaining non-low-carbon fuels in 2050 would be consumed by the freight and aviation subsectors, which have comparatively few low-carbon options (Climate Action Tracker, 2018, 2020d).

Japan's commitment to a clear timeline for 100% zero-emission vehicles in new sales could potentially be a game changer in the global car market. As of November 2020, 17 national and subnational governments had set phase-out targets for ICE vehicles, covering 13% of new passenger car sales globally in 2019 (Cui and Wappelhorst, 2020). Considering the global - and national - importance of the Japanese car manufacturing industry, this is an opportunity for the government and manufacturers to define an ambitious strategy for the production and deployment of zero-emissions vehicles.

8 Next-generation vehicles include battery electric vehicles (BEVs) and fuel cell EVs (FCEVs), but also hybrids, plug-in hybrids, 'clean diesel' and gas-powered vehicles.

The ban of ICE vehicles should, however, not be considered a panacea. Additional policies are necessary to encourage the uptake of EVs, but also to promote modal shift and an overall decrease of transport demand (see Emmrich et al. for a discussion of the decarbonisation of the transport sector in the EU (Emmrich et al., 2020)). To speed up the adoption of low-emission vehicles, Japan needs to adopt policy packages including behavioural incentives (free parking, toll road fee exemptions, etc.) as well as financial incentives such as subsidies for the purchase of EVs and reduced value added tax (Steinbacher, Goes and Jörling, 2018; Emmrich et al., 2020).

Table 3: 1.5°C-consistent benchmarks for the global transport sector (excluding international aviation and shipping). Source: adapted from Climate Action Tracker (Climate Action Tracker, 2020d).

Country	Year	EV share in sales % of annual vehicle sales	Share of low carbon fuels in the total transport sector (Electricity-hydrogen+biofuels) % of final energy demand [1)]
Global (EU and USA)	**2030**	75–95% (95–100%)	15% (15–20%)
	2040	100%	40–60% (45–60%)
	2050	100%	70–95% (75–100%)

[1)] Japan in 2018: 2.7% (IEA, 2020a)

3.4 Buildings sector

CO_2 emissions have risen since 1990 in the Japanese commercial and residential buildings sectors, which accounted for 32% of Japan's total energy-related CO_2 emissions in 2018 when including electricity-related emissions (GIO, 2020).

The current NDC is comparatively more ambitious in this sector; it aims to reduce energy-related CO_2 emissions (including electricity-related emissions) by 40% by 2030 below 2013 levels. For comparison, emissions in 2018 were 19% below 2013 levels. The Japanese government has been promoting Zero Energy Houses (ZEHs) and Zero Energy Buildings (ZEBs); the current national target is for all newly-built houses and buildings to be net zero energy buildings by 2030 (METI, 2014).

Table 4: 1.5°C-consistent benchmarks for the global buildings sector. Source: adapted from Climate Action Tracker (Climate Action Tracker, 2020d).

Country	Year	Emissions intensity $kgCO_2/m^2$ (% reduction from 2015 levels)	Renovation rates (%/year)
Global	**2030**	-	2.5–3.5%
	2040	90% (residential) 90–95% (commercial)	3.5%
	2050	95–100% (residential) (100% in OECD/ developed countries) 100% (commercial)	-

1.5°C-consistent benchmarks for 2030 and 2040

Rapid decarbonisation is also necessary for the buildings sector under a 1.5°C-consistent emissions pathway (Table 4) where an annual renovation rate of the existing buildings stock as high as 3.5%/year would have to be reached by, at the latest, 2040. In addition, all newly constructed buildings should be net zero emission buildings – a global benchmark to be implemented immediately (Climate Action Tracker, 2020d). It is possible to completely eliminate emissions from buildings by 2050 using existing technologies. To do so will require substantial investment in zero carbon (renewable or electric) heating and cooling sources and improvements to building envelopes.

As of 2018, only 13% of Japan's new residential buildings were zero energy houses (ZEH) or "nearly-ZEHs", a long way from the 100% target for 2030 specified in the Basic Energy Plan (METI, 2018a) while the development of zero-energy buildings is still in its infancy (Sustainable open Innovation Initiative, 2019b, 2019a). More stringent measures, therefore, are necessary to achieve the government's goal of net zero primary energy consumption for new builds by 2030.

Implementing deep decarbonisation in existing buildings is challenging because they are largely private properties (Murakami, 2017). Besides the strengthening of building codes, measures such as accelerated replacement of existing buildings with new ones may be effective in Japan because the large majority of the existing stock as of 2016 would be replaced by 2050 (Murakami, 2017). Finally, promoting energy efficient appliances and lighting, sustainable heating systems and smart demand-side management would help reducing energy demand, while on-site generation of renewable energy would help address existing demand (Sterl et al., 2017; Carnevale et al., 2019; IEA, 2019; Climate Action Tracker, 2020d).

3.5 Importance of energy efficiency and savings in end-use sectors

All the benchmarks presented above confirm the urgent need for Japan to strengthen its mitigation effort to achieve long-term decarbonisation in all areas (Sugiyama et al., 2021). In Japan, there has been much focus on the power sector decarbonisation (Hanawa, 2020) but strengthened efforts in the end-use sectors such as energy efficiency, reduced energy service demand, electrification of energy end-use are equally crucial. Large reductions in energy demand could relieve some of the constraints on emissions mitigation options, e.g. reliance on negative emission technologies, and mitigation costs to keep warming within 1.5°C (Rogelj et al., 2015; Grubler et al., 2018).

Long-term decarbonisation is expected to contribute to enhanced energy security in Japan, a nation that has historically depended heavily on imported fossil fuels (Oshiro, Kainuma and Masui, 2016). However, there could potentially be a disruptive impact on energy security during the transition period if the nation fails in reducing its energy demand. One of the major energy security concerns in the context of 2050 GHG neutrality in Japan is the potential increase in imports of expensive liquefied natural gas as a "bridging fuel", especially in the power sector if the share of coal-fired power is to be drastically reduced (Akimoto et al., 2012). Gas-fired power generation increased from 326 TWh/year in 2010 to 438 TWh/year in 2014 following the nuclear power plant shut-downs in the aftermath of the 2011 Fukushima Daiichi nuclear power plant accident; since then it has decreased to about 340 TWh/year in 2019 (IEA, 2020a).

The 1.5 °C-consistent electricity generation benchmarks in 2030 in Section 3.1 suggest that gas-fired power may have to make up about 40% share in total generation, if coal-fired power is to be phased out by then. If gas-fired power generation is to be kept below, e.g., 320–340 TWh/year, total electricity generation would need to be kept to roughly 800–850 TWh/year. The estimated level of total generation is roughly in line with that in a 1.5°C scenario with gradual nuclear phase-out investigated in Oshiro et al. (2018), and requires a massive 20% reduction from 2019 levels (IEA, 2020a).[9] Achieving such a large electricity demand reduction while enhancing electrification in energy end-use sectors requires exploration of drastic social changes (Oshiro, Masui and Kainuma, 2018).

9 For comparison, the IEA World Energy Outlook (WEO) 2020 projected that the total electricity generation would decrease by only 1.3% by 2030 below 2019 levels under the Stated Policies Scenario (STEPS) and 5.6% under the Sustainable Development Scenario (SDS) (IEA, 2020b). WWF Japan's 2050 net zero scenario estimated a total electricity generation of about 900 TWh/year in 2030, of which close to 400 TWh/year from gas (Research Institute for Systems Technology, 2020).

4 Conclusion and way forward

1.5°C-consistent benchmarks presented in this brief call for a significant increase of ambition in Japan's NDC. On an economy-wide level, we show that a GHG reduction of more than 60% from 2013 levels by 2030 would be 1.5 °C-consistent. While this is a challenging benchmark, the analysis of mitigation options and scenarios presented in this brief has shown how this could be achieved. It is also in line with what would be necessary at the global level to be on a pathway consistent with 1.5°C. It is therefore essential for Japan to consider this range throughout the current NDC revision process.

On a sector-level, we have shown that transformational changes need to occur in all sectors by 2030. The clearest example is in the power sector: Japan would need to phase out unabated coal-fired power plants by 2030 and increase electricity generation from renewables to about 60% or more to avoid reliance on nuclear or fossil fuels with CCS, and to increase its chance of achieving 100% renewable energy by 2050.

It is equally important to drastically strengthen efforts to reduce energy demand through, for example, energy efficiency, energy service demand through infrastructural changes, and (induced) behavioural changes.

Electrification of end-use sectors is an additional key strategy, leading to higher electricity generation, but also additional options for integration of variable renewable energy. Green (renewable energy-based) hydrogen will become another key to decarbonisation in a number of industrial processes, or in heavy-duty transport and aviation where direct electrification is not viable. It is crucial, however, that the hydrogen consumed is produced from renewables and deployed only where alternatives are not available.

While not covered here, deep reductions of non-CO_2 GHGs by 2030 are also crucial. Of particular concern is hydrofluorocarbons (HFCs), the emissions of which have shown a recent significant increase (GIO, 2020). Negative emissions from carbon dioxide removal (CDR) would also need to be deployed to compensate for emissions that cannot be reduced to zero, in particular from agriculture. This is also not covered in this short brief.

Finally, we stress that it is most important to deploy existing commercial technologies that are considered essential for 2050 net zero (e.g. existing wind – including offshore wind – and solar PV technologies, ZEB/ZEH, EVs) as much as possible by 2030. Additional investment into development of innovative technologies, as laid out in the Green Growth Strategy, will facilitate Japan achieving net zero by 2050.

Appendix

A1: Summary of the methodology on CAT's 1.5°C-consistent domestic pathways

For each of the global least-cost emission pathways, the emissions of the OECD region are distributed amongst the OECD member states following an extension of the Impact, Population, Affluence, and Technology (IPAT) method that was developed by van Vuuren et al. (2007) and refined by Gidden et al. (2019). It assumes country-specific emission intensities converge from their present-day values to the regional value for each given IAM pathway by the end of the modelled time horizon (i.e., by 2100). We then assess the full distribution of downscaled outcomes to find the median of country-level emissions pathway in order to form an upper-bound for Paris-Agreement compatibility for each country.

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Climate Analytics is a non-profit climate science and policy institute based in Berlin, Germany with offices in New York, USA, Lomé, Togo and Perth, Australia, which brings together interdisciplinary expertise in the scientific and policy aspects of climate change. Climate Analytics aims to synthesise and advance scientific knowledge in the area of climate, and by linking scientific and policy analysis provide state-of-the-art solutions to global and national climate change policy challenges.

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NewClimate Institute is a non-profit institute established in 2014. NewClimate Institute supports research and implementation of action against climate change around the globe, covering the topics international climate negotiations, tracking climate action, climate and development, climate finance and carbon market mechanisms. NewClimate Institute aims at connecting up-to-date research with the real world decision making processes.

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