Evaluation of Japan's Policy for CO_2 Reduction at the First Commitment Period of the Kyoto Protocol

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***Abstract*—Japan achieved its 6% reduction target under the first commitment period stipulated by the Kyoto Protocol by using flexibility mechanisms and land use, land use change and forestry. Carbon dioxide emission from the energy sector increased by 6.7% compared to 1990. We analysed the change of Japan's carbon dioxide emission from the energy sector during the period with official reference year 1990 and with the five years(i.e. 2003-2007) just before the first commitment period (i.e. 2008-2012) comparing with Germany, UK, France, and Spain. Japan reduced its greenhouse gases emissions by 23.6% through contribution from sectors other than energy, while the emission from the energy sector increased by 9.3%. It contrasts with the fact that the other four countries achieved reduction in the energy sector. Though Japan achieved a certain level of GHG reductions on the demand-side through various policy measures, including Top-Runner method and technology R&D, it failed to low-carbonize the energy sector which increased its carbon dioxide emission. This structure would not have changed even if the accident of Fukushima nuclear power station in 2011 had not occurred. Without a fundamental energy policy change, Japan might not achieve a substantial emission reduction of carbon dioxide from its energy sector under the coming era of Paris Agreement.**

***Index Terms*—Carbon dioxide from energy sector, CO_2, Japan, Kyoto protocol.**

I. Introduction

The Kyoto Protocol under the UNFCCC is a legally binding multilateral environment agreement and was aimed at achieving effective reduction of GHGs. There have been a number of studies on Kyoto Protocol, on its implementation costs, joint mechanisms, CDM, etc. The key research topics covered the history of the Kyoto Protocol [1], CDM [2], ex-ante assessments of the Kyoto Protocol's economic costs [3], [4], discussion on the effectiveness of the CDM [5], [6], and Joint Implementation [7]. However, there have been only a few ex-post studies evaluating GHG emission reductions of the Annex I countries after the completion of the first commitment period (CP1: 2008-2012), using the final data. Igor, Romain, & Valentin concluded that 9 out of 36 Annex 1 countries exceeded their reduction targets and complied with the reduction targets by using the flexibility mechanism, and that the Annex I countries as a whole over-achieved a reduction of 2.4 $GtCO_2e$/year, of which 2.0 $GtCO_2e$/year came from the hot air [8]. Shuo Liu calculated the contribution of each sector to the GHG reductions of 37 developed countries (i.e. 35 countries that participated in CP1, besides USA, and Canada) compared to the base year 1990, and the results were energy (36.9%), industrial process (12.4%), agriculture (9.9%), Land use, Land use Change and Forestry (LULUCF) (7.7%), wastes (3.4%), and solvents (0.1%) [9].

While the ultimate objective of the UNFCCC is to stabilize the concentrations of GHGs in the atmosphere, reduction of carbon dioxide is crucial because of its largest attribution to the greenhouse effect. According to the IPCC AR5, 65.2% of anthropologic GHGs are attributed to carbon dioxide emission from the energy sector. Whether the global temperature raise can be limited within 2 degree or even 1.5 degree largely depends on how much carbon dioxide emission from the energy sector can be reduced. Carbon dioxide emission from the energy sector comprises combustion of fossil fuels and evaporation of fuels, and the latter contributes only 1%. Thus, this study focuses on the carbon dioxide emission from combustion of fossil fuels, referred to from here on in this paper as CO_2 emission. This study explores the causes why Japan could not reduce CO_2 emission during CP1, and evaluates Japan's climate and/or energy policy compared with those of Germany, UK, France, and Spain, which have relatively large GHG emissions among CP1 members, to obtain a strategy for the successful implementation of the Paris Agreement.

II. Methodology

This study draws data mainly from the Biannual Reports that each government submitted to UNFCCC in 2015.

CO_2 emission in CP1 was compared with that of two reference years. One is 1990, the official base year of CP1. This base year was adopted from article 4-1 (b) of the UNFCCC. It stipulates that GHG emissions from the Annex I countries return "individually or jointly to their 1990 levels these anthropogenic emissions of carbon dioxide and other greenhouse gases". However, Japanese industries argued that it was "unfair" to set 1990 as the base-year. They claimed that Japan had little room to improve its energy efficiency after 1990 because Japan had already achieved high levels of energy efficiency during the 1970s in advance of other developed countries, and that Germany, for example, reunited in 1990 and obtained hot-air from the former East Germany [10].

Table I indicates GHG emissions of each country per GDP based on purchasing power parity [11]. In 1990, UK and Germany had larger figures than Japan, which support the claim of Japanese industries. Therefore, this study took another period as reference in addition to 1990, 5 years just

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before CP1 (i.e. 2003-2007). During this period, EU had also achieved the same level of energy efficiency as Japan, and the benefits of reunion of Germany had no more positive impacts. Actually, the average figures of Japan from 2003 to 2007 exceeded those of the other four countries. So the reference period can be regarded more "fair" for Japan.

TABLE I: CO_2 EMISSIONS (KG PER PPP $ of GDP) [11]

Year	1990	Average from 2003 to 2007
Japan	0.455	0.309
Germany	0.555 (1991)	0.300
UK	0.573	0.273
France	0.364	0.196
Spain	0.412	0.279

III. GHG EMISSIONS

During CP1 both Japan and the EU bubble achieved their GHG reductions targets, 6% and 8% respectively. Table II indicates the net change of GHG emissions without Land Use, Land Use Change and Forestry (LULUCF) or the flexible mechanism. Compared with 1990, EU reduced GHG emissions by 11.6%, while Japan increased GHG emissions by 1.4%. Within the EU bubble, 15 countries jointly accepted the obligation of 8% reduction, to which Germany, UK, and France contributed the most. These three counties accounted for as much as 106.3% of the total reduction of the EU bubble. Spain increased GHG emissions and reduced as much as 13.8% of the total reduction.

Table III features the contribution of three groups of GHGs (i.e. CO_2, CH_4 & N_20, and CFCs) to the whole change of GHGs compared to 1990 and 2003-2007. In Japan, total GHG emission increased 269 $MtCO_2e$ (4.2%), in which CO2 increased by as much as 145.6% of the whole, while CH4 & N2O, and CFCs contributed towards reduction by 36.8% and 8.8% of 269 $MtCO_2e$, respectively. In contrast to Japan, Germany, UK, and France reduced GHG, in particular CO2, by 73.4%, 50.5%, and 85.6%, respectively. Spain increased total GHG mostly by CO_2 and the other two groups of GHGs also increased.

In comparison with 2003-2007 the five countries reduced their collective GHGs. CO_2 reduction was the greatest, followed by CH_4 & N_2O, while CFCs increased slightly.

TABLE II: NET CHANGE OF GHG EMISSIONS IN CP1 [12]

	Change in CP1 ($MtCO_2e$)		Compared to 1990
Japan	86		1.4%
EU15	-2,483	Contribution to EU	-11.6%
Germany	-1,456	58.6%	-23.6%
UK	-905	36.4%	-13.0%
France	-281	11.3%	-10.0%
Spain	3431	-13.8%	23.7%

IV. CO_2 EMISSION

A. Contribution by Sector

Table IV shows contribution of each sector to the change of CO2 emission. Compared to 1990, Japan largely increased emissions from the energy sector (142.9%) and the transport sector (16.1%), while it reduced emissions from the manufacturing industry, construction and others (58.9%). As a result, Japan increased 482 $MtCO_2eq$ (8.9%) in total. Germany, UK, and France, on the contrary, achieved net reduction of CO_2 emission by 21.9%, 15.4%, and 14.6%, respectively. The three countries reduced CO_2 emissions from the energy sector. In Spain, CO_2 emission increased by 32.4%. The major contributors were the transportation sector (48.7%) and other sectors (24.6%), while the energy sector had a relatively small negative impact (18.8%).

In comparison with 2003-2007, all the five countries achieved reduction of CO_2 emission and only the Japanese energy sector presented a significant negative contribution.

B. Change of CO_2 Emissions by Sector

Table V shows the change of CO_2 emission by sector. Compared to 1990, Japan and Spain increased CO_2 emission from the energy sector by 39.0% and 16.2%, respectively, while Germany, UK, and France decreased. The manufacturing industry and construction sector of all countries except Spain achieved reduction. The transport sector of all countries except Germany increased emissions. The other sector of Spain increased by 65.0%. In general, Japanese sectors except for energy, showed the same trend with Germany, UK, and France.

In comparison with 2003-2007, all five countries achieved reduction of CO_2 emission. In Japan, only the energy sector increased by 9.3%, while manufacturing and construction, transport, and the other sector reduced emission by 13.1%, 7.9%, and 18.8%, respectively. The energy sector of all countries except Japan, the manufacturing and construction sector of all countries except Germany, the transport sector of all countries, and the other sector of all countries except Spain achieved reduction.

C. Factors to CO_2 Reductions in Germany, UK, France, and Spain

In Germany the major factors contributing to CO_2 reduction were, improvements in the efficiency of the energy supply facilities and the economic reform of East Germany [13]. The government of Germany has reported that the expansion of renewable energy further contributed to the reduction. In 2013 the share of renewable energy in gross electricity consumption rose up to 25.3%, in gross final energy consumption to 12.0%, and in the transport sector to 5.5% [14].

In UK, the major contributing factors were the liberalization of the electric markets and the switch of fuel for power generation from coal & oil to natural gas [13]. The government of UK has reported that the conversion of fuel for power generation, improvement in energy efficiency and fuel conversion in industrial process contributed further to the reduction. Energy supply increased 13% in 2013 compared to 1999, as conversion of fuel from coal to gas had been promoted until 1999. From 1999 to 2006, the trend went in the opposite direction because of the high price of natural gas. From 2006 to 2013, the conversion from coal to gas made progress again. Energy efficiency also further increased [15].

France, registered phenomenal improvements in its energy sector between 2005 and 2009 due to the establishment of the emission credit market and its promotion of the energy conservation policy. The economic recession in 2008 had its effect too [16].

TABLE III: CONTRIBUTION OF EACH GHG TO THE CHANGE OF TOTAL EMISSIONS [13]-[18]

	Change from 1990 ($MtCO_2eq$)		Contribution to the Change (%)			Change from 2003-2007($MtCO_2eq$)		Contribution to the Change (%)		
			CO_2	CH4 and N_2O	HFCs and others			CO_2	CH4 and N_2O	HFCs and others
Japan	269	4.2%	145.6	-36.8	-8.8	-342	-4.9%	98.5	5	-3.3
Germany	-1,563	-29.7%	73.4	26.7	-0.2	-342	-6.8%	80.3	20.2	-0.4
UK	-986	-24.4%	50.5	49.1	0.5	-455	-13.0%	71.7	30.4	-2.1
France	-201	-7.3%	42.7	76	-18.7	-207	-7.5%	87.8	18.4	-6.2
Spain	384	26.4%	85.6	7.5	6.9	-316	-14.7%	97	5.4	-2.5

TABLE IV: CONTRIBUTION OF EACH SECTOR TO THE CHANGE OF CO_2 EMISSIONS [13]-[18]

	Change from 1990 ($MtCO_2eq$)		Contribution to the Change (%)				Change from 2003-2007($MtCO_2eq$)		Contribution to the Change (%)			
			Energy	M & C	Transport	Others			Energy	M & C	Transport	Others
Japan	482	8.9%	142.9	-53.6	16.1	-5.3	-290	-23.6%	-72.4	84.7	31.7	55.8
Germany	-1,079	-21.9%	33.2	29.9	4.2	32.7	-239	-5.8%	57.3	-3.5	17.2	29
UK	-431	-15.4%	51.5	42.4	-3.7	9.8	-292	-11.0%	40.6	33.1	15.3	11
France	-53	-2.9%	82.8	161.9	-117.4	-27.3	-167	-8.6%	19	34.3	24.1	22.6
Spain	332	32.4%	18.8	7.9	48.7	24.6	-268	-16.5%	51.6	29.1	21.5	-2.2

TABLE V: CHANGE OF CO_2 EMISSIONS FROM EACH SECTOR [13]-[18]

	Change from 1990				Change from 2003-2007			
	Energy	M & C	Transport	Others	Energy	M & C	Transport	Others
Japan	39.0%	-13.6%	7.8%	-3.5%	9.3%	-13.1%	-7.9%	-18.8%
Germany	-16.9%	-34.9%	-5.6%	-32.9%	-7.2%	1.4%	-5.1%	-33.5%
UK	-18.8%	-38.0%	2.8%	-7.7%	-11.0%	-24.5%	-7.1%	-17.1%
France	-13.4%	-20.0%	10.5%	3.1%	-10.0%	-14.2%	-5.7%	-7.2%
Spain	16.2%	11.8%	55.5%	65.0%	-23.5%	-24.0%	-11.3%	3.0%

In Spain, the share of renewable energy has been as high as 5.8% since 2005. In 2012 the share in the final energy consumption reached 14.3%. Between 2005 and 2012 the final energy consumption decreased at a high pace because of the installation of high-efficiency natural gas power generation and the dissemination of energy conserving home apparatus. In Spain too, the economic recession did its bit [17].

V. CO_2 Emission in Japan

A. Trend during CP1

As discussed above, compared to 2003-2007, the EU bubble reduced its CO_2 emission during CP1 and the energy sector contributed to it. On the contrary, Japan's energy sector increased the emission by 9.3% leading to a total increase of 1.4% in GHG emission in CP1.

According to the government of Japan, in 2008 and 2009, its CO_2 emission decreased but in 2010, the CO_2 emission turned the other way because of increases in energy consumption and the GDP per capita, even as the carbon intensity in power generation continued to decrease. In 2011 and 2012, CO_2 emission increased further because of the significant increase in carbon intensity for power generation even as per capita energy consumption decreased [18].

TABLE VI: EMISSION WITH/WITHOUT THE NUCLEAR POWER ACCIDENT COMPARED TO 2003-2007 [18]

$MtCO_2eq$	With accident	Without accident
Energy	210	52
M & C	-246	-238
Transportation	-92	-91
Others	-162	-146
Total	-290	-423

Basically, fossil fuels consumption increased following a nuclear power plant accident in 2011. Table VI presents CO_2 emissions negating the nuclear power accident in 2011 to show that emission levels in 2011 and 2012 would have been the same as in 2010.

Without the accident, CO_2 emission from the energy sector would still have increased. In the other three sectors, the emission would not have changed much, and the total

reduction would have been about 423 $MtCO_2eq$, or about 133 $MtCO_2eq$ more than the actual case.

B. Demand-Side Reductions

Japan's energy policy was determined by the Basic Energy Plan, which is decided by the Cabinet. The Basic Energy Plan of 2007 [19] defined four principles:

1) To achieve maximum reduction of energy consumption by energy conservation;
2) To steadily promote nuclear power including establishment of the nuclear-fuel recycling system;
3) To promote development and use of renewable energy; and
4) To switch fuel from coal and oil to gas, to promote clean coal and oil technologies, and to increase efficiency of power generation.

The first of the four principles, defining the demand-side policy, actually contributed to CO_2 reduction. Under this principle, various policies and measures were successfully implemented in four areas (i.e. business and household, transport, industry, and cross-sectoral).

1) Business and household

Four measures were implemented for business and household:

1) Top-runner method and labelling for apparatus of high-efficiency based on the Energy Conservation Law;
2) Promotion of energy consumption management by utilizing IT technology;
3) Promotion of energy conservation business including Energy Service Company (ESCO); and
4) Promotion of energy conservation of house and buildings and energy performance indicators.

Under the Top-runner method, designated energy-consuming apparatus are required to satisfy special energy efficiency standards, which are set at the same level as the most energy-efficient products of a designated year in the market (Top-runner). Top-runner method has been substantially contributing to improve energy efficiency of various apparatus. Number of designated apparatus has been increasing year by year. In 2009, designated apparatus as a whole consumed around 60% of electricity and around 70% of the total energy in a household. As of 2004, air-conditioners achieved 67.8% improvement in efficiency compared to 1997, refrigerators 55.2% to 1998, and freezers 29.6% to 1998. As of 2008, TV sets achieved 29.6% compared to 2004, and microwave-ovens 10.5% to 2004 [20]. As for compliance of house and building to energy standards, about 30 to 50% of houses, depending on their sizes, reached the standards in 2013, and about 90% of large buildings complied in the same year [21].

In the household, however, while energy efficiency of apparatus was increasing, the number of the household increased 31.6% in 2012 compared to 1990. In the business area, while the carbon dioxide emission per floor-area is decreasing, the floor-area itself increased by 42.9% compared to 1990. This cancelled the reduction achieved by improved efficiency [22].

2) Transportation

Three measures were implemented for transportation:

1) To require large transport enterprises and large consigners to formulate their individual Energy Conservation Plan based on the Energy Conservation Law;
2) To improve fuel efficiency of vehicles by the Top-runner method, and to promote diesel-fueled vehicles; and
3) To improve traffic flows, to promote modal-shifts to trains and vessels, and to improve efficiency of the distribution systems.

By the implementation of the Top-runner method, as of 2012, gasoline-fueled passenger-vehicle achieved 74.4% improvement in fuel-efficiency compared to 1996 [20], and as of 2005, diesel-fueled freight vehicles improved efficiency by 21.7% compared to 1995 [21].

3) Industry

Measures for industry included promotion of R&D for energy conservation, investment in energy conservation, official support to energy conservation for small and medium sized enterprises (SMEs), promotion of energy conservation business, as well as thorough energy management of factories and offices based on the Energy Conservation Law.

Under the financial support scheme for SMEs, 3,863 SMEs obtained subsidies to the tune of US$ 760 million during 2013 and 2014. On average 1kL of crude oil was saved with an investment of about US$ 455. The accumulated saving between 2004 and 2014 amounted to 4.8 ML of crude oil, which is as much as 3% of the total energy consumption of industry in 2013 [20]. 90% of factories and 40% of offices were covered under the regulation of the Energy Conservation Law [20].

In addition, Keidanren, an association of large enterprises in Japan, formulated Voluntary Action Plan and achieved 12.1% reduction compared to 1990, including emission credits purchased from abroad [23].

C. Supply-Side

Table VII shows the sources of electricity generation for the five countries. Before the nuclear power accident, share of renewable and wastes in Japan was 11%, the second lowest to UK. Fossil fuels generated 62% electricity, the second highest to UK. Both UK and Japan were heavily dependent on fossil fuels. In 2014, after the nuclear power accident, the share of renewable and wastes of Japan remained at 15%, the lowest among five countries, and the share of fossil fuels increased to 85%, the highest among the five countries.

While the Japanese government has been positive in promoting demand-side energy policy and has recognized it as the top among its four priorities, the Basic Energy Plan has been rather conservative regarding supply-side management and even negative in promoting renewable energy. The Basic Energy Plan of 2007 prioritized nuclear power over fuel change or renewables. It determined the promotion of nuclear power as the second highest priority and dedicated 8 pages of the Basic Energy Plan to describe the nuclear policy. It placed renewable energy as third priority and confined itself largely to the promotion of R&D. It lacked concrete measures and numerical targets, and the description was written in less than a page. The conversion of coal and oil to gas was

recognized as the fourth priority. No numerical target was given and the description was only 1.5 pages long.

TABLE VII: BREAKDOWN OF ELECTRICITY GENERATION BY ENERGY SOURCE [24]

2009	Japan	Germany	UK	France	Spain
Nuclear	27	23	18	77	18
Coal	27	44	28	4	12
Oil	7	0	0	0	0
Gas	28	13	45	4	36
Hydro	8	0	0	11	9
Wind	0	7	3	2	14
Biomass and Wastes	0	6	4	0	0
Others	3	6	3	2	10
Renewable and Wastes	11	19	10	15	33
Fossil fuels	62	57	73	8	48

2014	Japan	Germany	UK	France	Spain
Nuclear	0	16	19	76	17
Coal	30	45	32	3	12
Oil	12	0	0	0	0
Gas	43	10	30	3	22
Hydro	8	0	0	11	12
Wind	0	10	8	3	25
Biomass and Wastes	4	8	7	0	0
Others	3	10	4	3	11
Renewable and Wastes	15	28	19	17	48
Fossil fuels	85	55	62	6	34

The rigidity of the supply-side policy can also be observed in the government policy to attain Kyoto numerical target of 6%. It was actually revised four times after the adoption of the Kyoto Protocol. Table VIII indicates numerical targets for each item [22]. Japanese policy was consistent since the preparation of COP3 and until the revision of the principles in 2002 that it would not reduce carbon dioxide emission attributed to energy consumption and keep zero reduction compared to 1990. Moreover, in 2005 when the Kyoto Protocol became effective, Japan loosened the target to plus 0.6%. In 2008, just before CP1, it was further loosened to 1.3-2.3%. In fact, the actual emission had always exceeded the targeted emission. As a result, Japan emitted +6.7% more carbon dioxide compared to 1990. Japan achieved the 6% reduction target only by using LULUCF and by buying emission credits from other countries.

VI. RESULTS AND DISCUSSION

The difference between Japan and EU under the Kyoto Protocol can be attributed to the difference in their low-carbon policies for the supply-side.

The power grid and gas pipeline networks connecting countries have already been established in EU and they provide the base for EU supply-side policy implementation. Utilizing the infrastructure, EU integrated climate policy as a major element in its energy and economic policy, and materialized structural reforms in the energy supply-side. EU pursued co-benefits between energy security, which is the most important national agendum, and reduction of GHGs, developing a portfolio of policies with mitigated negative impacts to economic development and employment. Under the portfolio, EU developed engineering technologies and social systems that enables it to promote renewable energy use in a stable and economically affordable manner. In the beginning, however, the renewables were not stable or affordable. After the liberalization of the electricity markets, establishment of Feed-in-Tariff (FIT), and development of distribution systems to sufficiently accommodate the FIT, the renewables were rapidly expanded over EU. The total power supply system has been reformed based on a new concept that gives priority to renewables and accept them as much as possible, and respond to the changing demand by tuning the outputs from the other sources that are located in domestic and international transmission networks. Furthermore, European Union Emission Trading Scheme (EU-ETS) was established. It not only improves energy-efficiency by promoting R&D but also plays an effective role in controlling the total amount of GHG emissions.

On the other hand, the following four factors seem to hinder substantial CO_2 reduction from the energy sector in Japan.

1) Energy policy was prioritized over climate policy and the latter was not fully integrated with the former.
2) Electricity supply system is monopolized by seven power companies, and both the liberalization of energy markets and the separation of power generation and distribution are delayed.
3) Nuclear power is prioritized over the renewables.
4) Japan is a mountainous island country. The construction cost of transmission network is high. There exists no international network of power-grid or gas-pipe line network.

The climate policy was regarded as a constraint to the energy and economic policy. The government has been hesitating to adopt substantial supply-side policy change. There are several geographical and social reasons. There are no international networks to distribute electricity or natural gas. Domestically there exist two power distribution networks with different electric frequencies hindering nationwide power supply network. Japan does not have enough infrastructure necessary for low-carbonization of the supply-side.

Though Liberalization of the energy market is slowly progressing in Japan, the power generation and distribution are still monopolized by seven electric companies that were historically allocated own regions and so the realization of competitive markets are far beyond. Separation of power generation and distribution is scheduled in 2020 finally, but concrete rules or solutions for the above problems have not been proposed yet.

Recently, the government expressed its intention to establish a new concept of “non-fossil value” aiming to promote both the nuclear and the renewables together and to maintain nuclear power [25]. As almost all fossil fuels are imported, nuclear is regarded as “domestic source” since there is enough fuel already imported and stored for the nation’s energy security. Although the price difference

between renewables and nuclear is becoming smaller, nuclear is still more affordable as the imported gas is more expensive than for other countries due to the lack of an international pipeline. Moreover, the government wants to maintain its advanced nuclear technology. To compromise the public pressure to increase renewable and to maintain priority for nuclear, "non-fossil value" is a good solution. As a result, nuclear is prioritized over the renewables and the promotion of renewable has been less significant compared with EU. For example, a purchasing system for electric companies to buy the remaining electricity from offices and households equipped with solar cells were established as late as 2009, but it had to wait until 2012 to realize the full-fledged FIT system that applies to all renewables.

TABLE VIII: TRANSITION OF THE SUB-TARGETS OF GHGS FOR THE 6% REDUCTION OF JAPAN [22]

Year	1997	1997	1998	2002	2005	2008	2008～2012
National Target	Japan's position at COP3	Agreement at COP3	Ex-Principle	New Principle	Ex-Plan for 6% reduction	New Plan for 6% reduction	Actual GHGs Emissions
CO_2 from the Energy Sector	0%	0%	0%	0%	0.60%	+1.3～+2.3%	6.7%*
(Actual emission change from 1990)		(+8.5%)	(+5.7%)	(+13.1%)	(+14.3%)	(+8.1%)	
Revolution technology development & further efforts of various stakeholders	-2%	-2%	-2%	-2%	-	-	-
CO_2 from non-energy sectors, Methane, and N_2O	-0.5%	-0.5%	-0.5%	-0.5%	-1.2%	-1.5%	-3.1%
HFCs, etc.	-	2%	2%	2%	0.10%	-1.6%	-2.2%
LULUCF	-	-3.7%	-3.7%	-3.9%	-3.9%	-3.8%	-3.8%
Credit from other countries	-	-	Description without target	Description without target	-1.60%	-1.6%	-5.9%**
Total	-2.5%	-4.2%	-4.2%	-4.4%	-6%	-5.7～-6.7%	-8.3%
Difference from -6%	-	-1.8%	-1.8%	-1.6%	0	-0.3～+0.7%	2.3%

Note: * The CO_2 emission reductions +6.7% at Table VIII is based on the report at the end of CP1, while that at Table IV is +8.9% based on the latest data reflecting the revision of the IPCC guideline for reporting and addition of new sources of emission.

** The official accounting data at UNFCCC shows that Japan used credits for its 5.9% reduction (Government 1.6%、Private sectors 4.3%) from its total holding of 6.2% credits (Government 1.6%、Private sectors 4.6%).

The Nationally Determined Commitment (NDC) submitted by Japan based on the Paris Agreement stipulated that Japan's NDC is to be harmonized with the energy-mix. That implies that the mitigation policy is, as a matter of fact, located under the energy policy that determines the energy-mix, as it was during CP1 (Tsukamoto & Fujikura 2018). The same hierarchy is maintained in the Plan for Global Warming Countermeasures [26] that was decided by the Cabinet to realize the NDC. Hundreds of measures are described for the demand-side with concrete figures, while in the supply-side there are only a few measures (i.e. reform of the existing FIT system, technology R&D, establishment of the distribution system and rules to operate them, and rationalization of regulations, if necessary) with a target to double the amount of renewables in 2030 compared to 2013, or about 25% of the total energy supply, which Germany and Spain achieved in 2014.

One example of the slow uptake for renewables in Japan came to the fore in 2017 when the government announced an open-call for 0.5 MW of solar power generation under the FIT scheme, but received applications from the private sector for only 0.14 MW. The seven electric companies monopolizing the distribution systems frequently refused to accept newly installed renewables blaming the scarcity of capacity in the distribution systems. The private sector became reluctant to join the bidding. Naito questioned their claim arguing that it does not reflect the real situation [27].

The costs of solar power remain high in Japan compared to the rapid decrease observable elsewhere. The price of solar power systems on the ground in Japan is 2.5 US$/W, about twice that of Germany's and Italy's because of the high costs of construction and modules. Construction fee in Japan is about 1200 US$/kW, four times to 300 US$/kW in Germany and the construction period in Japan is two to seven times longer. Share of Japanese enterprises in the module market in Japan is as large as 70% leading to high costs of the module. In Germany, cheaper modules made by Chinese or Taiwanese enterprises have a large share of the market [28].

Japan still insists on the conventional system that puts priority to nuclear and coal power as the base-load sources and uses the other sources as the stabilizer to the fluctuation in demand. In order to recover the huge investments to develop nuclear power, operations of a long period (more than 40 years for each station) are required, making it further difficult to reform the existing system. The low-carbonization on the supply-side in Japan will continue to have difficulty. Some Japanese enterprises intend to survive international competition through promoting low-carbonization, taking into account the international trend of divestment from fossil fuels. Historically external pressures from abroad, or "gaiatsu", have made good or bad influences to Japan, stimulating big changes of policy. Sometimes the government itself used "gaiatsu" to realize difficult policy reforms. Low-carbonization of the

supply-side in Japan might be also triggered by "gaiatsu".

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