Long-term Low-carbon Vision

Global Environment Committee, Central Environment Council
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Foreword

In order to avoid the immense climate change risks to future generations, action must be taken now based on long-term policies and strategies that look to the year 2050 and beyond. Moreover, it must be recognized that there is no reversing the movements and trends of international initiatives aimed at achieving the decarbonized society that was agreed upon in the Paris Agreement, and that no retreat is permissible from targets that have been set for future reductions of greenhouse gas (GHG) emissions.

This "Long-term Low-carbon Vision" was prepared by the Central Environment Council with an eye to Japan's formulation of a long-term strategy concerning climate change policy that is required of signatories of the Paris Agreement. It was compiled with the aim of putting forth ways of thinking that should form the basis of that strategy from the standpoint of environmental policy and, particularly, a philosophy that clarifies Japan's role and a "vision" of the kind of country Japan should aim to become in the future. It is hoped that the strategy as well as the programs implemented to give shape to it will be formulated with reference to this Vision.

Japan should make it its orientation and philosophy to become a country that contributes to international society's sustainable growth and development and that is looked to with expectation and trust by international society through initiatives aimed at achieving decarbonization and low-carbonization. This Vision presents what Japan must do over the medium and long term, based on a precise understanding of targets agreed upon by international society. In studying those actions, we stressed above all else the scientific knowledge that forms the foundation of the Paris Agreement and, further, placed importance on a long-term perspective.

The "Plan for Global Warming Countermeasures" that was approved by the Cabinet on May 13, 2016, already states, "Leading the international community so that major emitters will take steps to reduce their emissions in accordance with their abilities based on the Paris Agreement and within a fair and effective international framework in which all major countries participate, Japan will, as a long-term target, aim to reduce its GHG emissions by 80% by the year 2050 while balancing global warming countermeasures and economic growth." Further, the same plan also points out that "the achievement of such a long-term significant reduction of GHG emissions will be difficult with the extension of conventional initiatives alone." In other words, this long-term target, which presents the direction that Japan must take to achieve an 80% reduction by 2050, differs in nature from another target mentioned in the same Plan for Global Warming Countermeasures that calls for reducing emissions by 26% compared to 2013 by the year 2030. Thus, it must be remembered that, when studying the ideal future for Japan that is presented in this Vision based on the long-term target, applying the measures that are identified in consideration of the 2030 target in the plan—or more specifically, measures that involve simply building on what can be achieved by extending out already existing technologies and systems—will not be able to adequately attain the target.

The Plan for Global Warming Countermeasures goes on to state, "Accordingly, Japan will pursue, to the maximum degree possible, solutions that are based on innovation, including the development and dissemination of innovative technologies that make possible fundamental emissions reductions, and will strive to achieve major emissions reductions within long-term and strategic initiatives while simultaneously encouraging domestic investment, raising international competitiveness, and seeking broad knowledge among the citizenry. Moreover, Japan will also contribute to global reductions." Taking this Cabinet decision as a basis, this Vision presents a future policy direction that incorporates various recommendations, such as the fact that not only technical innovation but

also innovation of economic and social systems and lifestyles are included within the scope of innovation, and the fact that climate change measures also contribute to the simultaneous solution of the various challenges facing Japan, among them economic growth, regional revitalization, and the falling birthrate and aging society. We hope that the thinking presented in this Vision will be adequately reflected in Japan's policy and that, along with this, a strategy for medium- and long-term initiatives that incorporates effective policies and measures (PaMs) and also looks ahead to the end of the current century, as well as programs that give concrete shape to that strategy, will be formulated in the very near future.

Chapter 1 describes climate change primarily from the standpoint of scientific knowledge-based initiatives. Climate change is an actually observed scientific fact and may cause irreversible risks for the ecosystem and human society into the future.

The Paris Agreement, based on such scientific knowledge pertaining to climate change, presents targets that include what is called the “2°C target” and the effective elimination of GHG emissions throughout the world. It has been agreed to by 197 countries and regions. The building of a decarbonized society throughout the world while efficiently using a “carbon budget” (requiring the suppression of cumulative emissions throughout the world to approximately 1 trillion tons) will form the bedrock of climate change policy for reaching these targets.

Based on the Paris Agreement, Japan has set a medium-term target of a 26% reduction from the FY2013 level in FY2030 and a long-term goal signaling the desired way forward of an 80% decrease in 2050. It will be necessary to promote scientific knowledge-based initiatives to achieve these targets.

Chapter 2 describes international trends that are occurring in light of the Paris Agreement. As a result of the Paris Agreement, climate change policy has become a promising field in which a “promised market” requiring continuous long-term investment will be created and in which companies can actively invest with a clear view of their prospects. For example, according to a calculation by the IEA, decarbonizing the electric power sector under the 2°C scenario will require approximately nine trillion USD in additional investment between 2016 and 2050, and reaching energy conservation goals in the three sectors of building, industry, and transport will require approximately three trillion USD in additional investment between 2016 and 2050.

Today, as the world enters a major period of transition, which includes the emergence of a vast market that will be sustained into the future, many actors—among them the countries of the world, local governments, private companies, financial industries, and ordinary citizens and scientists—are taking action toward building a decarbonized society throughout the world.

Chapter 3 examines the economic and social challenges that Japan faces. As its population decreases, its outlying regions become depopulated, and its society grows older, Japan must address economic revitalization and various challenges of regional and international society. Approaches to these challenges could include shifting from “quantity to quality” by, for example, raising added-value productivity (labor productivity based on added value); bringing out regions’ inherent originality; and utilizing “soft power.”

Moreover, although various factors deserve consideration when studying a future vision of Japan within the context of a modern society marked by dramatic change and complex interrelationships among various phenomena, particular attention must be paid to the advancement of ICT, which has the potential to bring about a significant transformation in all fields and sectors.

Chapter 4 presents a basic concept aimed at long-term significant reduction with a view to building a decarbonized society based on the facts presented in Chapters 1 to 3. First, it examines the “simultaneous solution” of socio-economic problems that is triggered by climate change policy. We believe that the challenge of entering the vast “promised market” of the future is directly tied to growth strategy. Making maximum use of regional energy will help build robust local economies and lead to stronger resilience during disasters as decentralized and self-reliant energy is added to the existing power grid, thereby contributing to regional revitalization and national resilience.

Furthermore, as a nation possessing outstanding technologies and know-how, Japan can contribute to emissions reductions throughout the entire world. Accordingly, it can contribute to stronger climate security as it also strengthens its own energy security by raising its energy self-sufficiency.

Being the fifth largest emitter in the world and possessing outstanding technologies, Japan will continue to promote long-term significant reductions domestically while also making a contribution to worldwide reductions through exports of advanced technologies and products, and supply-chain initiatives. Domestically Japan has considerable room for major reductions, particularly in the civilian sector and transport sector. By advancing in a multi-faceted manner efforts aimed at encouraging the purchase of low-carbon products to replace conventional products, at eliminating emissions from houses and buildings, at reforming urban and regional structures, and at diffusing decentralized and self-reliant energy, while at the same time making unceasing efforts to further improve the industrial sector's carbon productivity, Japan will encourage low-carbon investment and create a vast new domestic market, thereby achieving long-term significant reduction. Progress is being made in the achievement of major emissions reductions toward a decarbonized society in other countries as well, and amid expectations that competition in the "promised market" will become fierce, Japan must accumulate knowledge in the forms of technology and know-how so that it can continue contributing to worldwide reductions while maintaining a high level of international competitiveness. Initiatives aimed at achieving significant domestic reductions are a source of international competitiveness.

Moreover, in addition to the maximized use of existing technologies, know-how, and knowledge, achieving long-term significant reduction will require innovation that breaks away from conventional paths. Promoting innovation improves productivity and is directly linked to economic growth. Thus, the creation of innovation in terms of technology, socio-economic systems, and lifestyle that is driven by climate change policy is the key to the simultaneous achievement of long-term significant reduction and the solution of economic and social challenges.

The time to tackle the aforementioned points is now. Japan must accelerate its actions as soon as possible, taking into consideration the carbon budget, carbon "lock-in" effects (once introduced, urban structure as well as large-scale equipment and other forms of infrastructure bring high CO_2 emission levels for many years), and other relevant standpoints.

Chapter 5 presents a vision of Japanese society capable of achieving the target of an 80% reduction by 2050, as a means toward building a decarbonized society throughout the world.

The mainstays of measures here will be (1) thorough energy conservation, (2) promotion of low-carbonization in electric power generation through use of renewable energy and other technologies, and (3) a shift toward electrification and use of low-carbon fuels. The chapter illustrates a vision of a society that will achieve an 80% reduction by 2050 in which, for example, CO_2 emissions from citizens' daily lives (e.g., from households, family cars) have been reduced to almost zero, more than 90% of supplied energy comes from electricity generated from low-carbon sources (e.g., renewable energy, thermal power generation with CCS, and nuclear power), and lumber and other regional resources as well as local energy are utilized.

Chapter 6 outlines the direction of policy oriented toward realizing the vision presented in Chapter 5. The fundamental direction will be the full-scale implementation of all PaMs for the maximum use of existing technologies, know-how, and knowledge and the creation and dissemination of new innovation.

We believe that means of achieving long-term significant reductions include steady actions based on the current “Plan for Global Warming Countermeasures” together with, as the thrust of main PaMs, (1) “carbon pricing” that strengthens the market competitiveness of low-carbon technologies, products, and services by offering emissions-reduction incentives to all actors of the world; and (2) preparation and disclosure of environmental information, technical development, land use, human resources development, and contribution to worldwide emission reductions.

Moreover, steady progress must be made on initiatives that are oriented toward long-term significant reduction. Japan will tie such initiatives to more effective and successful emissions reduction by reviewing progress with attention to cumulative emissions.

Chapter 1: Climate Change

Climate change is an actually observed scientific fact and could possibly lead to irreversible risks for the ecosystem and human society into the future.

The Paris Agreement, which sets forth targets that include what is called the "2°C target" and the effective elimination of GHG emissions throughout the world, has been agreed to by 197 countries and regions. In order to achieve these targets, the building of a decarbonized society throughout the world,[1] while efficiently using a "carbon budget"[2] as the foundation for science-based initiatives, will form the bedrock of climate change policy.

Based on the Paris Agreement, Japan has set a 26% decrease in emissions in FY2030 compared to the FY2013 level[3] as a medium-term target and an 80% decrease in 2050 as a long-term goal that shows the desired way forward.

(1) Scientific knowledge concerning climate change

(a) Climate change is a threat to society

Observed changes and their causes

According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (hereinafter "IPCC"),[4] which was released between 2013 and 2014, there is no room for doubt that the Earth's climate system is warming, and many of the changes that have been observed since the 1950s are unprecedented on time scales of several decades to several millennia (see Figures 1 and 2 and Page 3 of the Reference Materials). For example, the global mean surface air temperature, obtained by combining land and sea-surface temperatures, rose 0.85°C between 1880 and 2012. Climate change in recent years is having effects that extend broadly throughout the world, including warming of the atmosphere and oceans, smaller amounts of snow and ice, rising sea levels, and ocean acidification. According to the results of carbon dioxide and methane measurements taken by the Ministry of the Environment, National Institute for Environmental Studies, and Japan Aerospace Exploration Agency (JAXA) using "IBUKI," a greenhouse gas-observing satellite (GOSAT), average monthly concentrations of carbon dioxide for the entirety of the Earth's atmosphere are rising year by year with seasonal variations, and the measurement for May 2016 was 402.3 ppm, which was the highest ever recorded (as of October 27, 2016) (see Page 4 of the Reference Materials). Thus, it is very highly probable (at least 95%) that GHG emissions from human sources are the dominant factor behind the warming that has been measured since the mid-20th century.

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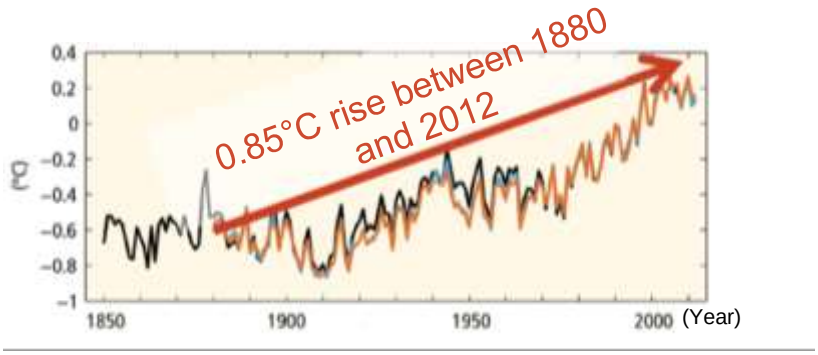
1 See Chapter 1 (1) (c)

2 In this report, the "[achievement of] a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century" that is specified in Article 4-1 of the Paris Agreement—specifically, the effective elimination of anthropogenic emissions throughout the world—is referred to as a "decarbonized society."

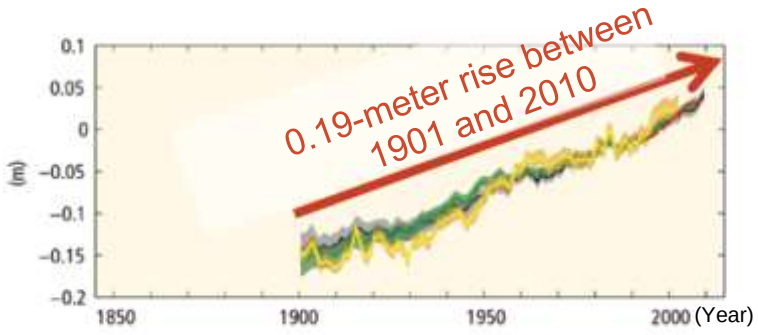
3 The Plan for Global Warming Countermeasures (Cabinet decision of May 13, 2016) states that Japan's GHG emissions in FY2013 amounted to approximately 1.408 billion tons.

4 Intergovernmental Panel on Climate Change



From AR5 SYR SPM Fig. SPM.1(a),(b) (IPCC)

Figure 1 Changes in the Global Mean Air Temperature Deviation when Land and Sea Surface Areas are Combined



From AR5 SYR SPM Fig. SPM.1(a),(b) (IPCC)

Figure 2 Changes in the Global Mean Sea Level when Land and Sea Surface Areas are Combined

Future climate change: Risks and effects

The Fifth Assessment Report includes predictions of the climate of the future that are based on four scenarios called Representative Concentration Pathways (RCP[5]), the results of which forecast that the degree to which the global mean surface air temperature will rise by the end of the 21st century (2081 to 2100) compared to the 1986-2005 average is highly likely to fall into the 2.6 to 4.8°C range in the scenario in which no countermeasures that go above and beyond the current situation are executed and GHG emissions are extremely large (RCP8.5); and it is highly likely to fall into the 0.3 to 1.7°C range in the scenario in which strict mitigation measures are executed (RCP2.6) (probability of 66 to 100%). As for the oceans, it is predicted that rising seawater temperatures and acidification will continue, and that the global mean sea level will continue to rise (see Page 5 of the Reference Materials).

The Fifth Assessment Report presents five “reasons for concern” as major future risks[6] affecting multiple sectors and regions, namely: i) unique and threatened systems, ii) extreme weather events, iii) distribution of impacts, iv) global aggregate impacts, and v) large-scale singular events. Together with these, the report also arranges sectoral risks that include freshwater resources, terrestrial and freshwater ecosystems, coastal systems and low-lying areas, and marine systems. According to

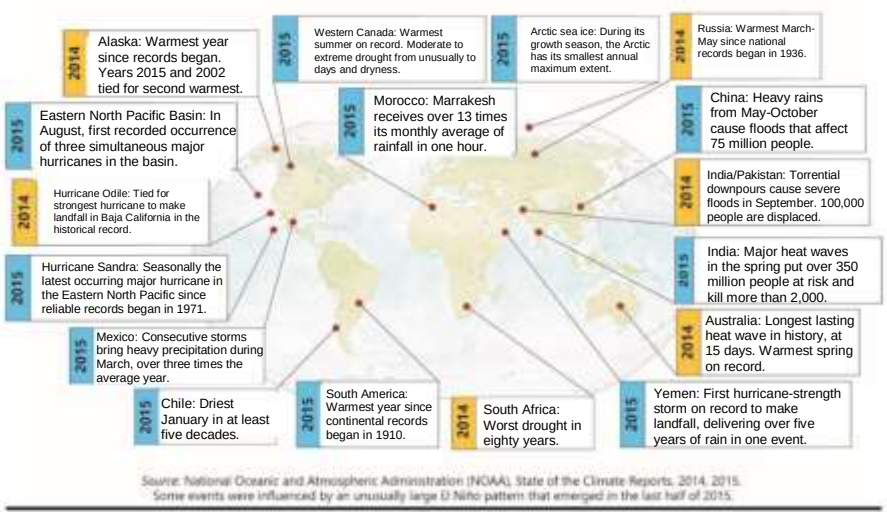
[5] Representative Concentration Pathways
[6] Potentially serious impacts related to the “dangerous anthropogenic interference with the climate system” that is mentioned in Article 2 of the United Nations Framework Convention on Climate Change

this, for example, a 1°C rise in atmospheric temperature would lead to the risks attributable to extreme events (heat waves, extreme rainfall, coastal flooding) being high, and a 2°C rise in atmospheric temperature would expose many species of organism and systems that have limited ability to adapt (particularly arctic sea ice and coral systems) to extremely high risk. If the atmospheric temperature rises more than 3°C, because of the possibility of rising sea levels caused by large-scale and irreversible ice sheet loss, the risks associated with the "tipping point"[7] would increase (see Page 6 of the Reference Materials).

Climate change will also give rise to new risks for human society. For major crops of tropical and temperate zones (wheat, rice, and corn), although a rise in temperature in those zones of 2°C or more compared to late 20th-century levels may be beneficial in certain locations, it is predicted that failure to adapt to climate change will have negative impacts on production. In urban areas, it is predicted that risks associated with heat stress, destructive storms and torrential rainfall, inland and coastal flooding, landslides, air pollution, drought, water scarcity, and rising sea levels and storm surges will increase. In rural areas, a changing climate may lead to global shifts in suitable production areas for food and non-food crops, but on the other hand since such areas may not have infrastructure such as water supply available, there will be accompanying risks in securing supply, leading to large impacts on food security for the country and on incomes for farmers.

By the middle of this century, predicted climate change will affect human health primarily by worsening existing health problems. It is expected that, over the course of the 21st century, climate change will bring greater health hazards to many regions, particularly low-income developing countries, compared to a baseline with no climate change. Examples include higher possibility of disability, illness, or death as a result of stronger heat waves and fires, and greater risk of foodborne and waterborne infectious diseases.

Furthermore, in the Fifth Assessment Report, climate change-caused increases in forced migrations of people and impacts on national security policy are predicted. Such impacts on security policy are also mentioned in a report prepared by the United States' National Intelligence Council (NIC) in September 2016 (see Figure 3 and Page 7 of the Reference Materials).



*However, wholly attributing each of the instances of extreme weather shown in the above figure to climate change is difficult.
Excerpted from material presented by Yasuko Kameyama to the Long-Term Low-Carbon Vision Subcommittee (Fourth Session), Global Environment Committee, Central Environment Council

Figure 3 Report of the US National Intelligence Council (NIC)

[7] A level of change (critical point) in system properties beyond which a system reorganizes, often abruptly, and does not return to the initial state even if the drivers of the change are abated

The economic aspects of climate change's impact have been reported in various studies, among them the Stern Review. In a recent calculation, Citigroup estimated that the cost of climate change countermeasures between 2015 and 2040 (190.2 trillion USD) will be 1.8 trillion USD lower than the cost of taking no countermeasures (192 trillion USD). Moreover, Citigroup estimated that lost GDP if no climate change countermeasures are implemented will amount to 20 trillion USD in the case of a 1.5°C increase, 44 trillion USD in the case of a 2.5°C increase, and 72 trillion USD in the case of a 4.5°C increase by 2060 (all estimates with a 0% discount rate).[8]

Furthermore, looking at climate change's effects on Japan, the "National Plan for Adaptation to the Impacts of Climate Change" (Cabinet decision of November 27, 2015) states that extreme weather events are being observed and that floods and landslides, for example, are occurring almost every year in all parts of Japan and causing tremendous damage. It additionally notes that higher temperatures, changes in precipitation, and other various forms of climatic change, sea level rise, and acidification of the oceans are possible in the future, and also presents predictions based on a climate change assessment report[9] of impacts to be felt in various areas. These include increased disaster risk (such as increasingly serious water shortages, floods and landslides, and storm surges and tidal waves), deteriorating water quality, further deterioration in crop quality, increased frequency of summer heat waves, and a change in the feeling of the seasons due to the change of the cherry blossom period and so on.

(b) The 2°C target and effective elimination of GHG emissions

Substantial mitigation of the various risks mentioned in (a) above will be achieved by significantly reducing GHG emissions over the next several decades and controlling global warming in the latter half of the 21st century and beyond. Given that, for the most part, rises in global mean temperature through the end of the 21st century and beyond will be determined by cumulative emissions of carbon dioxide, controlling the various climate change risks means limiting cumulative carbon dioxide emissions.

It is considered highly probable (probability of at least 66%) that emissions scenarios in which GHG concentrations are approximately 450 ppm CO_2-eq or below in the year 2100 will be capable of maintaining a temperature rise less than 2°C in comparison to the preindustrial level. Such scenarios have the characteristic of significantly reducing annual emissions over several decades into the future, with anthropogenic GHG emissions being reduced by between 40% and 70% compared to the 2010 level by 2050 and emissions levels falling to almost zero or below by 2100 (see Page 8 of the Reference Materials).

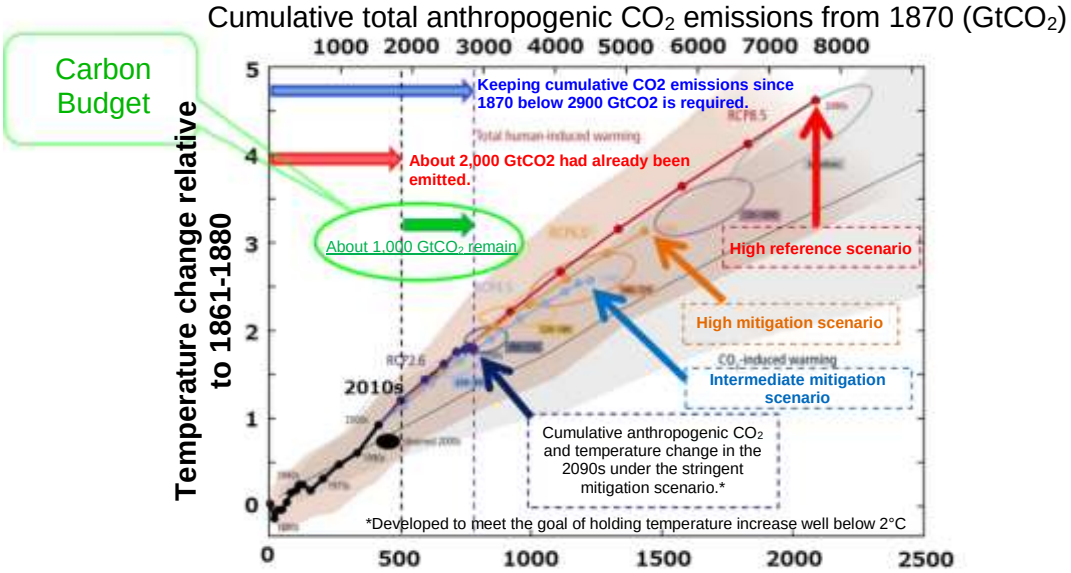
A range exists in scientific estimates of climate sensitivity,[10] which is a parameter that correlates these emissions scenarios and degree of climate change, and this range produces a breadth of values in the long-term prediction of climate change when particular emissions scenarios are realized. Likewise, there is a range in estimates of the temperature rise threshold, etc., where the tipping point will occur. Additionally, in the report of Working Group I of the Fifth Assessment Report, no best estimate for climate sensitivity could be given "because of a lack of agreement on values across assessed lines of evidence and studies." Because such ranges in values can significantly

[8] Citi GPS; ENERGY DARWINISM II, Aug 2015
[9] "On the Report regarding Assessments of Climate Change Impacts in Japan and Future Challenges" (submitted by the Central Environment Council in March 2015)
[10] Degree of change in the global mean surface temperature when change (in the climate system) caused by doubling the atmospheric CO2 concentration reaches equilibrium

influence long-term analyses, continued accumulation of scientific knowledge will be required to ascertain actual circumstances and improve prediction accuracy. On the other hand, climate sensitivity may be lower than the 3°C presented as the best estimate at the time of the Fourth Assessment Report, but it may also be higher. In terms of risk management, it is important to advance global warming countermeasures that consider both possibilities, and it is appropriate to proceed with discussions based on knowledge obtained from the Fifth Assessment Report's Synthesis Report while also referring to the latest knowledge made available since the report.

(c) The carbon budget

According to the Fifth Assessment Report's Synthesis Report, it is becoming clear that there is a strong, consistent, and almost linear relationship between cumulative CO_2 emissions and projected global temperature change to the year 2100. Limiting total human-induced warming to less than 2°C relative to the period between 1861–1880 with a probability of greater than 66% would require keeping cumulative CO_2 emissions from all anthropogenic sources since 1870 below roughly 2,900 $GtCO_2$ (2.9 trillion tons) (with a range of between 2,550 to 3,150 $GtCO_2$ depending on non-CO_2 drivers). Given that roughly 1,900 $GtCO_2$ had already been emitted by 2011, keeping cumulative emissions to below roughly 2,900 $GtCO_2$ will require holding global cumulative emissions at roughly 1,000 $GtCO_2$, or approximately 1 trillion tons, in 2012 and beyond. "Carbon budget" is a phrase that expresses this idea (see Figure 4 and Page 9 of the Reference Materials.)



Prepared based on AR5 SYR Figure 2.3 (IPCC)

Figure 4 Cumulative Anthropogenic CO_2 Emissions and Climate Change

On the other hand, the corresponding cumulative carbon dioxide emissions for limiting anthropogenic temperature rise to 2°C with a probability exceeding 50% and exceeding 33% are 3,000 $GtCO_2$ (3 trillion tons, range of 2,900 and 3,200) and 3,300 $GtCO_2$ (3.3 trillion tons, range of 2,950 and 3,800), respectively. In other words, in order to limit warming to 2°C with higher probability, lower emissions are required. Given that there is a range in carbon sensitivity, in light of scientific knowledge available at the present time, a carbon budget of roughly one trillion tons remaining is indicated by the IPCC as the most reliable figure.

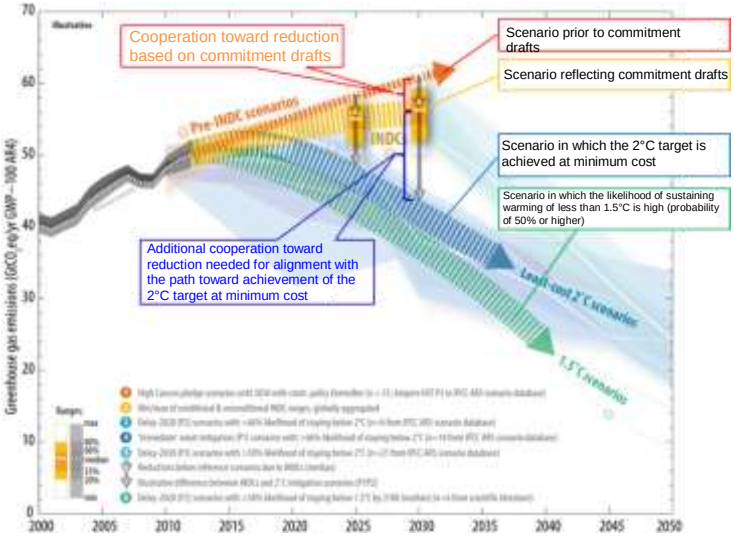
As stated in (a) above, it is feared that the effects of climate change may bring tremendous and irreversible damage to society in its entirety. Indeed, vis-à-vis the "environment as the foundation of human survival" (Article 3 of the Basic Environment Law), global warming will have a "serious impact on the environment of the entire planet" (Article 1 of the Act on Promotion of Global Warming Countermeasures). In light of the fact that the Paris Agreement clearly states that developed nations must take the lead by working to reduce absolute emissions throughout their economies, along with taking action to ensure that "interference with environmental conservation can be prevented in advance" (Article 4 of the Basic Environment Law) in reducing anthropogenic GHG emissions, which are the dominant factor behind the warming that has been measured since the mid-20th century, Japan must also execute countermeasures based on "preventive initiatives and methods" while working to further enhance scientific knowledge in areas that include adaptation to climate change.[11] Moreover, Japan experienced in the Great East Japan Earthquake how important it is to be prepared for "unanticipated" events. Based on these concepts, the building of a decarbonized society by the latter half of this century, together with effective use of the remaining carbon budget at the global level, forms the foundation of climate change policy oriented toward avoiding the serious impacts of climate change and holding off its irreversible aspects. We believe it is appropriate for Japan to play a role in leading the international community in tackling climate change.

According to a report issued by the UNFCCC[12] in May 2016 titled "Aggregate Effect of the Intended Nationally Determined Contributions: An Update," even when the commitment drafts submitted by all countries are aggregated, the total is not enough to achieve the 2°C goal at minimum cost, and thus additional reduction efforts will be required (the UNEP, IEA, and others have made the same point) (see Figure 5 and Page 10 of the Reference Materials). Moreover, the same report states that, when commitment drafts are aggregated, the result is that 2.629 trillion tons of CO2 will be emitted by 2030, and the remaining carbon budget is 261.0 billion tons. Thus, to limit warming to less than 2°C, countries' current reduction efforts are insufficient; each country must improve its countermeasures as quickly as possible and take steps toward further raising the ambitiousness of its nationally determined contribution (hereinafter "NDC").[13]

[11] Some within the subcommittee raised concerns about the idea of simply spending any amount to reduce GHG. Because anticipatory prevention and the preventive measures to be taken will differ depending on the risk severity, necessary costs will vary in accordance with the risk level. Thus, careful discussion with attention to the simultaneous solution of issues is, naturally, a prerequisite for study of concrete countermeasures and PaMs.

[12] United Nations Framework Convention on Climate Change

[13] Nationally Determined Contributions



Aggregate effect of the intended nationally determined contributions: Prepared based on "Aggregate effect of the intended nationally determined contributions: an update" (UNFCCC)

Figure 5 Gap between 2030 GHG Emissions and the 2°C Target

(2) Significance of the Paris Agreement

On December 12, 2015 (early in the morning of December 13 in Japan), the Paris Agreement—a new legally binding international agreement and the first in eighteen years, following the Kyoto Protocol—was adopted at the COP21 summit held in Paris, France (see Page 11 of the Reference Materials). Conditions for the Paris Agreement's coming into force were met on October 5, 2016, and the agreement entered into force on November 4. A total of 132 of the 197 countries and regions that are parties to the UN Framework Convention on Climate Change have entered into it (as of February 27, 2017). Japan signed the Paris Agreement in New York on April 22, 2016, and, with the Diet's approval on November 8 of the same year concerning Japan's signing of the agreement, deposited an instrument of acceptance with the UN Secretary-General on the same day. The Paris Agreement was promulgated and announced (Treaty No. 16 and Ministry of Foreign Affairs Announcement No. 437) on November 14 and came into force for Japan on December 8 of the same year.

The Paris Agreement is the first international agreement to set targets based on the scientific knowledge described in Section (1). Among these targets are "[to hold] the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels,"[14] "to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century," and "[to make] finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development." These targets were agreed upon by Japan and the entire international community as being based on the most precise scientific knowledge available at the present time. Given that it must faithfully comply with the Paris Agreement,[15] in order to achieve

[14] Article 2 of the Paris Agreement stipulates "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels." However, this Long-term Low-carbon Vision uses the more convenient term "2°C target" for ease of understanding.

[15] Article 98 paragraph 2 of the Constitution of Japan: The treaties concluded by Japan and established laws of nations shall be faithfully observed.

the Agreement's extremely ambitious and unavoidable targets, Japan must consider not only the accumulation of actions it is capable of taking now, but also what it needs to do going forward.

Aside from its stipulations concerning targets, the Paris Agreement is groundbreaking as an international framework because it contains regulations concerning the participation of all countries in a manner that exceeds the fixed dichotomy that is based on its Annex (specifically, the Annex I Parties [so-called "developed countries"] and Non-Annex I Parties [so-called "developing countries]), a mechanism for submitting and updating NDCs for a worldwide response to climate change every five years, the implementation of adaptation planning and action, and formulation and notification of long-term strategies for advancing low-carbonized GHG development.

Another important point is that the Paris Agreement is a mechanism for advancement and improvement toward achievement of its long-term targets with re-examinations of each country's targets, reporting and reviews, and a PDCA cycle that checks progress for the world as a whole (see Page 12 of the Reference Materials). Each country is obligated to prepare a "nationally determined contribution" that sets GHG reduction targets and other goals, and to sustain that contribution while executing domestic measures to achieve those targets.[16] Moreover, each country is obligated to update and submit its NDC every five years, and it is stipulated that the targets of that NDC will show progress from the previous targets. Prior to that, it is also stipulated that a study of the status of execution throughout the world compared to the objectives of the Paris Agreement (called a "global stock-taking") will be conducted every five years, and the results will furnish information when individual countries update and strengthen their initiatives. In this way, the Paris Agreement contained unprecedented characteristics—namely, that long-term targets are clearly stated in a document that forms a legal agreement applicable to all countries, and that a direction was spelled out toward improving mechanisms and ambition to promote climate change policy through international cooperation toward those long-term targets—and presented a clear message concerning the kind of society we should aim to build in the years to come. In other words, it is a turning point in international climate change policy that is founded on accumulated efforts through the UN Framework Convention on Climate Change and the Kyoto Protocol, and can be said to be a new point of departure.

Another important point is that the agreement mentions the participation of all countries in a manner that exceeds the fixed dichotomy that is based on its Annex (specifically, the Annex I Parties [so-called "developed countries"] and Non-Annex I Parties [so-called "developing countries]). Under the agreement, each signatory must prepare, provide notification of, and sustain successive NDCs that they intend to achieve; and each signatory must execute domestic mitigation measures for achieving the objectives of its NDC. Even if a particular signatory country's production-based emissions fall as a result of its execution of domestic measures, emissions may still rise globally if on the other hand the emissions of other countries rise with the generation of increased emissions that are associated with consumption in the signatory country and consumption-based emissions grow. The Paris Agreement aims for, as a goal that should be pursued by signatories, the achievement of a balance between anthropogenic emissions by sources and removals by sinks of GHG in the second half of this century. It goes without saying that achieving this goal will require reduction of both production-based and consumption-based emissions. In addition to reducing its production-based emissions, it is essential for Japan to also deploy its outstanding technologies, know-how and low-carbon lifestyles and systems to other countries while making behavioral

[16] Unlike the Kyoto Protocol, each country's reduction targets are not included in the text of the Paris Agreement, which is a legal agreement. Instead, a mechanism is used whereby each country sets, updates, and submits its targets.

changes that involve the active selection of low-carbon goods and services (see Page 13 of the Reference Materials).

(3) Japan's long-term targets

Changes in Japan's GHG emissions

Japan's GHG emissions in FY2015 (preliminary value) were 1.321 billion tons (see page 14 of the Reference Materials). Of this amount, CO_2 emissions from energy sources accounted for 1.148 billion tons. Breaking this figure down by sector, including indirect emissions due to consumption of electricity and heat, the industrial sector accounted for 413.0 million tons (approximately 36%), the commercial and other sectors accounted for 249.0 million tons (approximately 22%), the transportation sector accounted for 216.0 million tons (approximately 19%), the residential sector accounted for 182.0 million tons (approximately 16%), and the energy transformation sector accounted for 88.2 million tons (approximately 8%)[17] (see Page 16 of the Reference Materials). Additionally, the main high-emissions industries within the industrial sector[18] were manufacture of iron and steel with 190.0 million tons; manufacture of chemicals and allied products with 67.0 million tons; machinery manufacturing with 41.0 million tons; and manufacture of ceramic, stone, and clay products with 40.0 million tons[19] (see Page 18 of the Reference Materials).

Looking at emissions trends in recent years, until the early 2000s, Japan's real GDP and CO_2 emissions from energy sources showed roughly similar growth. Moreover, Japan's carbon productivity (the amount of GDP produced per unit of GHG emitted) and energy productivity (the amount of GDP produced per unit of primary energy supplied) were among the highest in the world until the mid-1990s but began declining around the year 2000 and can no longer be described as being among the best in the world (see Figures 6 and 7 and Pages 19 to 28 of the Reference Materials). On the other hand, over the course of the most recent three years, a "decoupling" trend whereby Japan's GHG emissions are declining while its GDP is growing has become apparent (see Page 29 of the Reference Materials).

Based on the Paris Agreement, Japan has set a 26% decrease in emissions compared to the FY2013 level[20] in FY2030 as a medium-term target and, having traversed the path described below, will aim to achieve an 80% decrease in 2050 as a long-term target.

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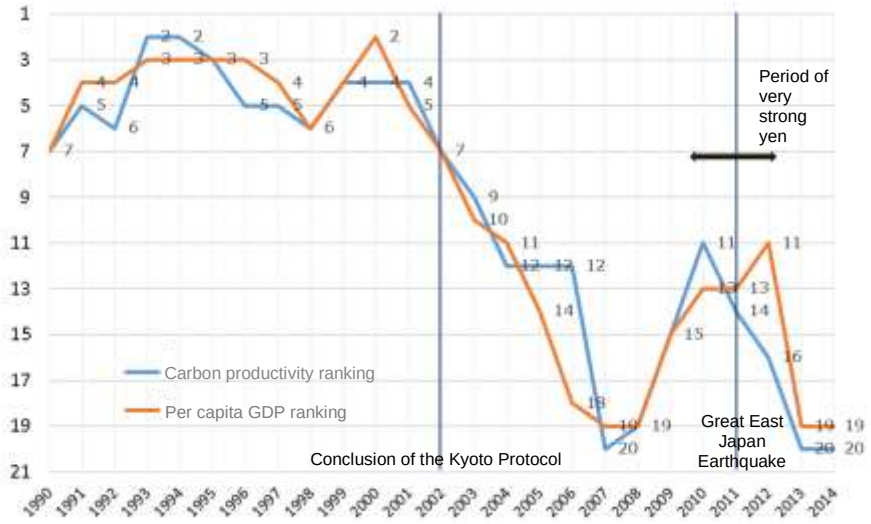
[17] Regarding figures prior to allocation of electricity and heat, GHG emissions for FY2014 (confirmed report values) are used for statistical purposes. The energy transformation sector accounted for 507.0 million tons (approximately 43%), the industrial sector accounted for 340.0 million tons (approximately 29%), the transportation sector accounted for 208.0 million tons (approximately 17%), the commercial and other sector accounted for 80.0 million tons (approximately 7%) and the residential sector accounted for 55.0 million tons (approximately 5%) (see Page 17 of the Reference Materials).

[18] Regarding industry emissions, GHG emissions for FY2014 (confirmed report values) are used for statistical purposes.

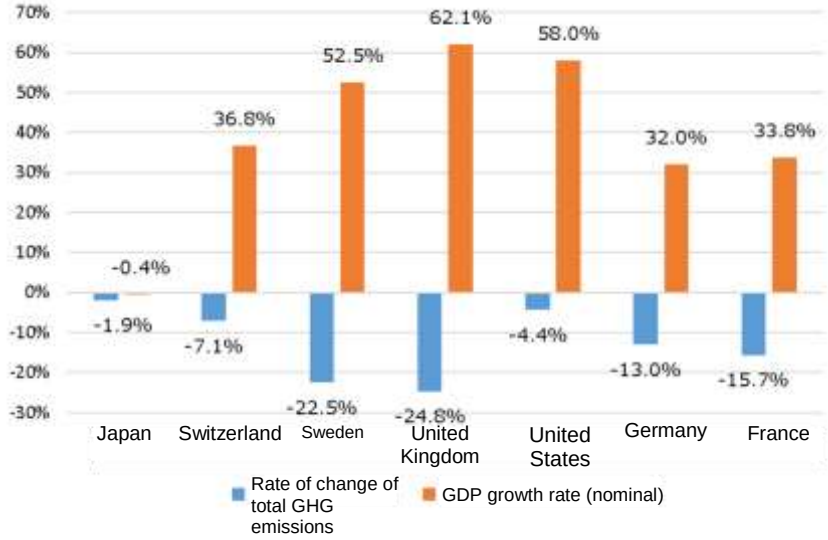
[19] Additionally, the CO_2 emissions from energy sources of agriculture, forestry, and agriculture, for example, amounted to 3.6 million tons. In agriculture, 600,000 tons of CO_2 from non-energy sources, 27.6 million tons from methane (CO_2-eq), and 10.2 million tons from nitrous oxide (CO_2-eq) were emitted.

[20] The Plan for Global Warming Countermeasures states that Japan's GHG emissions in FY2013 amounted to roughly 1.408 billion tons.



GHG Data (UNFCCC), World Economic Outlook Database (IMF),
Prepared based on the Annual Report on National Accounts for 2015 (Benchmark Year Revision of 2011) Summary (Flow Accounts) (Cabinet Office)

Figure 6　Changes in Japan's per capita GDP and carbon productivity (GDP/GHG emissions) within the OECD



GHG Data (UNFCCC), World Economic Outlook Database (IMF),
Prepared based on the Annual Report on National Accounts for 2015 (Benchmark Year Revision of 2011) Summary (Flow Accounts) (Cabinet Office)

Figure 7　GDP growth rate and rate of change of total GHG emissions

Background behind the 2050 target

Ten years ago, in May 2007, then-Prime Minister Abe proposed setting a long-term target of "cutting global emissions by half from the current level by 2050" as a common goal for the entire world in a speech titled "Invitation to Cool Earth 50." Based on this, it was decided at the G8 Heiligendamm Summit held the following June that serious study would be given to at least halving global CO_2 emissions by 2050.

In a June 2008 speech entitled “Japan as a Low-carbon Society,” then-Prime Minister Fukuda stated, “For its part, Japan will set a long-term goal of reducing, by 2050, 60-80% of its current level of emissions, so as to bring about a low-carbon society that we can proudly present to the world,” and this long-term goal was approved by the Cabinet as the Action Plan to Create a Low Carbon Society in July 2008. It was agreed at the G8 Hokkaido Toyako Summit of July 2008 to share a vision of halving global emissions by 2050 with UNFCCC signatories and to seek its adoption in framework negotiations.

The leaders’ declaration of the G8 L'Aquila Summit held in July 2009 (then-Prime Minister Aso) states, “We reiterate our willingness to share with all countries the goal of achieving at least a 50% reduction of global emissions by 2050, recognizing that this implies that global emissions need to peak as soon as possible and decline thereafter. As part of this, we also support a goal of developed countries reducing emissions of greenhouse gases in aggregate by 80% or more by 2050 compared to 1990 or more recent years. [Omission].”

Later, Japan and the United States agreed within the Japan-U.S. Joint Message on Climate Change Negotiations (November 2009) to aim to reduce their own emissions by 80% by 2050 and endorse a global goal of reducing emissions by 50% by that year.

In the wake of the Great East Japan Earthquake of March 2011, Japan’s energy environment came face-to-face with difficult challenges. Against this backdrop, the Fourth Basic Environment Plan (Cabinet decision of April 2012) makes the following statement that was approved by the Cabinet: “Japan recognizes the need to greatly reduce greenhouse gas emissions in order to hold the rise of the average global temperature compared to the pre-industrial revolution level to within 2°C, and will strive to share the target of reducing global GHG emissions to at least half by 2050 with all nations. Moreover, Japan will strive to reduce its GHG gas emissions by 80% by the year 2050 as a long-term target.”

Additionally, a strategy titled “ACE: Actions for Cool Earth” (November 2013) restates the goals of achieving at least a 50% reduction of global GHG emissions by 2050 and of developed countries’ reducing GHG emissions by 80% by 2050 in order to realize the vision of “Cool Earth.” Moreover, the leaders’ declaration of the G7 Schloss Elmau Summit (June 2015) states, “Mindful of this goal and considering the latest IPCC results, we emphasize that deep cuts in global greenhouse gas emissions are required with the decarbonization of the global economy over the course of this century. Accordingly, as a common vision for a global goal of greenhouse gas emissions reductions, we support sharing with all parties to the UNFCCC the upper end of the latest IPCC recommendation of 40 to 70% reductions by 2050 compared to 2010, recognizing that this challenge can only be met by a global response” (see Page 31 of the Reference Materials).

Finally, the “Plan for Global Warming Countermeasures” that received Cabinet approval in May 2016 presents a medium-term target of reducing emissions by 26.0% compared to the 2013 level by FY2030, stating that the target was “formulated by bringing together substantiated policies and measures and technologies with full consideration for technical limitations, cost-related issues, etc., so that it will be consistent with Japan’s energy mix.” As for a long-term target, the plan states: “Leading the international community so that major emitters will take steps to reduce their emissions in accordance with their abilities based on the Paris Agreement and within a fair and effective international framework in which all major countries participate, Japan will, as a long-term target, aim to reduce its GHG emissions by 80% by the year 2050 while balancing global warming countermeasures and economic growth. The achievement of such a long-term significant reduction

of GHG emissions will be difficult with the extension of conventional initiatives alone. Accordingly, Japan will pursue, to the maximum degree possible, solutions that are based on innovation, including the development and dissemination of innovative technologies that make possible fundamental emissions reductions, and strive to achieve major emissions reductions within long-term and strategic initiatives while simultaneously encouraging domestic investment, raising international competitiveness, and seeking broad knowledge among the citizenry. Moreover, Japan will also contribute to global reductions."

In these ways, Japan has continually pursued long-term significant reduction with an eye to 2050 and played an important role in the international community as an environmentally advanced country.

Setting per capita emissions of approximately 2 tons as a 2050 target for achieving a decarbonized society

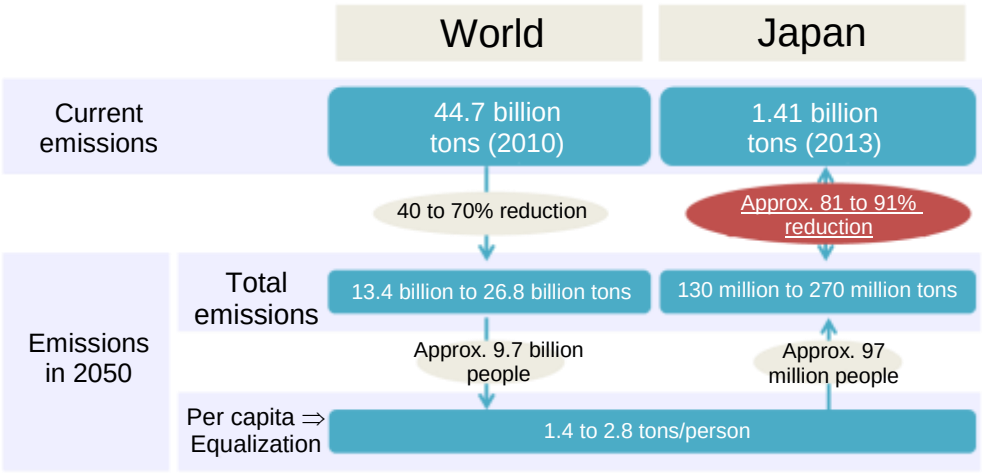
With this background, Japan has made the decision to aim for an 80% emissions reduction in 2050 as a waypoint toward the building of a decarbonized society throughout the world. Given this, Japan must advance initiatives such that it leads the international community as it also continues its endeavor to achieve large-scale reductions.

According to the long-term low greenhouse gas emission development strategies that the developed nations are currently proposing, the United States will aim for a reduction of at least 80% compared to the 2005 level, Germany will aim for a reduction of between 80 to 95% compared to 1990, France will aim for a 75% reduction compared to 1990, and Canada will aim for an 80% reduction compared to 2005. Japan's target compares favorably with these goals.

Additionally, under current scientific knowledge, an emissions scenario having a high probability of achieving the 2°C target established by the Paris Agreement is one in which anthropogenic GHG emissions are reduced by between 40 and 70% compared to the 2010 level by 2050 and emissions levels fall to almost zero or below by 2100. This level of reduction means that the per capita annual emissions for the entire world will be between 1.4 and 2.8 tons in the year 2050. If it is assumed that Japan's population in 2050 will be 97 million,[21] per capita annual emissions of between 1.4 and 2.8 tons will translate into total emissions of between 130 million and 270 million tons. Considering for example that Japan's emissions were approximately 1.41 billion tons in FY2013, this represents a decrease of approximately 81 to 91% (see Figure 8 and Page 32 of the Reference Materials).

Converting the targets of the long-term low greenhouse gas emission development strategies currently being proposed by the developed countries into per capita emissions, the results are 3.8 tons for the United States, 2.1 tons for Germany, 1.9 tons for France, and 3.4 tons for Canada. Additionally, although it has not registered a long-term low greenhouse gas emission development strategy with the United Nations, the United Kingdom, which has already established a long-term target of reducing emissions by 80% compared to the 1990 level in its Climate Change Act, will have estimated per capita annual emissions of 2.1 tons. In this way, the per capita annual emissions of developed countries largely fall in line with the IPCC scenario of between 1.4 and 2.8 tons per person (see Page 33 of the Reference Materials).

[21] Result of an estimate based on assumed median births and median deaths presented in the National Institute of Population and Social Security Research's "Population Projections for Japan (January 2012)"



*World population from World Population Prospects, The 2015 Revision (United Nations). Japan's population from Population Projects for Japan (January 2012) (National Institute of Population and Social Security Research). World GHG emissions based on CO_2 Emissions from Fuel Combustion 2015 (IEA) (excludes "CO_2 other") and SAR (IPCC). Japan's GHG based on Japan's greenhouse gas emissions data (confirmed report values for 1990 to 2014) (Greenhouse Gas Inventory Office of Japan) and GWP of AR4 (IPCC).

Figure 8　Required reductions when per capita emissions are equalized

Chapter 2: Global Trends Taking Place based on the Paris Agreement

The scale of markets for the technologies, products, and services needed to realize a decarbonized society will be huge, and thus climate change policy can be considered to have a direct link to growth strategy. Because of the Paris Agreement, climate change policy has become a promising field in which a "promised market"[22] requiring continuous long-term investment will be created and in which companies can actively invest with a clear view of future prospects.

According to IRENA,[23] it is estimated that the cost of generating power from renewable energy will fall in the years leading up to 2025 and, depending on the type, be on the same level as the current cost of generating power from fossil fuels (see Page 35 of the Reference Materials). Additionally, according to a calculation[24] by the IEA[25], decarbonizing the electric power sector under the 2°C scenario will require approximately nine trillion USD in additional investment between 2016 and 2050, and reaching energy conservation goals in the three sectors of building, industry, and transport will require approximately three trillion USD in additional investment between 2016 and 2050 (see Page 36 of the reference materials). Thus, today, as the world enters a major period of change, which includes the emergence of a vast market that will be sustained into the future, many actors—among them the countries of the world, local governments, private companies, the financial industry, and ordinary citizens and scientists—are pursuing initiatives toward building a decarbonized society throughout the world. We believe this trend will not waver.

(1) Trends in the world's countries

Various countries are already taking action based on the Paris Agreement. For example, in their declaration at the Ise-Shima Summit, which was the first G7 summit conference held following the Paris Agreement, the G7 leaders reaffirmed their determination to ensure swift and successful implementation of the Paris Agreement, and committed to formulating and communicating mid-century long-term low GHG emission development strategies well ahead of the 2020 deadline (see Page 31 of the Reference Materials). With respect to these long-term strategies, as of January 19, 2017, six countries (the United States, Mexico, Germany, Canada, Republic of Benin, and France) have already communicated their long-term low-emission development strategies to the United Nations (see Page 37 of the Reference Materials). It is important that Japan recognize these circumstances and trends occurring in other countries, such as those presented below, and link them to the formulation of its own long-term strategy. Countries all around the world, even those that are not G7 members, are taking steps toward the steady implementation of the Paris Agreement and formulation of long-term strategies. For example, the leaders' communique for the G20 Hangzhou Summit expresses the expectation of the Paris Agreement's timely implementation

[22] Climate change policy is action that is required based on science. It is predicted that it will require long-term, continuous, and large-scale investment. Associated actions are already accelerating in all parts of the world. Measures to tackle climate change possess great possibilities, including some that remain unknown at the present time. Moreover, there is much room for innovation and growth to be born from maximizing market dynamism. It is thought that there will be great sustained demand for initiatives oriented toward low-carbonization and decarbonization, including those targeting existing infrastructure, and thus the possibility that markets will expand as a result is extremely high. Given these points, the market associated with climate change policy is referred to in this report as the "promised market." The phrase "promised market" refers to market size, and does not mean that simply entering the market will result in steady generating of earnings.

[23] International Renewable Energy Agency

[24] International Energy Agency

[25] Energy Technology Perspectives 2016

in all its aspects.

Examples of initiatives taken by countries of the world

2050 Pathways Platform	Established at COP 22 (November 2016) as a platform for the early transition to pathways toward long-term goals ((1) effective elimination of GHG emissions, (2) building of a society resilient to climate change, and (3) sustainable development). In addition to national governments (22 countries), local governments (15 cities and 17 states and regions) and companies (196 companies) also participate. The platform supports countries that are formulating long-term strategies for a decarbonized society and promotes the building of a network among cities, companies, etc., through the sharing of resources, knowledge, and experience.
Climate Vulnerable Forum	The Climate Vulnerable Forum (CVF) is a partnership organized by countries that are vulnerable to climate change. It currently has 48 members, most of which are nations of Africa, Asia, Latin America, and Pacific islands. The leaders of the CVF member nations issued their first joint statement sounding the alarm on climate change in the Maldives in 2009. CVF serves as a South-South cooperation platform for efforts to tackle climate change.

(Pages 38 and 39 of the Reference Materials)

(2) Trends in local governments

Cities and other local governments of the world are also advancing various initiatives, among them those presented below. In the case of some of the leading climate change policies, it is expected that not only will they evolve and develop as initiatives in themselves, but that they will also spread horizontally to other cities and local governments.

Examples of initiatives being taken in countries of the world

C40	C40 (Cities Climate Leadership Group) is a network of cities organized with the purposes of sharing knowledge concerning climate change policy and promoting effective action. C40 classifies its activities targeting climate change into seven initiatives. Within the initiatives, it forms a total of 20 networks that are energizing cooperation among cities in specific fields. Its membership currently encompasses 86 cities in all parts of the world (corresponding to a total population of more than 600 million and one-fourth of global GDP).
Under 2 MOU	Under 2 MOU is a leadership agreement that sub-national local governments (states, prefectures, cities, etc.) of the world join with an eye to achieving the Paris Agreement's 2°C target. Member regions sign an Under 2 MOU (memorandum of understanding) and engage in international cooperation in accordance with the MOU, with a goal of reducing greenhouse gas emissions by 80-95% below the 1990 level by 2050. At the present time, 136 regions of the world have signed the MOU (corresponding to a total population of more than 830 million and one-third of global GDP).
Global Covenant of Mayors for Climate & Energy	The Global Covenant of Mayors for Climate & Energy is the world's largest federation of cities concerned with climate change. It is composed of 7,100 cities in 119 countries (representing a total population of 600 million people, or 8% of the world's population). The coalition was launched in January 2017. Member cities commit to emissions reduction goals that are even more ambitious than those of their home countries. It is an integration of two initiatives: the EU Covenant of Mayors, which was established in 2008, and the Compact of Mayors, which was founded in 2014. It collaborates with existing city networks, including C40, ICLEI (Local Governments for Sustainability), and UCLG (United Cities and Local Governments).
ICLEI: Local Governments for Sustainability	ICLEI: Local Governments for Sustainability is an international network made up of local governments working to realize a sustainable society. Through ICLEI, more than 1,000 local governments in 85 countries are working to resolve the various environmental issues that cities face. ICLEI disseminates information and provides tools for sustainable urban development by managing various campaigns, programs and events; organizing seminars; and issuing publications.

(Pages 40 to 43 of the Reference Materials)

(3) Trends in private enterprises

Seeing the Paris Agreement as a new business opportunity, a variety of private enterprises are taking steps forward in implementing leading climate change policies. For example, the following

international initiatives are being actively advanced.

Examples of initiatives being taken by private enterprises

Mission Innovation	At the time of the COP21 summit, national leaders and private investors who supported the summit's intent came together to hold a conference for establishing "Mission Innovation." At the conference, initiatives to encourage expanded public-private investment for R&D in the clean energy sector were shared based on the necessity for innovation in climate change policy. Mission Innovation sets forth goals that include the following: (1) Participating countries will aim to double their public clean energy R&D investment over five years. (2) New investment will be focused on innovative technologies. (3) Countries will accelerate their initiatives using appropriate methods in the recognition that each country faces its own circumstances.
WE MEAN BUSINESS	We Mean Business (WMB), a coalition of leading companies and investors of the world, was formed in September 2014 with the objective of promoting initiatives for the transition to a low-carbon society. Companies and investors join WMB by pledging to implement at least one initiative promoted by WMB. WMB serves as a platform linking companies and investors with the initiatives of international organizations. Companies participating in WMB number 494 (gross earnings in excess of 8.1 trillion USD), while investors number 183 institutions (total managed assets in excess of 20.7 trillion USD). The total number of pledges is 1,100 (as of December 8, 2016). In addition to the above activities, WMB has issued multiple reports thus far and makes recommendations concerning climate change policy.
Science Based Target	Science Based Target is a joint initiative by CDP, UN Global Compact, WRI, and WWF. In order to limit the average global temperature increase to "under 2°C," it recommends to companies the establishment of emission reduction targets in line with scientific knowledge. The number of companies certified as having targets that are in conformity with science (conformity with the 2°C target) is 28 (as of December 7, 2016).
RE100	RE100 was formed in 2014 as an organization of companies striving to meet 100% of their business power needs with renewable energy. A total of 83 companies in manufacturing, information and communications, retailing, and other sectors participate in RE100, among them not only companies of Europe and the United States but also China and India (as of December 8, 2016). Each year, each company reports to RE100 its performance in terms of introducing renewable energy through a CDP climate change questionnaire. The results are made public in the "RE100 Annual Report."
Global Cleantech 100	Global Cleantech 100 is a group of 100 clean technology companies not listed on major stock exchanges that were selected by the Cleantech Group, a leading research company, as being most likely to have a serious commercial impact in a 5-to-10-year time frame. Twenty-seven of the companies are European, 66 are North American, and seven are from Africa, the Middle East, or Asia.
Breakthrough Energy Coalition	Breakthrough Energy Coalition (BEC) is a partnership founded by Bill Gates and other private investors in November 2015 for the purpose of promoting the early application of new clean energy technologies. BEC also seeks to build a partnership with Mission Innovation, an initiative whose membership comprises developed nations, and to establish collaboration with national governments and companies. In December 2016, BEC established Breakthrough Energy Ventures (BEV) as a new investment fund committed to these goals.
Carbon Pricing Leadership Coalition	The Carbon Pricing Leadership Coalition is an international collaborative framework that was established in November 2015 for the purpose of promoting carbon pricing. It supports the setting of targets concerning the percentage of global emissions to be covered by carbon pricing, promotes the implementation of carbon pricing measures by countries and companies, and makes agreements concerning periodic progress reports.
In-house carbon pricing	The number of companies that are voluntarily introducing in-house carbon pricing schemes so that they can reflect those schemes in investment decisions is growing rapidly. Globally, 1,249 companies have informed CDP* that they "are implementing an in-house carbon pricing scheme" or "plan to introduce a scheme within the next two years)" (a 23% increase over the 2015 figure).

(Pages 44 to 51 of the Reference Materials)

(4) Trends in the financial sector

In response to the Paris Agreement, trends in the global financial sector are also changing. As mentioned previously, according to a calculation released by the IEA, decarbonizing the electric power sector under the 2°C scenario will require approximately nine trillion USD in additional

investment between 2016 and 2050. In light of this and other developments, the movement of vast amounts of capital toward society's decarbonization is expected. Realizing this movement will require the advancement of initiatives in the financial sector. It should be noted that, outside of Japan, if the premise of major reductions is taken, there is a risk that investment in fossil fuels will result in stranded assets, and given this, major financial institutions, institutional investors, and other actors are beginning to reexamine their investments in, and loans for, fossil fuels.

Examples of initiatives being taken in the financial sector

Green bonds	The issued amount of "green bonds," which are bonds issued to raise the funds needed for environment-friendly projects, is growing year by year. According to the Climate Bond Initiative (CBI), approximately 118.0 billion USD in green bonds was issued cumulatively by 2015. It is predicted that green bonds issued for the single year 2016 will amount to 100.0 billion USD. One of the factors behind this increase in the issuance of green bonds is diversification of the issuing entities to include private enterprises and local governments. Additionally, the amount of green bonds issued has been growing rapidly in emerging Asian economies such as India and China since 2015.
Movements by major institutional investors, money managers, etc.	On August 24, 2016, 130 institutional investors, money managers, and other actors from countries around the world (total investments of more than 13 trillion USD [1.3 quadrillion JPY]) called on the G20 nations to conclude the Paris Agreement. This call incorporated the following points: (1) Completing the process for joining/ratifying the Paris agreement in 2016 if possible; (2) Implementing the recommendations published in the 2015 Global Investor Statement on Climate Change; (3) Supporting a doubling of global investment in clean energy by 2020; (4) Prioritizing the implementation of, and making preparations to strengthen, nationally determined contributions; (5) Prioritizing rule-making by national financial regulators to require disclosure of climate risks; and (6) Welcoming the work of the G20 Green Finance Study Group.
TCFD	In April 2015, the G20 Finance Ministers and Central Bank Governors Meeting called on the Financial Stability Board (FSB) to bring together concerned members of the public and private sector to study how the financial sector should consider climate-related issues. In December 2015, the FSB announced the establishment of the Task Force on Climate-related Financial Disclosures (TCFD), to be chaired by Michael Bloomberg, the former mayor of New York City. In March 2016, the TCFD presented its "Phase 1 Report," which clarified the objectives, scope, and general rules of climate-related financial disclosure. In December 2016, it publicly announced its "Recommendations of the Task Force on Climate-related Financial Disclosures" for Phase 2, which will serve as a permanent framework for the future, and is currently conducting public consultations that will last until February 12, 2017. The TCFD plans to issue its final version in early 2017. The TCFD is promoting the voluntary and consistent disclosure of climate change-related financial risk information for use when companies supply information to investors, banks, insurance companies, and other concerned parties.
Engagement	Assuming the premise of major emissions reductions, given the risk that investment in fossil fuels will result in stranded assets, major financial institutions, institutional investors, and other actors doing business overseas are already seeing coal and other fossil fuels as "stranded assets" and have begun activities (i.e., engagement) to influence the actions of the companies they provide investment and loans to by, for example, exercising rights attached to their held stock. For example, "Aiming for A," an engagement activity conducted by 108 organizations (including local governments in the United Kingdom, the Church of England, funds, insurance companies, investment managers, asset owners, and others), is demanding that BP and Royal Dutch Shell disclose information concerning their "management of GHG emissions arising from corporate activities," "effective analysis of their existing assets composition with an eye to 2035 and beyond," and other matters. As a result, disclosure proposals were presented at the companies' general meetings of stockholders in 2015. The proposals were passed with 98.3% approval at BP and 98.9% approval at Royal Dutch Shell.
Divestment	Given the risk that investment in fossil fuels will result in stranded assets under the premise of major emissions reductions, major financial institutions, institutional investors, and other actors doing business overseas are already seeing coal and other fossil fuels as "stranded assets" and have begun activities (i.e., divestment) that involve withdrawing related investment and loans. On June 5, 2015, Norway's Norwegian national assembly officially approved a policy whereby it would sell off all coal-related stocks held by the Government Pension Fund Global (GPFG). Also, in October 2015, the State of California of the United States approved a policy based on state law to sell coal-related stocks held by the California Public Employees' Retirement System (CalPERS) and California State Teachers' Retirement System (CalSTRS).

(Pages 52 to 54 of the Reference Materials)

(5) Trends among private citizens and scientists

Since global warming will affect a variety of people, including those of future generations, various civic groups and scientists are also engaged in independent efforts to tackle it.

Examples of initiatives being taken by private citizens and scientists

Climate Justice	"Climate justice" is a social movement based on the recognition that those who have emitted GHG heretofore are developed countries (and emerging economies), while those who are most seriously affected by those emissions are poor developing countries, vulnerable people, and future generations, and that climate change is an international human rights issue. The Paris Agreement also states that attention must be given to the importance of this concept for certain people.
350.org	350.org is a large-scale global network of private citizens that engages in online campaigns and grass-roots activities oriented toward resolving climate change. Formed in 2008, 350.org is currently active in 188 countries. Calling for problem resolution through civic strength, 350.org organizes campaigns throughout the world. Among them are those demanding the stop of a coal-fired thermal power station in India, the cessation of construction of the Keystone XL pipeline in the United States, and the withdrawal of public institutions' investment in fossil fuel-related companies.
Future Earth	Future Earth is an international research platform for global environmental research aimed at realizing a sustainable global society providing an integrated research foundation for interdisciplinary research upon which the academic community and social partners can work together. It was proposed at the United Nations Conference on Sustainable Development (Rio+20) in 2012, and then went through a preparatory period before beginning activities based on a ten-year plan in 2015. It merges four international research programs* of the Earth System Science Partnership (ESSP), a partnership that promotes global environmental research at the international level.

(Pages 55 to 57 of the Reference Materials)

Chapter 3: The Economic and Social Challenges Facing Japan

(1) Major internal and external challenges and the orientations of responses

(a) Major economic and social challenges

Advancing population decline and depopulation

Japan's total population has been declining since peaking at approximately 128 million in 2008, and Japan's working-age population is also declining after peaking at approximately 87 million in 1995. It is estimated that, in 2050, the nation's total population will be approximately 97 million and its working-age population will be approximately 50 million[26] (see Page 59 of the Reference Materials). Although Japan's total fertility rate rose to 1.46 in 2014, this is far below the 2.07 that is said to be the replacement-level fertility rate, and it is anticipated that the population decrease that began in 2008 will accelerate in the years ahead.

Additionally, it is estimated that places losing half or more of their population in 2050 will account for 60% of currently inhabited areas (currently approximately 50%), and that approximately 20% of places will become uninhabited.[27] In particular, it is estimated that the populations of municipalities that currently have populations of less than 10,000 will fall by roughly half[28] (see Page 60 of the Reference Materials).

Population aging at a pace unparalleled in the world

Japan's population is aging at a pace unparalleled in the world, as its population aging rate[29] reached its highest level ever at 26.7% in 2015.

A comparison of the number of years needed from the time a population aging rate exceeds 7% until it doubles to 14% (doubling time) shows that, in contrast to France's 126 years and Sweden's 85 years as well as Germany's comparatively short 40 years and the United Kingdom's 46 years, Japan's doubling time was 24 years between 1970 and 1994[30] (see Page 61 of the Reference Materials).

It is expected that, in a super-aged society, various challenges will emerge, among them an increasing fraction of people demanding medical care, nursing care, and welfare services and an increasing fraction of households in which elderly people live alone. The extension of healthy life span, activation of local communities, development of fulfilling lives, and other various fine-tuned actions will be required in each region.

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[26] Result of an estimate based on assumed median births and median deaths presented in the National Institute of Population and Social Security Research's "Population Projections for Japan (January 2012)"

[27] Ministry of Land, Infrastructure, Transport and Tourism, "Grand Design of National Spatial Development towards 2050, Japan" (2014)

[28] Prepared based on Ministry of Internal Affairs and Communications, "Population Census of Japan," and estimates of the National Spatial Planning and Regional Policy Bureau, Ministry of Land, Infrastructure, Transport and Tourism

[29] Share of the elderly population (aged 65 or older) in the total population

[30] White Paper on Aging Society 2016

Economic revitalization

Since the mid-1990s, Japan's nominal GDP has remained largely unchanged, moving at a level between approximately 500 trillion JPY and 530 trillion JPY (see Page 62 of the Reference Materials). Japan's per capita GDP ranking in the world has plunged since the 2000s, falling from third in the mid-1990s to 26th (20th among the OECD countries) in 2015 (see Table 1 and Page 63 of the Reference Materials).
One of the reasons cited for this long-term low growth is prolonged deflation. Factors said to be behind the deflationary trend include stagnant added-value productivity resulting from inadequate innovation, and expanded and protracted use of irregular employment. It has been pointed out that, amid intensifying competition with products from emerging economies, Japanese companies have attempted to maintain their competitiveness primarily by lowering their prices through better efficiency in their manufacturing processes and overseas production, while companies in the United States and Europe are maintaining high prices by, respectively, improving profitability through the creation of new businesses and building up their product brands[31] (see Figure 9 and Page 25 of the Reference Materials).

Japan's economy has been showing gradual improvement in recent years; for example, in 2013, Japan's real GDP recovered to the level it had attained prior to the financial crisis sparked by the Lehman Brothers bankruptcy. However, as the Annual Report on the Japanese Economy and Public Finance 2015 points out, "Since 2000, like European and American listed companies, which have increased their internal reserves and cash ratios, Japanese listed companies have also built up their internal reserves and, at the same time, maintained cash and deposits. Generally speaking, there are various reasons why companies build up their cash and deposits; securing working capital and funds for future investment and preparing for worsening business performance or crises, such as that sparked by the Lehman Brothers bankruptcy, can be counted among proactive reasons for doing so. On the other hand, a deficiency of investment opportunities can be considered to be a passive reason." Numerous other challenges also exist, including inhibited personal consumption against the backdrop of an uncertain future (see Page 64 of the Reference Materials), constraints on the labor supply attributable to the decreasing working-age population[32] (see Page 65 of the Reference Materials), improved productivity in the service industry and other sectors, a falling potential growth rate and response to the "Fourth Industrial Revolution," capture of competitive advantage in global markets and of external demand in emerging economies and other countries, and, additionally, restoration of fiscal health and dealing with social security benefit expenses.

[31] Cabinet Office, "Keizai no Kojunkan Jitsugen Kento Senmon Chimu Chukan Hokoku" (interim report of the special study team for realization of a virtuous economic cycle) (November 2013)

[32] The Council for the Realization of Work Style Reform is engaged in discussions to promote the building of environments in which everyone can participate in the workforce, including people with child-rearing responsibilities, young people, the elderly, women, men, and people with intractable diseases or disabilities. Thus, it is possible that constraints on the labor supply may be alleviated in the future.

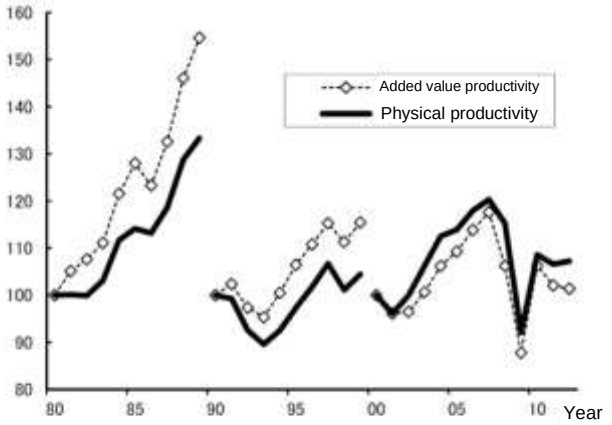
Table 1　Ranking of countries' capita GDP (nominal GDP)

Unit: USD

	1995		2005		2015	
1st	Luxembourg	51,190	Luxembourg	80,308	Luxembourg	102,717
2nd	Switzerland	48,716	Norway	66,643	Switzerland	80,603
3rd	Japan	42,536	San Marino	65,911	Norway	74,598
4th	Denmark	35,478	Iceland	55,852	Macao	71,394
5th	Norway	34,794	Switzerland	54,959	Qatar	68,940
6th	Germany	31,709	Qatar	54,229	Ireland	61,206
7th	Austria	30,289	Ireland	51,212	United States	56,084
8th	Sweden	29,883	Denmark	48,893	Singapore	52,888
9th	Netherlands	28,911	United States	44,218	Denmark	52,139
10th	United States	28,763	United Arab Emirates	43,989	Australia	51,181
11th	Belgium	28,617	Sweden	42,999	Iceland	50,277
12th	France	27,898	Netherlands	41,648	Sweden	50,050
13th	Iceland	26,769	United Kingdom	41,567	San Marino	49,615
14th	United Arab Emirates	26,394	Finland	39,107	Netherlands	44,323
15th	Finland	25,643	Austria	38,319	United Kingdom	43,902
16th	Singapore	24,936	Japan	37,244	Austria	43,414
17th	Hong Kong	22,909	Belgium	37,147	Canada	43,280
18th	United Kingdom	22,759	Canada	36,316	Finland	42,414
19th	Australia	20,937	France	36,210	Hong Kong	42,295
20th	Canada	20,642	Australia	36,144	Germany	40,952
21st	Italy	20,609	Germany	34,769	Belgium	40,529
22nd	Ireland	19,220	Italy	32,066	United Arab Emirates	38,650
23rd	Brunei	18,292	Singapore	29,870	France	37,653
24th	Israel	18,095	Brunei	28,589	New Zealand	37,066
25th	Kuwait	17,252	New Zealand	27,206	Israel	35,743
26th	New Zealand	16,780	Kuwait	27,015	Japan	34,522
27th	Qatar	16,238	Hong Kong	26,554	Brunei	30,993
28th	Bahamas	15,882	Spain	26,550	Italy	29,867
29th	Spain	15,548	Cyprus	25,368	Kuwait	27,756
30th	Cyprus	15,377	Macao	24,970	South Korea	27,222

World Economic Outlook Databases (IMF),
Prepared based on the Annual Report on National Accounts for 2015 (Benchmark Year Revision of 2011) Summary (Flow Accounts) (Cabinet Office)

Base point in time = 100



Sources: Ministry of Finance, "Financial Statements Statistics of Corporations by Industry"; Ministry of Economy, Trade and Industry, "Economy, Trade and Industry Statistics"; Ministry of Health, Labour and Welfare, "Monthly Labour Survey"

Notes: Physical productivity was obtained by dividing production volume by number of employed workers, and added-value productivity was obtained by dividing amount of added value (Financial Statements Statistics of Corporations by Industry) by number of employed workers.
Production volume is from the Indices of Industrial Production (manufacturing industry).
Number of employed workers refers to full-time employment in manufacturing (Monthly Labour Survey, business establishments of at least 30 people).
Amount of added value = ordinary income + personnel expenses + interests paid + depreciation expenses (based on quarterly reports)

* Material submitted by Hisashi Yamada, director of the Research Department, The Japan Research Institute, Limited, to the Special Study Team for Realization of a Virtuous Economic Cycle (first session) on September 24, 2013

Looking at changes in the added-value productivity and physical productivity of Japan`s manufacturing, during the 2000s, the rate of increase of added-value productivity was below the rate of increase of physical productivity.

Figure 9　Added-value labor productivity and physical labor productivity of manufacturing

Regional challenges

Regional economies are highly dependent on public demand,[33] and there is a tendency for those local governments with smaller populations to have greater dependency on public demand and weaker financial capability (see Page 66 of the Reference Materials). In addition to over-concentration in Tokyo bringing about population decline and economic contraction in outlying regions, the low total fertility rate in the Tokyo metropolitan area, where much of Japan's population is concentrated, is tied to Japan's national population decline. Furthermore, the Tokyo metropolitan area is also grappling with many challenges that exceed the merits that come with population concentration.[34] Moreover, there will be a nationwide increase in the number of areas that will become uninhabited by 2050[35] (see Page 67 of the Reference Materials) as well as various issues that will include the diffusion of urban areas, appearance of vacant houses and abandoned farmlands, maintenance and management of social capital, rising dependence on automobiles, and effects of skyrocketing energy prices on household budgets.

Challenges in the international community

Japan's share of GDP in the world is shrinking, and it is expected to continue falling with the growth of emerging economies, among other factors. Thus, Japan's "quantitative" presence in the international community is diminishing (see Page 68 of the Reference Materials).

In addition, Japan's security environment is becoming increasingly severe as the international situation becomes less stable amid growing protectionism and recent changes in the power balance that are referred to as "multi-polarization" or "unpolarization." In an era when threats to the security of nations and their citizens from international terrorist organizations, cyberattacks, the appearance of large numbers of refugees, and the like are diversifying, no country can build a peaceful, safe, and prosperous future alone. At present, Japan in particular subsists within its connections to the world, as it imports almost all of its fossil fuels and mineral resources and more than half of its food and acquires capital in global markets (see Page 69 of the Reference Materials).

(b) Direction of responses to economic and social challenges

Economic growth

Japan must respond to its unprecedented population decrease and societal aging, the advance of the Fourth Industrial Revolution, changes in the international situation, and other developments based on recognition of the various factors that were behind the prolonged deflationary trend and sluggish nominal GDP growth that have prevailed in Japan for more than 20 years. Among those factors that have been identified are the following: "The extremely rational behavior, when viewed at the individual company level, of cost reduction creates a 'paradox of thrift' in the form of reduced

[33] Here, this refers to the total of public capital formation, final government consumption expenditure, and amount of pension benefits.

[34] Tokyo must deal with more living environment-related issues than outlying regions. They include extremely long commute times and high housing prices as well as shortages in childcare services, as seen in waiting lists for nursery schools, and shortages in long-term nursing care services for the elderly. Additionally, as Japan's population becomes increasingly concentrated in Tokyo, there is greater risk of increased damage caused by a massive disaster, such as an earthquake striking the heart of Tokyo. ("Comprehensive Strategy for Vitalization of Towns, People, and Jobs," Cabinet decision of December 2014)

[35] Grand Design of National Spatial Development towards 2050, Japan

consumption and investment and stagnating accumulation of human capital and drives a vicious deflationary cycle when viewed in terms of the entire macro economy"; and "With the formation of a deflationary mindset, Japan's 'animal spirits' have evaporated and product innovation that creates new next-generation demand has been lost."[36] Unless Japan reflects on the past and breaks through the impediments to growth it will encounter going forward, it faces the strong possibility that its stagnating growth rate will become even more pronounced and that it will feel even more serious effects of long-term sluggishness.[37]

For this to happen, technologies that correspond to new fields and support new goods and services, social systems that include business models and institutions to support the diffusion of those technologies, lifestyles incorporating public values demanding "better" rather than "cheaper," and innovation covering all technical and social systems and lifestyles will be essential.[38]

- ○ Responses on the supply side (shifting from quantity to quality in economic growth)

To maintain a certain level of economic growth under constraints on the supply of labor in a society experiencing population decline and under quantitative constraints in domestic demand, there must be a major shift in direction "from quantity to quality" throughout the entire economy, and improvements in added-value productivity (labor productivity based on added value) will be essential (see Page 70 of the Reference Materials). It is thought that, rather than absorbing the cost of improving productivity by simply raising prices, companies must raise their added-value rates while increasing unit prices through the development of new fields and product innovation and generate a virtuous cycle linked to high wages.[39] Particularly with regard to the promotion of innovation, the need for investment in intangible assets, such as R&D, computerized information, design, brands, and human capital, has been pointed out in recent years.[40]

Moreover, the implementation of sophisticated, cutting-edge, and innovative technologies through the Fourth Industrial Revolution—in such areas as IoT, AI, self-driving vehicles, and advanced robotics, for example—could have significant impacts on the economy and society in ways that include cost reduction and provision of high added-value services.

- ○ Responses on the demand side (promoting investment and stimulating latent demand)

The domestic market will face quantitative constraints as Japan's population decreases, but the market could shrink even more depending on how responses are executed. It will be necessary to encourage investment among companies that are building up their cash and deposits due to passivity arising from a lack of investment opportunities, and, through innovation that addresses latent needs, to stimulate positive consumption behavior among consumers who control their spending out of concerns about the future. At that time, it will be necessary to identify latent needs while raising unit prices, and to link them to higher added-value productivity throughout the

[36] Cabinet Office, "Keizai no Kojunkan Jitsugen Kento Senmon Chimu Chukan Hokoku" (interim report of the special study team for realization of a virtuous economic cycle) (November 2013)
[37] Ministry of Economy, Trade and Industry, "New Industrial Structure Committee, Industrial Structure Council, 'An Interim Report on the New Industrial Structure Vision'" (April 2016)
[38] Ministry of the Environment, "Long-term Climate Change Strategy Advisory Group Recommendations" (February 2016)
[39] Cabinet Office, "Keizai no Kojunkan Jitsugen Kento Senmon Chimu Chukan Hokoku" (interim report of the special study team for realization of a virtuous economic cycle) (November 2013)
[40] Ministry of Health, Labour and Welfare, "Analysis of the Labour Economy 2016" (September 2016); Ministry of Economy, Trade and Industry, "New Industrial Structure Committee, Industrial Structure Council, 'An Interim Report on the New Industrial Structure Vision'" (April 2016); and others

economy, in order to overcome quantitative constraints in Japan's domestic market that are attributable to population decline.

- International development (capturing external demand, etc.)

Japan must actively capture external demand so that it can break through its domestic demand constraints at a time of decreasing population. As a developed nation beset by problems, Japan can build new competitive advantage in the global market by leading the world in bringing about advanced innovation as a social system, rather than on a company-by-company basis only.[41]

Moreover, given the possibility that Japan's current account surplus will shrink as the domestic savings rate decreases in line with the declining working-age population, improving Japan's terms of trade (export prices/import prices) will be important. Skyrocketing prices of raw materials, including energy, have worsened Japan's terms of trade, and thus reducing the nation's dependence on those materials will be effective in preventing the worsening of those terms and in minimizing the effect that price fluctuations have on them. Raising export prices by bringing added value to exported goods and services will also be important.

Regional revitalization

As for the direction of regional initiatives in a mature society like Japan's, rather than taking a nationally uniform "catch-up" approach like that applied when Japan's population was growing, it will be important for each region to demonstrate its unique identity by finding its own "special something," starting with its historical or cultural elements that have arisen from its unique natural environment or climate, and refining it. Developing diverse and attractive regions that take advantage of such originality will necessitate the building of regional economies that are autonomous and robust. Also important will be the maintenance and enhancement of natural capital[42] as the regional foundation as well as improvement of productivity and reduction of administrative costs within the region by utilizing ICT and other cutting-edge technologies and expansion of sales channels for regional products through direct access to the global market.

Response to the international community

Japan's striving to raise its "qualitative" presence in the international community by using the kind of "soft power" it has wielded heretofore (e.g., in technology, culture, content, and interpersonal exchanges) will serve to compensate for its diminishing "quantitative" presence amid growth among emerging economies, and it will be important to continue initiatives in this area.

Additionally, we believe that, in an increasingly severe security environment, Japan's active contribution to the resolution of global issues by being a "proactive contributor to peace based on the principle of international cooperation," which is the guiding principle of its national security, as well as efforts to secure shared global-scale benefits in free trade and other areas, will take on even greater importance.

Furthermore, given that disruptions in world peace and stability could negatively impact Japan's

[41] Ministry of Economy, Trade and Industry, "New Industrial Structure Committee, Industrial Structure Council, 'An Interim Report on the New Industrial Structure Vision'" (April 2016)

[42] A viewpoint that sees the natural environment (e.g., water, soil, ecosystems) as important capital that supports citizens' daily lives and companies' operating foundation

energy and food security, as before it will remain extremely important for Japan to strive to raise its self-sufficiency in energy and resources.

(2) Main factors deserving consideration in a rapidly changing society

Advancement of ICT

Japan's 5th Science and Technology Basic Plan (Cabinet decision of January 2016) states: "Through an initiative merging the physical space (real world) and cyberspace by leveraging ICT to its fullest, we are proposing an ideal form of our future society: a 'super smart society'[43] that will bring wealth to the people. The series of initiatives geared toward realizing this ideal society are now being further deepened and intensively promoted as 'Society 5.0.'[44]" (see Page 71 of the Reference Materials).

ICT is advancing at a pace so remarkable as to warrant the title the "Fourth Industrial Revolution," which is evident in the Internet of Things (IoT), in which various forms of information are linked to "things" via the Internet, artificial intelligence (AI), and "big data" technologies that accumulate, analyze, and utilize vast amounts of data. This revolution has the potential to fundamentally change conventional social rules and people's values (see Page 72 of the Reference Materials). Great changes are envisioned in all fields and sectors. For example, the diffusion of in-home medical care and nursing care, which will be essential to the building of a regional comprehensive care system, telecommuting leading to work-style reform, and distance education may help correct population maldistribution. Other changes will likely be seen in the use of smart technology in energy use and in the maintenance, management, and upgrade of infrastructure. Although various problems exist in terms of security and other aspects, we believe that the trend toward global-scale networking will continue.

Coexistence with nature

Japanese culture is founded on harmony with nature. The *satochi*, *satoyama*, and *satoumi* (rural lands, mountains, and seas) of past times were places where local residents worked together and where, through people's association with nature, sensitivity to nature was cultivated and traditional artistic culture and advanced manufacturing culture were born. However, particularly beginning with the nation's post-war period of high economic growth, Japan increased its dependence on overseas resources as its people's connection with nature weakened. Nonetheless, as people's values and lifestyles diversify, we believe the creation of varied and attractive regions that utilize their local identity will be essential to maintaining and improving Japan's national vitality. Moreover, from the standpoint of developing safe and secure regions in terms of disaster preparedness and mitigation using the ecosystem, we believe it will be necessary to renew people's awareness of the unique values each region has vis-à-vis nature—including the forests, rural areas, rivers, and seas—and to rebuild the link between people and the natural environment (see Page 73 of the Reference

[43] This refers to a society that is capable of providing the necessary goods and services to the people who need them at the required time and in just the right amount; a society that is able to respond precisely to a wide variety of social needs; and a society in which all kinds of people can readily obtain high-quality services, overcome differences of age, gender, region, and language, and live vigorous and comfortable lives.

[44] So called to denote the new society created by transformations led by scientific and technological innovation, after the hunter–gatherer society, agricultural society, industrial society, and information society

Materials).

Growing awareness of safety and security

Based on the recognition of Japan's unique geographical characteristics, where many types of natural disaster can occur, including the kind of major earthquake and tsunami witnessed in the Great East Japan Earthquake, there is a growing awareness of safety and security, both in people's daily lives and also in socio-economic systems, including supply chains.

At the same time, the diversification of lifestyles is progressing in various ways, including in the ways in which women work, the growing number of people who wish to continue working even after reaching the mandatory retirement age, the expanding shift away from "ownership" to "sharing," the transition in preferences for "services" instead of "things," and a growing desire to return to the countryside.

Chapter 4: Basic Concept toward Long-Term Significant Greenhouse Gas Reduction with a View to Building a Decarbonized Society

As seen in Chapter 1 and Chapter 2, climate change is one of the major threats to society, and humankind's enormous challenge of building a decarbonized society throughout the world is beginning. Given its history of overcoming incidents of pollution that became unprecedented environmental problems[45] when they arose and turning its experience into a source of industrial competitiveness, Japan is in an excellent position to play a leading role in pioneering paths toward significant GHG reduction and fulfilling its responsibility to bequeath this Earth to future generations.

Moreover, a distinguishing characteristic of modern society is that its manifold activities have complex interrelationships with various fields. The problem of climate change originates from humankind's many socio-economic activities and therefore, as shown in Chapter 3, it is essential to consider it from multifaceted and complex perspectives, among them economic growth, regional issues and other social aspects, and responses by the international community.

Additionally, Japan is the country most affected by population decrease and societal aging, phenomena already challenging nations around the world, and it is under various constraints in terms of geography, land, and resources. Given these circumstances, by simultaneously addressing in Japan climate change and economic and social challenges, Japan will make a major contribution to the global community as a forerunner in finding answers to emerging issues.

Based on the above, we believe Japan must fulfill the following roles.

Through its climate change policy, pass on to future generations our environment as a foundation for humanity's continuing existence, while at the same time contributing to global sustainable development and being a trustworthy country that meets expectations in international society.

In accordance with this role, the following is the future vision for which Japan must strive.

By tackling simultaneously the problem of climate change and various socio-economic issues, become a problem-solving advanced country that leads the world in achieving deep GHG reductions and wealth at the same time.

In the following we present the basic concept that will become the core of Japan's initiatives to significantly reduce its GHG emissions, with the goals of realizing the future vision of Japan and of building a decarbonized society throughout the world.

(1) Simultaneous solution of economic and social problems, driven by climate change policy

Fixing its sight on the realization of a decarbonized society throughout the world by the end of this century, Japan's efforts to achieve a long-term significant reduction in GHG emissions by aiming for an 80% reduction by 2050 can spark simultaneous solutions to climate change and economic and social challenges.

It has been pointed out that solving the problem of climate change should be premised on economic growth and be framed centrally within the viewpoint of achieving a society that remains vibrant into

[45] It must not be forgotten that there are still people who suffer from pollution-related effects, among them victims of Minamata disease.

the future. In the first place, it is important to bear in mind the point that human activity will not be viable unless the environment as the foundation of human survival can be preserved into the future[46] (Article 3 of the Basic Environment Law), but still the importance of economic growth in general, not only as it pertains to the issue of climate change, goes without saying. As seen in Chapter 3, if Japan does not make necessary reforms in response to internal and external changes and constraints—such as heretofore unexperienced population decrease and societal aging and intensifying global competition against the backdrop of the Fourth Industrial Revolution—it runs the risk of falling into long-term stagnation.[47] Thus, Japan finds itself in a situation where it must pursue improvements in its added-value productivity.

Likewise, the achievement of long-term significant reductions in GHG emissions will be difficult through only the extension of conventional initiatives. Reforms that cover all aspects of technology, socio-economic systems, and lifestyles must be considered. In other words, whether it is achieving long-term significant reduction of greenhouse gases or sustainable economic growth, success will require consideration of reforms that reach across the economy and society in their entirety. Accordingly, rather than thinking about climate change and economic growth individually, it is prudent to seek their solutions simultaneously, and indeed ways of thinking that are oriented in this direction are already being seen.[48] This kind of "simultaneous solution"-based thinking will become an important concept that aspires to realize true compatibility of global warming countermeasures and economic growth and, further, to contribute to the resolution of Japan's various challenges by tackling climate change based on its special nature as a phenomenon that originates from humankind's many socio-economic activities.

(a) Economic Growth from Climate Change Policy

Although the relationship between environmental conservation and the economy has been debated ever since the era of pollution control, the view that "environmental conservation measures have a negative effect on the economy" remains persistent. Particularly from the perspective of the production sector, which is required to implement environmental conservation measures, concerns have been raised about effects on corporate earnings arising from the cost of implementing those measures, the accompanying reduction in demand, and the loss of export competitiveness, among other consequences.

On the other hand, environmental conservation measures generate new investment and consumption demand for associated technologies, and spur innovation. In addition, imports of fossil fuels decrease under climate change policy. In the debate surrounding renewable energy, while there are concerns about the impact that rising energy prices will have, at the same time the question of whether payments for energy are being made to overseas or domestic interests—in other words, whether the income attributable to energy prices is going overseas or being returned

[46] An opinion expressed in the subcommittee was that, because global warming is a threat to sustainable society and thus also a threat to the continuation of corporate activity that sees society as its "customer," companies should view the realization of a low-carbon/decarbonized society not as someone else's problem but rather as an issue that has a bearing on their own business continuity.

[47] Similar views are expressed in Ministry of Economy, Trade and Industry, "New Industrial Structure Committee, Industrial Structure Council, 'An Interim Report on the New Industrial Structure Vision'" (April 2016) and Cabinet Office, "2030-nen Tenbo to Kaikaku Tasukufosu Hokokusho (prospects for 2030 and reform task force report)" (January 25, 2017).

[48] One very recent example is Cabinet Office "2030-nen Tenbo to Kaikaku Tasukufosu Hokokusho (prospects for 2030 and reform task force report)" (January 25, 2017). Another example is Ministry of the Environment, "Long-term Climate Change Strategy Advisory Group Recommendations" (February 2016).

domestically (and particularly locally)—can also be identified as an important point of contention in terms of macroeconomics.[49]

Particularly in recent years, the corporate sector has been composed of surplus units, and the cash and deposits held by companies continue to grow, having reached 246 trillion yen[50] as of December 2016. As mentioned in Chapter 3, this is thought to be possibly due to passivity coming from a lack of places to spend, and indeed a deficit of investment opportunities is emerging. Considering the question of where Japan will invest in the future, as mentioned previously, the scale of future markets for the technologies, products, and services needed to achieve long-term significant emissions reductions throughout the world will be huge, and thus climate change policy that seeks to seize this "promised market" can be considered to have a direct link to growth strategy. Especially given the current economic conditions, and from the standpoint of realizing an economic society that will remain vibrant into the future, climate change policy can be viewed as a form of promising investment for new growth. Japan, a nation possessing outstanding technologies and know-how, is positioned to lead the world in climate change policy. It will generate innovation by strengthening initiatives aimed at achieving long-term significant emissions reductions within its borders, drive its economy by applying its strengths and potential to the maximum extent possible, and, in the short term, tie these results to overcoming deflation and to new growth.

On the other hand, climate change policy can become a factor behind rising production costs. It is highly likely that if the same goods and services are supplied even when costs rise, demand for those goods and services will decrease. However, it is also possible that climate change policy will serve to trigger a shift toward the direction currently demanded (i.e., increasing productivity by elevating the ratio of value added while raising unit prices through the development of new fields and product innovation) that was described in Chapter 3.[51]

The following sections will delve deeper into this topic using "carbon productivity" as a starting point.

Improving Carbon Productivity

In order to maintain a certain level of economic growth when a 2°C goal has been incorporated into the Paris Agreement and a one-trillion-ton cap has been placed on CO_2 emissions—in other words, at a time when carbon inputs are limited—it is indispensable to generate high added value with low

[49] Surcharges imposed by the Feed-in Tariff (FiT) scheme place a large burden on a country's citizens. However, in general, those surcharges tend to be redistributed within the country and therefore generate a certain degree of economic effect. In FY2013, surcharges associated with the FiT scheme amounted to 328.9 billion yen. However, the domestically-attributed added value that was generated from capital investment related to renewable energies amounted to approximately 2.0 trillion yen and added value related to power sales and management businesses reached 320 billion yen, making a total of approximately 2.3 trillion yen. Moreover, in FY2014, tariffs reached 652.0 billion yen; however, added value related to capital investment amounted to approximately 2.1 trillion yen and added value related to power sales and management businesses reached approximately 600 billion yen, making a total of 2.7 trillion yen. Investigative Commission on the Market Size of the Environment Industry, "Kankyo Sangyo no Shijo Kibo-Koyo-to ni kan-suru Hokokusho" (report on market size, employment, etc., of the environment industry) (March 2016).

[50] Bank of Japan, "Flow of Funds Accounts" (December 2016).

[51] We believe this view was concisely expressed in a policy speech given by Prime Minister Abe at the 190th Session of the Diet. "However, as economies grow, labor costs rise. Pollution occurs. Deflation-oriented economic growth that pursues the "ever cheaper" has its own limitations. (Omission) Through innovation, we generate new added value while ensuring sustained growth. We must transition away from "ever cheaper" towards innovation-oriented economic growth that takes on the challenge of making things "ever better." Cheap products made inappropriately, such as through counterfeits, labor exploitation, or causing environmental damage should be swept away from the world market." (Excerpt from a policy speech given by Prime Minister Abe on January 22, 2016)

carbon inputs and to greatly increase carbon productivity (added value against carbon input)[52] (see Page 75 of the Reference Materials). Japan will need to increase its carbon productivity by at least a factor of six by 2050.[53] It is thought that countries capable of achieving high carbon productivity will be able to achieve sustainable economic growth, and it must be recognized that international competition in the area of carbon productivity is already beginning.

○ Carbon productivity (the denominator)

What is needed to achieve significant improvements in carbon productivity? Naturally, significant reductions in carbon input, which is the denominator of carbon productivity, must be realized by a full-scale effort to implement all manner of reduction measures. Significantly reducing carbon input will require the promotion of thoroughgoing energy conservation (i.e., major improvement in energy productivity) and the optimization of activities (e.g., automobile travel distances and building floor space) by introducing low-carbon sources of power and heat and implementing urban structure-related measures.

○ Carbon productivity (the numerator)

On the other hand, the relationship between GDP and added value, which form the numerator of the equation, and carbon input is also important in achieving significant improvement in carbon productivity. In conventional thinking, GDP growth is accompanied by an increase in "activity" in such forms as production and shop floor space, and carbon input increases in conjunction with that growth. Thus, it has been understood that decreased GHG emissions and economic growth are incompatible. However, a phenomenon called "decoupling," whereby decreases in GHG emissions and economic growth are not linked, is not at all unusual in developed countries, including Japan. As mentioned previously, it has been pointed out that companies in developed countries have maintained high value and raised earnings by creating new businesses and building up product brands. In developed countries, there is a shift underway from the traditional economic structure in which earnings come from greater volume to one in which earnings come from quality and higher unit prices of goods and services, and it is possible that GDP growth and GHG emissions are not linked as they once were. Accordingly, seeking as the economy's substance a structure in which earnings come from quality based on the high added value of goods and services will be extremely important in achieving significant improvements in carbon productivity.[54]

Economic Growth and Climate Change Policy: Finding Compatibility between Added-Value Productivity and Carbon Productivity

○ Shifting from quantity to quality

As mentioned above, improving added-value productivity to achieve economic growth under

[52] Under its Basic Plan for Establishing a Recycling-Based Society, Japan has worked to achieve high added value with as few natural resource inputs as possible, using resource productivity (GDP/natural resource inputs) as an indicator.

[53] Carbon productivity will reach or exceed six times its current level if carbon inputs are cut to one-fifth and nominal GDP is increased to 600 trillion yen or more, or about 1.2 times the current GDP (government target for 2020).

[54] Under the Paris Agreement, each signatory country works to reduce its own GHG emissions. Given this, each country of the world must strive to reduce its emissions. Additionally, an opinion expressed in the subcommittee stated that, in the case of products, the volume of emissions is high at the production stage but expected to decrease when viewed in terms of the entire life cycle, which includes the use stage, and thus evaluating carbon productivity throughout the life cycle is also necessary. Moreover, it is thought that product-by-product "visualization" of products' contributions to lower emissions throughout their life cycles is important.

population decrease and other constraints, and improving carbon productivity to comply with the Paris Agreement, can be said to follow the same line in terms of a shift “from quantity to quality” in the economy’s character (see Figure 10 and Page 76 of the Reference Materials).

Statistically, no correlation between added-value productivity and carbon productivity was identified in 1990, but in 2014, countries that had high labor productivity tended to have high carbon productivity and, although weak, a positive correlation is already being identified (see Figure 11 and Page 77 of the Reference Materials). This report noted how some have recently pointed out that innovation is important in raising added-value productivity and that the role of intangible assets as a source of innovation is large. However, regarding the rise in added-value productivity, it is thought possible that the growing role of intangible assets that have a weak connection with increased carbon input is having an influence as a factor in the emerging interrelation between added-value productivity and carbon productivity.

It is quite likely that carbon productivity has qualities that will enable it to serve as an economic indicator for measuring the degree of progress toward the so-called “shift from quantity to quality in economic growth.”

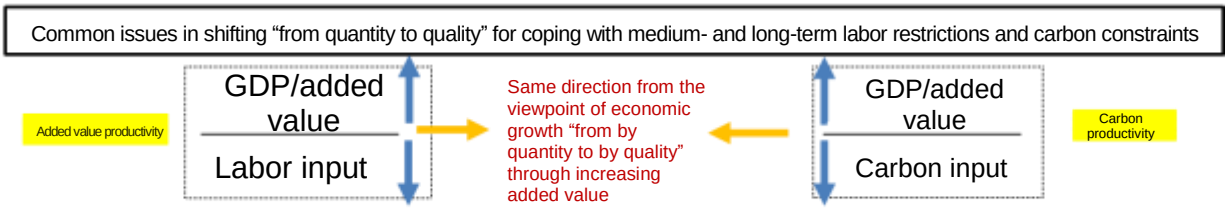
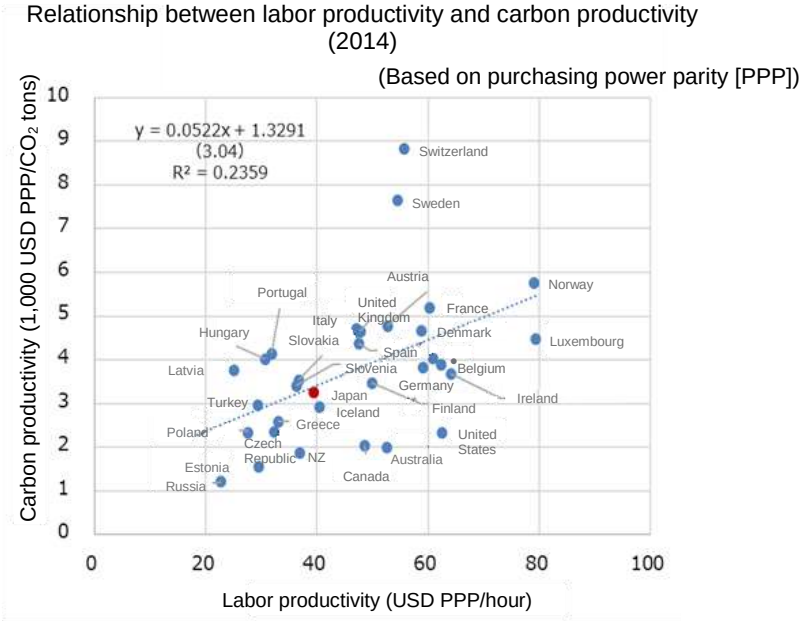


Figure 10 Shift “from Quantity to Quality” in Economic Growth



Prepared based on data of OECD, UNFCCC, and others

Figure 11 Relationship between Labor Productivity (Added-Value Productivity) and Carbon Productivity

○ Awakening latent demand and capturing external demand: the so-called “promised market”

The climate change policies requiring continuous long-term investment by the Paris Agreement represent the so-called “promised market.” While some aspects are dependent on the design of government schemes, for companies that are accumulating cash and deposits due to a passive investment stance arising from a lack of investment destinations, it is one of the promising fields in which active investment can be made with a clear view of prospects.

Enacted through worldwide consensus, the Paris Agreement will create a market of global scale. As mentioned previously, according to a calculation released by the IEA, decarbonizing the electric power sector under the 2°C scenario will require approximately nine trillion USD in additional investment between 2016 and 2050, and reaching energy conservation goals in the three sectors of building, industry, and transport will require approximately three trillion USD in additional investment during the same period.

For Japan, a country particularly facing quantitative demand constraints as its population decreases, this represents an opportunity to capture vast external demand. It is hoped that Japan will lead the world in presenting problem-solving models for a decarbonized society in areas that include not only technology but also socio-economic systems and lifestyles, and will seize a competitive advantage in the world market. It must be remembered that if, conversely, Japan cannot seize a competitive advantage in the world market, it is liable to fall into a situation where it will have to import models from other countries.

Furthermore, climate change policy will require long-term innovation in areas that include innovative reduction technologies. Innovation that grasps latent needs harbors the potential to generate positive consumption behaviors among consumers and lead to the next stage of innovation through increased income and further expansion of demand (see Figure 12 and Page 78 of the Reference Materials).

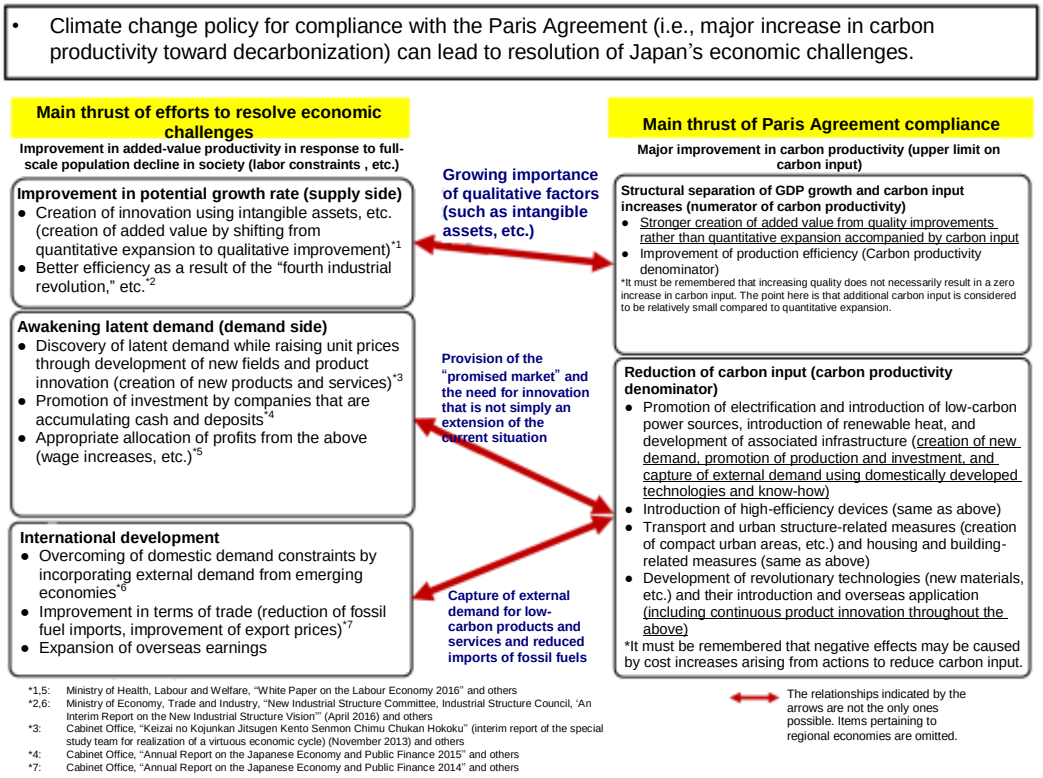


Figure 12: Relationships between Solutions to Economic Challenges and Compliance with the Paris Agreement (for Conceptual Purposes)

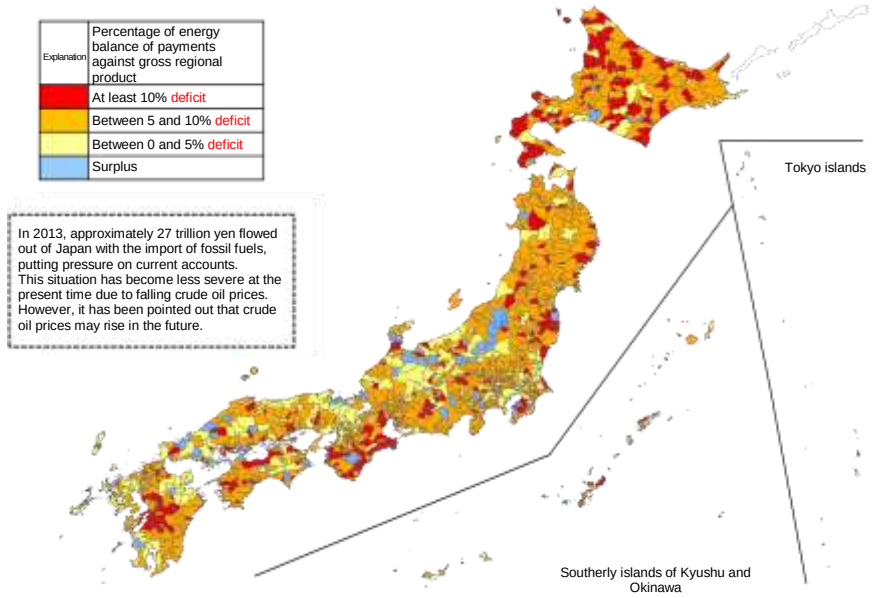
(b) Regional Revitalization and Land Resilience through Climate Change Policy

Local Energy

Looking at the balance of energy payments of individual regions, in the case of approximately 80% of local governments, funds equivalent to at least 5% of gross regional product flow out of the region, and in the case of 379 local governments, funds equivalent to at least 10% flow out (statistics as of 2010). Additionally, because fossil fuels account for the majority of current energy sources, a large portion of local energy payments flows outside of Japan as import fees (see Figure 13 and Page 79 of the Reference Materials). Although circumstances vary from region to region, improving the regions' balance of energy payments through a climate change policy that includes the introduction of renewable energy having great potential, particularly in outlying regions, will contribute to the building of robust local economies and lead to regional revitalization.

Moreover, projects associated with renewable energy will generate new jobs and employment and can therefore help prevent the outflow of working-age people (see Pages 80 and 81 of the Reference Materials).

In addition, much renewable energy is also independent distributed energy, and the addition of this independent distributed energy to the existing electric power grid will improve resilience against disasters and thus is expected to contribute to Japan's national resilience as well.



Prepared using the 2013 regional economic cycle analysis database (Ministry of the Environment)

Figure 13 Energy Balance of Payments against Gross Regional Product

Compact Urban Areas

Looking at lifestyles in relation to urban structure and transportation, there is a tendency whereby areas with low DID population density[55] have higher shares of automobile use and areas with high density have higher shares of walking and bicycle use. To achieve major reductions, it is important to develop communities by applying vehicle-related measures, such as those that reduce or eliminate carbon emissions, together with transport measures that inherently reduce the amount of energy consumed (see Page 83 of the Reference Materials). Making spread-out urban areas more compact by consolidating the various service functions that support people in their daily lives (e.g., medical care, nursing care, welfare, commercial services, financial services, and fuel supply) will help curtail transportation that results in fuel use and also contribute to lower GHG emissions through more streamlined use of floor space.

Additionally, we believe that the above-mentioned measures will also generate multiple benefits in terms of simultaneous solution of climate change and other policy challenges. These include greater labor productivity as a result of the aggregation of service functions and greater DID population density (see Page 84 of the Reference Materials), revitalization of urban areas through increased local consumption and restoration of community vitality (see Page 85 of the Reference Materials), reduced administrative costs needed to maintain and manage infrastructure and extension of healthy life span with more walking and use of bicycles (see Page 86 of the Reference Materials), and lower medical and nursing care costs.

Natural Capital

It is highly possible that forests, rural areas, rivers, seas, and other aspects of the natural

[55] DID (Densely Inhabited District): A district in which basic unit blocks with a population density of 4,000 or more per square kilometer are adjacent to each other in a municipality, and in which the population of those adjacent basic unit blocks is 5,000 or more.

environment will be greatly affected by changes in the ecosystem brought by advancing climate change. On the other hand, the natural environment not only supplies resources in the forms of lumber and food, but is also a source of renewable energy, such as biomass and hydroelectric power, and can help bring improvements in the local energy balance. Moreover, with proper management, it also functions as a carbon dioxide sink. Maintaining and enhancing such natural capital as a stock is a prerequisite for the enjoyment of these "blessings of nature" and for the continuation of sound economic and social activities in local areas.

Furthermore, natural capital is a source for generating high added-value goods and services that are based on regional originality and for attracting people from outside the area. In addition to this, the presence of familiar natural environments, such as village forests and parks and green spaces in urban areas, can lead to better health-related quality of life.

(c) Climate and Energy Security

Climate Security

As shown in Chapter 1 (1) (a), climate change creates various risks for the entire world, and has been a topic of discussion from the standpoint of national security since 2000.[56] A report prepared by the United States' National Intelligence Council in September 2016 also mentions security-related issues brought by climate change[57] (see Page 7 of the Reference Materials). In Japan too, various forms of damage have arisen, the most common in terms of climate being wind and water damage caused by typhoons and stationary weather fronts, for which the amount of insurance payments is also large. Furthermore, damage to rice, fruit, and other crops; health problems such as heatstroke and infectious disease; and impacts on Japan's unique ecosystems are also actually occurring, and it is possible that these effects will grow even larger in the years ahead. Because of such threats, all nations, including Japan, must implement climate change policy that is based on scientific knowledge, and the international community must work together in tackling climate change based on a "climate security" mindset to protect not only the current generation but also generations to come.[58]

Additionally, developing and disseminating Japan's technologies, know-how, lifestyles, and schemes overseas can lead to improvements vis-à-vis global environmental problems. In addition to reducing emissions by 80% in Japan, those technologies and other attributes will make a "+α" (read "plus alpha," a Japanese expression denoting "with a bit extra")[59] contribution to the entire world.

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[56] Climate change was first taken up as an issue in the United Nations Security Council in 2007. The discussion included the importance and urgency of climate change and reinforcement of international efforts to tackle it.

[57] Specifically, the report mentioned the threat to national stability, growing social and political tension, food concerns, impacts on human health, negative effects on investment and economic competitiveness, and unforeseen phenomena caused by climate discontinuity.

[58] Sub-Committee on International Climate Change Strategy, Global Environment Committee, Central Environment Council, "Report on Climate Security" (May 2007)

[59] With regard to "+α," there are a number of questions that must be examined going forward. They include whether "+α" should be quantified and, if so, how to calculate Japan's contribution to other countries, how to subtract other countries' contributions to Japan, and what goals should be set based on those calculations. However, the "National Energy and Environment Strategy for Technological Innovation towards 2050," for example, states that "[were selected technologies successfully developed and adopted throughout the world] in combination with technologies already in development and testing stages, we could expect a potential positive impact of almost the same level (between several billion

There is an initiative (JCM[60]) underway that contributes to global emissions reductions by assisting with initial costs and diffusing low-carbon technologies; it is important to execute this kind of "high-quality" international contribution. We believe that such an initiative would lead to worldwide reductions in GHG emissions and contribute to stronger global-scale security against climate change—in other words, "climate security"—and, simultaneously, bolster Japan's presence in the international community. Furthermore, it could also help Japan secure international competitiveness through the opening of international markets.

Moreover, it must not be forgotten that, because Japan is a major emitter that generates more than 1.3 billion tons of GHG annually, its success in reducing emissions as soon as possible and with an eye to its carbon budget will itself be an international contribution helping to ensure the international community's climate security.

Energy Security

It can be said that raising energy self-sufficiency rates by using local energy has a direct link to guaranteeing energy security. In a world of increasing uncertainty, the importance of utilizing local energy is growing. Moreover, because worldwide energy security and conflict prevention can result when regions raise their energy self-sufficiency without depending on fossil fuels, it is important to strive to accelerate initiatives toward this end, not only domestically but also through international cooperation.

(2) Japan Contributing to Global Emissions Reduction in addition to Domestic Policies

As a nation possessing outstanding technologies and know-how for GHG emissions reduction, Japan is positioned to lead the international community. Reinforcing domestic initiatives to achieve long-term significant reduction can lead to generating all manner of innovations, including in technologies and know-how, lifestyle, and socio-economic systems for overcoming the various constraints that Japan faces in terms of its geography, land, and resources.

Domestically, particularly in the civilian sector and transport sector, Japan has considerable room for major reductions. By advancing initiatives toward promoting transformation of consumption patterns and purchase of low-carbon products to replace convention products, eliminating emissions from houses and buildings, reforming urban and regional structures, and diffusing independent/distributed energy in a multi-layered manner, Japan can continuously generate innovation for achieving long-term significant reduction while promoting investment and creating a vast domestic market. It is important to promote these measures and, while doing so, tie them to the revitalization of Japan's economy and, simultaneously, to the resolution of the various challenges that face the nation (e.g., regional revitalization, national resilience, energy security, etc.) by, for example, also revitalizing the economies of weak regions and improving the energy balances and disaster readiness of local areas through the diffusion of renewable energy. Furthermore, we believe that long-term significant reduction presents a great challenge that all industries of the world, both in Japan and abroad, must overcome, and that making an unceasing effort to further improve the industrial sector's carbon productivity with an eye to such reduction has a direct link to the stronger international competitiveness of Japanese industry.

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tons and 10 billion tons) on global CO_2 by the year 2050." This is equivalent to between slightly less than 10% and 30% of global CO_2 emissions from energy consumption (32.2 billion tons) in 2014.

[60] Joint Crediting Mechanism

Even in other countries, progress in the achievement of major emissions reductions for a decarbonized society is being seen, and moreover as it is expected that competition in the "promised market" will intensify, Japan must maintain and improve a high level of international competitiveness if it is to continue making a sustained contribution to overseas reductions. Although Japan is faced with various constraints in terms of geography, land, and resources, we believe that realizing major reductions through various responses in such areas as technologies and know-how to overcome such constraints as well as lifestyle and socio-economic systems will provide a source of international competitiveness. In this sense, domestic measures in climate change policy are essential, and in parallel with its domestic long-term significant reductions, Japan must further global emission reductions by advancing its contributions to reduction through the JCM and product life cycle.

Moreover, as a country that emits more than 1.3 billion tons of GHG, Japan is naturally obligated to greatly reduce its emissions at a time when initiatives to build a decarbonized society under the Paris Agreement are getting underway around the world. Going forward, we believe it is likely that the circumstances will become such that human beings will need to make great reductions toward building a global decarbonized society even as many nations increasingly grapple with low birth rates and aging societies. In such circumstances, we believe that Japan can, by simultaneously achieving major reductions and solving economic and social challenges through innovation of its technologies, lifestyles, and socio-economic systems, serve as a model for the world as a forerunner of finding answers for emerging issues (see Figure 14 and Page 87 of the Reference Materials).

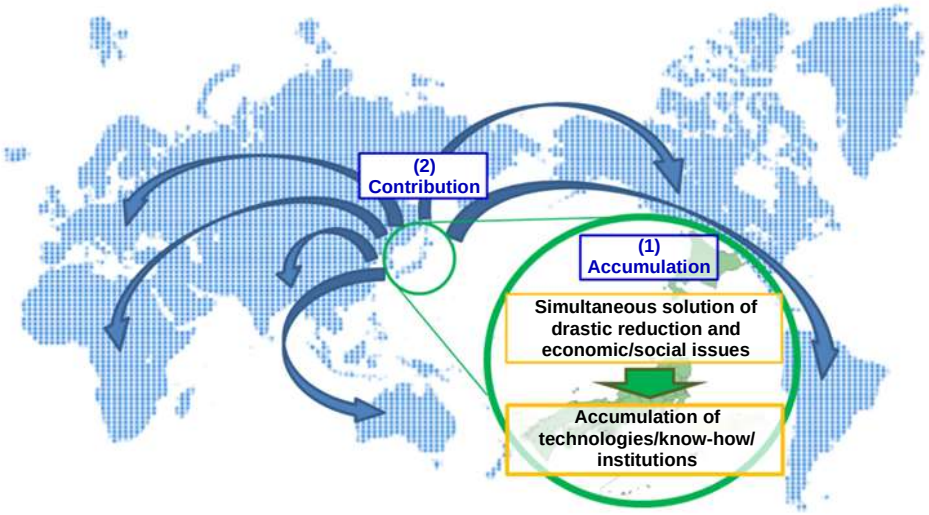
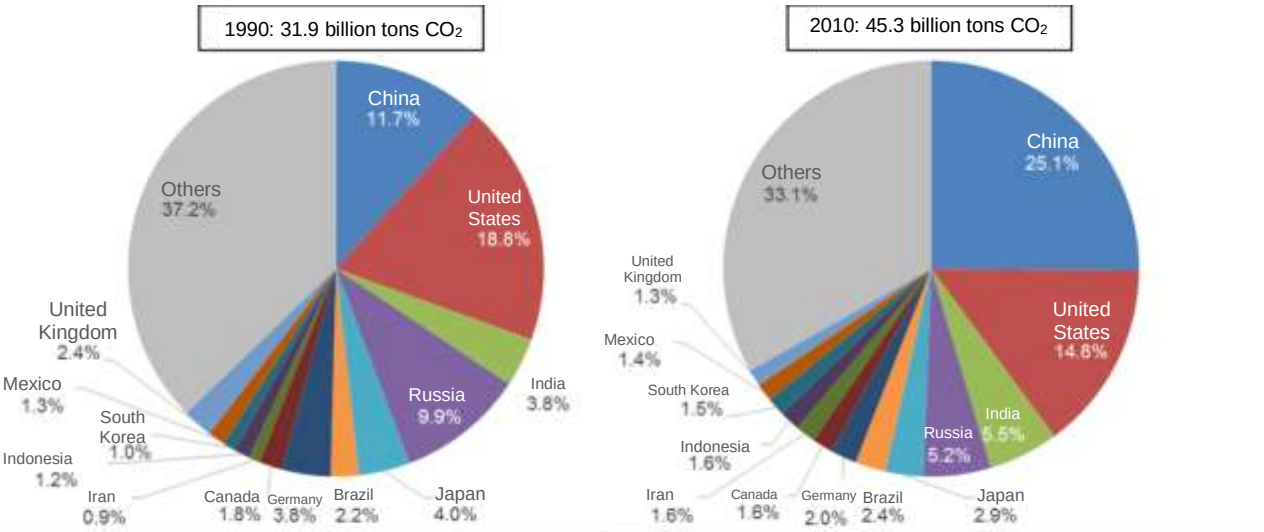


Figure 14　Major Reduction in Japan and Long-Term Overseas Contribution

As a percentage of global GHG emissions, Japan's emissions stood at 2.9% as of 2010 (see Figure 15 and Page 88 of the Reference Materials). There is a point of view that seeks to adjust the strength of measures to address emissions reduction depending on the size of a nation's share of global emissions. Because Japan and the countries that produce fewer emissions than Japan together represent approximately 40%[61] of global emissions, if they were to adopt this point of view, the goal of the Paris Agreement—to build a decarbonized society around the world—would

[61] EU member states are counted together as the EU (as the data are from 2010, the United Kingdom is also included). The total emissions from countries other than China, the United States, the EU, India, and Russia amount to approximately 40%. (→Page 89 of the Reference Materials)

become completely unreachable. In order to achieve its goal, the Paris Agreement, in addition to calling for initiatives based on the participation of all nations, clearly establishes that developed nations in particular must take the lead by working to reduce absolute emissions throughout their economies.[62] As one of the major emitters that is ranked fifth in the world, and as a nation possessing outstanding environmental technologies and know-how, Japan is in a position of responsibility whereby it must take the lead in executing initiatives toward the establishment of a decarbonized society throughout the world.



*Excludes "CO_2 Other"

Prepared based on "CO_2 Emissions From Fuel Combustion (2016 Edition)" (IEA)

Figure 15 GHG Emissions by Country (1990, 2010)

(3) The Key to Long-Term Significant Reduction is Innovation

In addition to the maximal use of existing technologies, know-how, and knowledge, achieving long-term significant reduction requires novel innovation that is not simply an extension of conventional methods. Promoting innovation improves productivity and is directly linked to economic growth,[63] and as such the creation of innovation that is driven by climate change policy is the key to the simultaneous achievement of long-term significant reduction and of solutions to economic and social challenges.

Technology Innovation

Further research and technical development are essential to achieving long-term significant reduction. In addition to the development of advanced elemental technologies (i.e., technologies that bring products into being, such as those related to production, quality, and infrastructure), the combination of existing elemental technologies, organic linkage of elemental technologies using ICT and other technologies, and linkage of advanced elemental technologies of the future will lead to the innovation of technologies. It is important to drive ceaseless movement toward long-term significant reduction in Japan and abroad by continuously producing innovation that fully employs the collective achievements of Japan's diverse industries.

[62] Article 4 paragraph 4 of the Paris Agreement states, "Developed country Parties should continue taking the lead by undertaking economy-wide absolute emission reduction targets."

[63] See Chapter 6 (1) (b)

As seen in a number of past examples in which Japanese technologies conquered the world—for example, through the practical application of heat-pump technology, hybrid vehicles, and LED lighting—it is possible to create new innovation by establishing a strategy and then methodically executing development, demonstration, and human resource development.

Economic and Social System Innovation

Mechanisms that enable continuous and long-term generation of innovation are indispensable for long-term significant reduction. Additionally, because elemental technologies and other individual technical innovations only bring reductions when they are disseminated, mechanisms that produce incentives for enhancing demand for new technology throughout society are required. Moreover, as society experiences dramatic change as a result of ICT and other advancements, the possibility exists that traditional values will change greatly in the future, and so innovation on the institutional side that will allow nimble responses to such change is also essential. We believe that the generation of innovation in economic and social systems in themselves will strengthen companies' desire to provide high added value in goods and services on the supply side and further spur the arrival of new markets on the demand side, and can lead to the simultaneous solution of various economic and social challenges that include overcoming deflation and achieving new growth.

Lifestyle Innovation

People's values, lifestyles, and work styles have a significant bearing on GHG emissions. Changing the orientation of our own lifestyles, work styles, and selection of goods and services toward decarbonization will generate new demand, and since this will lead to innovation in terms of new goods and services, innovation in the area of lifestyle is necessary.

Japanese culture is founded on harmony with nature. The Japanese people respect and fear nature, have developed a keen sensitivity to nature, and have made nature the foundation of their traditional artistic culture and sophisticated manufacturing culture. In addition, through the process of experiencing pollution during its post-war period of high economic growth, reflecting on the causes of that pollution, and then overcoming it, Japan may be said to have also cultivated a culture that pursues sustainability as a way of being in its corporate activities and regional society. To achieve long-term significant reduction of GHG emissions, Japan must become reacquainted with the above-noted values that underlie its society, aim to improve quality of life, and consider lifestyles with the appeal of an even higher level of "eminence."

(4) The Time to Act is Now

As described below, given not only the pressing need to respond in terms of climate change policy—specifically, with attention to carbon budgeting, the carbon "lock-in" effects of infrastructure, principles of environmental policy, early diffusion of decarbonization technologies, and global trends—but in the first instance Japan's responsibility as a signatory working for the achievement of long-term goals under the Paris Agreement, the time to engage in accelerating initiatives toward long-term significant reduction is now.[64]

[64] As seen in Chapter 1 (1) (c), it has been pointed out that, even when Intended Nationally Determined Contributions submitted by countries are aggregated, the total is not enough to achieve the 2°C goal at minimum cost, and thus additional reduction efforts will be required. Long-term significant reduction is a goal that lies beyond the mid-term target of 2030, and steady actions are proceeding toward it based on the current "Plan for Global Warming Countermeasures." Nonetheless, conducting strict progress inspections and accelerating initiatives to achieve long-term significant reduction are important.

Carbon Budget

"Carbon budgeting" is an important concept in climate change action (see Page 9 of the Reference Materials). If we are to make our socio-economic activities sustainable into the future, we must engage in these socio-economic activities while shrinking our carbon budget to the best of our ability. For this reason the concept of cumulative emissions, which promotes the reduction of CO_2 "as quickly as possible, and as much as possible," is extremely important.

This way of thinking is applicable to all countries in accordance with their abilities. Japan, which is one of the major emitters, has set a goal of achieving a 26% reduction compared to FY2013 in FY2030 and of achieving an 80% reduction by 2050. The importance of achieving these goals is obvious, but if we consider its carbon budget, the path that Japan will take toward achieving them becomes extremely important. Specifically, the question of how Japan will achieve its mid-term target while holding down its cumulative emissions (expressed by the integrated values in the graph) through FY2030, for example, is essentially crucial (see Page 90 of the Reference Materials).

To minimize cumulative emissions to the extent possible based on its carbon budget, Japan must achieve its FY2030 mid-term target without fail and steadily proceed with the preparations needed to achieve its long-term 2050 goal. At the same time, it has no choice but to maximize its reductions each fiscal year, and must execute full-scale initiatives toward this end immediately, continuously, and with a sense of urgency.

Infrastructure

Urban structures, large-scale facilities, and other forms of infrastructure require large amounts of time for their maintenance, upgrade, and termination. Responses that take into account long-term environmental impacts when maintaining infrastructure which, once in place, may lead to a high level of CO_2 emissions over a long period of time (the "lock-in effect") must begin immediately (see Page 91 of the Reference Materials). Conversely, investment in facilities expected to be needed in the future is also necessary starting now. For example, study of the capital investment needed to fully leverage the potential of renewable energy, the need for which will grow increasingly in the years ahead, must begin in a proactive manner now. A perspective that seeks to identify what to do now with an eye to the future is required.

Principles of Environmental Policy

In addition, action must be taken to guarantee that "the environment as the foundation of human survival can be preserved into the future" (Article 3 of the Basic Environment Law) in initiatives tackling environmental issues, and to ensure that "interference with environmental conservation can be anticipatively prevented" (Article 4 of the Basic Environment Law) in reducing GHG emissions from human sources, which are the dominant factor behind the warming that has been measured since the mid-20th century. At the same time, there is a need to execute countermeasures based on "preventive initiatives and methods" while working to further enhance scientific knowledge in areas that include adaptation to climate change. The perspective of intergenerational equity, which is established in Japan's history of experiencing and overcoming pollution and in the various international treaties to which Japan is a signatory, as well as prevention, preventive initiatives and methods, and the "polluter-pays principle" (PPP) are also perspectives that must not be forgotten in climate change policy. While damage is already becoming manifest, now is the time to take full-scale action to avoid and mitigate further damage.

Time Required for Dissemination

Outstanding technologies do not always spread quickly. Generally speaking, it takes a certain amount of time for a new technology to be disseminated (see Page 92 of the Reference Materials). Minimizing cumulative emissions based on the carbon budget requires the quick dissemination of outstanding reduction technologies, but even if the national or local governments implement policies and measures (PaMs) to drive dissemination, a certain amount of time is required until dissemination actually occurs. Thus, it must be remembered that, in addition to the time needed for technology research, development, and demonstration, a certain amount of time is required for dissemination.

The Global Trend

Moreover, it is not only the public sector—i.e., national and local governments around the world—that is taking accelerated steps toward long-term significant reductions based on the Paris Agreement, but also a broad variety of actors, including businesses, the finance industry, and civic communities. At a time when socio-economic activities around the world are incorporating low carbon- and decarbonization-based approaches, it must also be remembered that being slow to join this global trend could negatively affect national interests.

Achievement of the Paris Agreement's Long-Term Goals

The Paris Agreement establishes as long-term mitigation goals the "[holding of] the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" in Article 2 and "[achieving] a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century" in Article 4. As a signatory of the agreement, Japan must promote emissions reduction measures domestically and fulfill its responsibilities toward achievement of the agreement's goals internationally.

Chapter 5: A Vision of Long-Term Significant Reduction

(1) Vision of a Japanese society that achieves 80% reduction by 2050 (Figures 16 and 17 and Pages 94 and 95 of the Reference Materials)

As noted earlier, with its gaze fixed on the building of a decarbonized society world-wide, Japan's climate change policy aiming for an 80% reduction by 2050 can spark simultaneous solutions, through innovation among other ways, to Japan's economic and social challenges.

Given advancements in ICT and other factors, the future of today's rapidly changing society is difficult to forecast. This uncertainty vis-à-vis the future is universal and not specific to the environmental field. By clarifying and sharing its aims regarding the climate change issue, it will be important for Japan to promote initiatives executed by the nation's citizens as a whole.

What would a society that achieves the target of an 80% reduction by 2050—while simultaneously making integrated environmental, economic, and social improvements and becoming a society that is recycling-based and in harmony with nature—look like? The following presents a general vision from three standpoints.

(a) Sustainable growth through "creation of a decarbonization market" and realization of an "economy of quality"

Cognizant of the change in the epochal tide occurring in the wake of the Paris Agreement, Japan is earnestly tackling innovation that is not bound by the conventional industrial structure or customary practices, while remaining fully aware of the limitations posed by resources, energy, and national territory. Moreover, Japan has achieved enormous international competitiveness in the "promised market" concerning climate change and is a driving force of the decarbonization market.

Added value associated with goods and services is growing greatly, and the quality of people's lives is increasing. The sources of added value are high functionality (including environmental performance) as well as Japan's natural beauties (including its natural landscapes), culture, and art and any other elements that bring happiness, enjoyment, and deliciousness to life. People enjoy their lives and a virtuous cycle of high wages and high added value has been generated, and social disparities have also been corrected. Japan has become an international model for tackling problems posed by its falling birthrate and aging society by achieving a growth economy that is based on a shift "from quantity to quality."

By translating the "Fourth Industrial Revolution" and initiatives to tackle GHG gas emissions into a virtuous circle, Japan's carbon productivity and labor productivity have risen and its people are achieving low-carbon lifestyles and good work-life balance.

As a whole, Japan has accomplished significant decoupling on a consistent basis in both energy and resources by achieving economic growth of sustained quality while further reducing energy consumption attributable to the saturation of artificial goods, and by realizing a circular economy while raising its resource efficiency*.[65]

[65] A report issued by the European Union (EU) in December 2015 entitled "Closing the Loop: An EU Action Plan for the Circular Economy" describes how the EU will reexamine its existing socio-economic systems and build new industries and economies based on the keyword "circular." (Annual Report on the Environment, the Sound Material-Cycle Society and the Biodiversity 2016)

(b) "Regional revitalization" through renewable energy industries and compact urban development based on natural capital

In its rural areas, Japan has established environmentally-sound primary industries and renewable energy industries that utilize regional energy as key regional industries founded on natural capital. Various actors that include private citizens, local enterprises, and local governments participate and collaborate as supporters of renewable energy industries, leading to the creation of employment and the maintenance and improvement of regional community functions.

Healthy and long-living regional societies are built and greater transport comfort is achieved with an increase in the share of walking or bicycling that is made possible with greater urban compactness and use of public transportation, for example. And people can enjoy safe and secure regional societies through local industry and urban development pursued with an eye to "adaptation." The result is continually growing urban attractiveness. Additionally, the generation of new value has been intensified by, for example, the creation of new innovation through the intersection and "interaction"[66] of people from various generations and specialties and of information.

Each region raises quality of life, corrects disparities, and contributes to stronger national competitiveness by providing high value-added goods and services produced with its own natural capital, culture, and other attributes. Additionally, Japan's scenic beauty is sustained with appropriate maintenance and enhancement of its natural capital. The rich natural environment is something that people enjoy and, as an attractive feature of Japan, continues to be a powerful tourism resource.

Moreover, when disasters strike, damage caused by the effects of climate change is minimized or avoided because appropriate measures that fit with local characteristics are implemented. At the same time, the energy that is required is quickly provided by renewable energy in the form of decentralized and self-reliant power sources, and the resilience to enable a quick recovery, such as through power interchange, is secured to the maximum degree possible.

(c) Making a significant contribution to climate security while realizing a nation with improved energy security

Toward achievement of the 2°C target, Japan—in full awareness of the limitations posed by resources, energy, and national territory—is earnestly tackling innovation that is not bound by the conventional industrial structure or customary practices and is leading the world in achieving significant domestic reductions, and because of this Japan's accumulated technologies, know-how, lifestyles, systems, and other advantages are receiving international attention and helping Japan achieve enormous international competitiveness.

As with the present day, in 2050, the continuing diffusion of Japan's outstanding technologies to the world through the achievement of significant domestic reductions is contributing greatly to the building of low-carbon societies and decarbonized societies throughout the world. Moreover, Japan is solidifying the Paris Agreement's effectiveness and making a significant contribution to climate security by executing multifaceted initiatives of high "quality" that include fine-tuned practical aspects, such as means for preparing greenhouse gas inventories, improvement of adaptability, and

[66] "Interaction" refers to the active interaction of people, goods, money, and information between regions with various resources throughout Japan. In itself, "interaction" brings regional revitalization and creates innovation (National Spatial Strategy, Cabinet decision of August 2015).

development of human resources.

As for energy security, Japan has raised its energy self-sufficiency through thorough energy conservation and large-scale introduction of renewable energy that makes use of regional energy. With its geopolitical risks being minimized as much as possible, Japan's energy security has improved to the point that it is not influenced by uncertainties in international circumstances.

Figure 16 Vision of long-term significant reduction (conceptual image of an urban area)

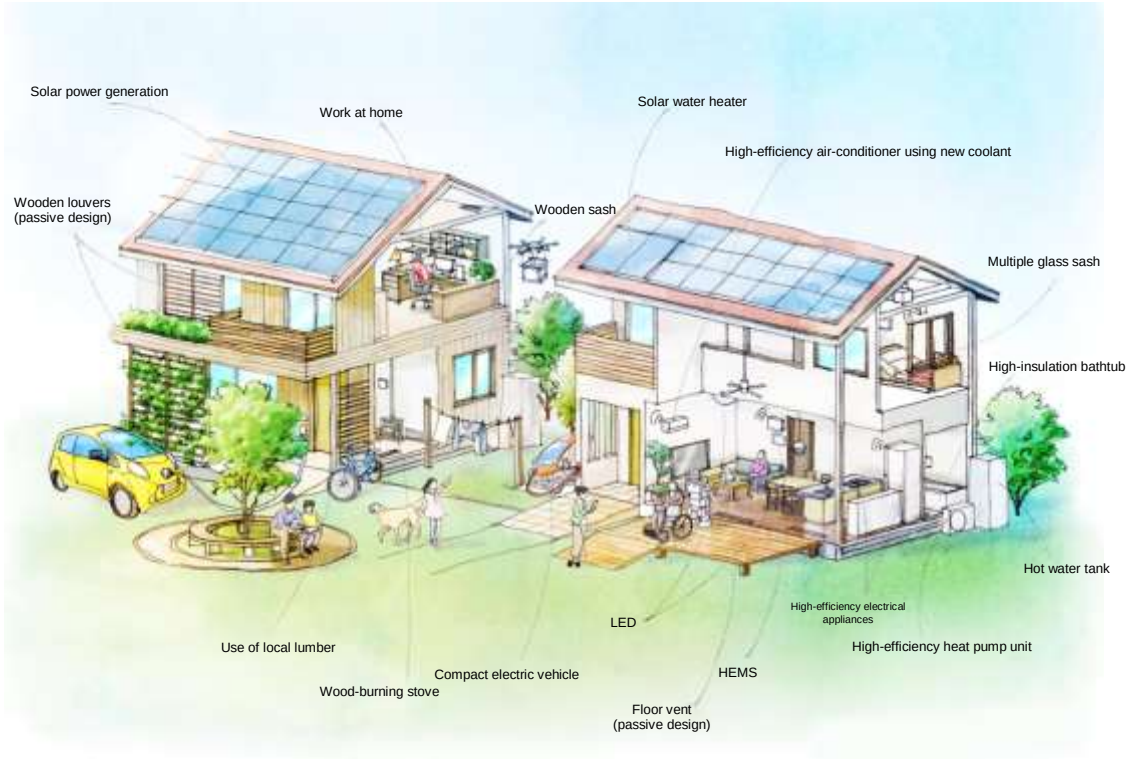


Figure 17　Vision of long-term significant reduction (conceptual image of houses)

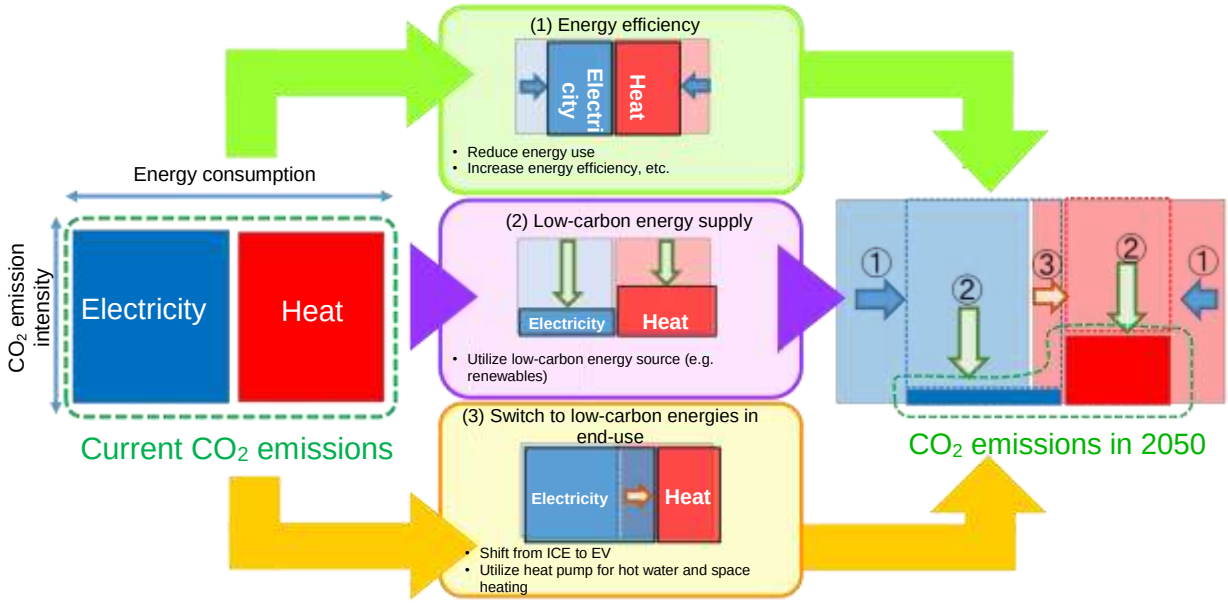
(2) A Vision of Society with Significant Reductions in Various Sectors

This chapter presents a vision of what society might look like if the goal of an 80% reduction by 2050 were achieved with the objective of spurring consideration of various challenges and measures on the way toward reaching that goal. Realizing significant reductions will require the advancement of initiatives in energy conservation, renewable energy, and other areas in all sectors and industrial categories, beginning with increased productivity through innovation, and is not to be premised on current production volumes or energy consumption levels.

There are three mainstays in Japan's effort to achieve an 80% reduction by 2050 on the way toward building a decarbonized society throughout the world. They are thorough energy conservation, maximization of low-carbonization in electric power generation through use of renewable energy and other technologies, and conversion to electrification and use of low-carbon fuels. Successfully promoting these three mainstays will require the persistent execution of various measures in diverse fields (see Figure 18 and Page 96 of the Reference Materials).

The following presents this vision of a successful 80% reduction by 2050 from primarily technical aspects.[67]

[67] It was pointed out in the subcommittee's discussions that the need also exists for study that takes into account such perspectives as economic influences, industrial structure, composition of power sources, and present technical prospects. This must be kept in mind as a valid viewpoint in future study.



Excerpted from the Long-term Climate Change Strategy Advisory Group

Figure 18　Directions to be Taken in Achieving an 80% Reduction by 2050

(a) Buildings/Lifestyle

○ Thorough energy conservation, low carbonization in the generation of the electric power they use, and electrification and conversion to low-carbon fuels have become the norm in housing and buildings. With effective use of ICT (information and communication technology), Japan is approaching zero emissions even in terms of the average over the entire stock of existing and new buildings (see Page 97 of the Reference Materials).

Building performance

○ Low-carbon room interiors that only use the minimum amount of energy needed are commonplace, as “passive design” with characteristics that include high thermal insulating properties and maximum use of inherent local characteristics (e.g., light, wind, etc.), in addition to seismic and fire resistance, has become the norm, and energy-saving equipment with maximum energy use efficiency has been evaluated, adopted, and come into universal use. Such room interiors help improve the quality of life (QOL) of their inhabitants by improving health and comfort (see Page 98 of the Reference Materials).

○ Such buildings have high thermal-insulating, health-promoting, and sound-insulating properties and improve daily comfort and labor productivity. Moreover, they are also resilient to disasters, as they can meet the minimum level of demand for communications, lighting, air-conditioning, and other functions required for daily life for a certain period of time even when the external energy supply has been disrupted, and as a result, a society is being realized in which safe and secure daily living is secured (see Page 99 of the Reference Materials).

New buildings

○ New buildings achieve zero emissions as soon as possible.

○Regarding new houses, in particular, houses that are “carbon minus” throughout their entire life cycle, from materials manufacture and construction to demolition and recycling (called life cycle carbon minus houses [LCCM houses]), become commonplace (see Page 100 of the Reference Materials).

Existing buildings

○As for existing buildings, the value of insulation investment and the introduction of energy-saving and energy-creating devices, which deliver multifaceted co-benefits in terms of not only price but also comfort and health-promoting qualities, have become universal. Consequently, building refurbishment technologies that contribute to low carbonization are improved and energy-saving and energy-creation investments are commonplace, and low-carbonization is maximized (see Page 101 of the Reference Materials).

○Because building owners enjoy such co-benefits, they actively conduct remodeling to improve insulation and make other improvements, and stock building measures are being executed.

Building measures corresponding to local characteristics

○Buildings that fit with local characteristics are common, and local lumber resources are fully utilized and new wood materials such as cross-laminated timber (CLT) are developed and universally used (see Page 102 of the Reference Materials). Moreover, although the electrification of heating and hot-water supply is progressing in terms of national average, in some areas, energy use that fits with local characteristics (such as hydrogen, heat from renewable energy, heat from biomass, etc.) is also progressing. Such fine-tuned measures that are adapted to Japan’s diverse climates revitalize local economies and serve as a source of strength in local culture.

Energy-saving devices

○Highly energy efficient devices that use gallium nitride semiconductors and other such technologies have diffused widely. At the same time, energy savings in devices is reaching the ultimate level possible through the development of new materials, technologies, and production systems and energy-saving designs. Moreover, system-wide energy savings are also being achieved in ways that go beyond individual elemental technologies to include the organic linkage of elemental technologies using combinations of those technologies and ICT (see Page 103 of the Reference Materials).

○GHG emissions from air conditioners, industrial freezers and refrigerators have been dramatically reduced through the development of new coolants that simultaneously achieve energy savings and low Global Warming Potential (GWP) and through improved recovery rates for used equipment.

Ways of living

○Information on the degrees to which consumed energy and used devices contribute to the low-carbon society is easily comprehensible and readily available. As a result, low-carbon energy and devices are commonly used in daily life because people actively select them by fully utilizing such information (see Page 104 of the Reference Materials).

○ Smart lifestyles that are sensible and waste-free are popular. People are voluntarily making and enjoying low-carbon behavioral changes that are founded on behavioral science-based knowledge (see Page 105 of the Reference Materials).

Energy use

○ Energy demand is met mainly by renewable energy that is generated on site. The portion of generated energy that exceeds demand is directed into power interchange or electricity storage or stored as hydrogen and made available for in-house consumption or power interchange whenever it is needed. As for energy supply in structures that have large energy demands, such as commercial facilities, priority is given to use of low-carbon electric power, or energy is supplied through low-carbon electricity, heat, or hydrogen from adjacent structures.

○ A low-carbon energy system is established that effectively links the energy demand side and energy supply side. For example, electric vehicles and heat pump-type water heaters are used to adjust the supply and demand of electric power with use of HEMS, BEMS, and information communication technology. At the same time, lifestyles take root with behavior that responds to electricity market prices that fluctuate depending on the supply conditions of renewable energy introduced on a large scale (see Page 106 of the Reference Materials).

(b) Transportation

○ Most passenger cars are electric motor-driven, and for the most part their energy source is low-carbon electric power or hydrogen produced from renewable energy. Electric vehicles charged at home help residents adjust their electric power supply-and-demand balance and cope with disasters through charging and discharging. As for large vehicles, such as cargo vehicles, the consumption of petroleum products as a source of power for transportation is largely reduced through improved fuel efficiency and the diffusion of electric motor-driven vehicles that run on biofuels, electric power, or hydrogen derived from renewable energy (see Page 107 of the Reference Materials).

Fuel performance

○ Fuel efficiency is greatly improved by making vehicles lighter yet safer with the increased availability of cellulose nanofiber and other strong and lightweight materials and with the introduction of aerodynamic car bodies and low-resistance gears and tires, the use of bio-mimicry, and the development and popularization of single-passenger vehicles (see Page 108 of the Reference Materials).

Self-driving

○ Self-driving has been achieved with the use of ICT and big data. Eco-friendly driving and optimum congestion-free routes are automatically selected, and safe and economical driving is the norm (see Page 109 of the Reference Materials).

○ In a society in which regional comprehensive care systems are in place, self-driving electric vehicles have become a means by which senior citizens can travel safely when they need to go from their home to a hospital or other facility. At the same time, electric vehicles are effectively used in elderly households; for example, their storage batteries serve to regulate electric power

supply and demand when not in use (see Page 110 of the Reference Materials).

Sharing

○Vehicle occupancy has increased through ride-sharing, and mechanisms such as car-sharing that give people access to vehicles only when they need them have become even more common. Throughout society, means of transportation are made available rationally and to the extent that they are needed. (see Page 111 of the Reference Materials).

Freight Transport

○Regarding freight transport, through the reduction of cargo volumes by shortening distances between production centers and consumption areas, the computerization of logistics by the application of AI and IoT, the cooperation between shippers, the improvement of loading rates, and the changes in mindset of distribution service users, efficient low-carbon distribution has been achieved (see Page 112 of the Reference Materials).

Railroads, aircraft, and ships

○Energy-saving functions in railroads, aircraft, and ships have been improved, and efficient use corresponding to specific purposes (e.g., long-distance transport, etc.) is commonplace. Moreover, operations have been optimized for greater operational efficiency, and the low-carbonization of sources of motive power has been realized with the introduction of hydrogen derived from renewable energy and biofuels (see Page 113 of the Reference Materials).

Shift in modes of transportation

○The transportation of people and cargo has become more comfortable and greatly streamlined with the use of walking and bicycles within certain distances as urban structures become more compact, combining efficient transport means, developing and enhancing the convenience of public transport, and promoting a modal shift to low-carbon public transport systems (see Page 114 of the Reference Materials).

(c) Industry and Business Activity

International competitiveness

○Companies are endeavoring to provide low-carbon products and services and linking them to stronger economic growth in Japan through their dissemination, and capturing world markets by marketing such products and services internationally (see Page 115 of the Reference Materials).

○Due to the spread of renewable energy, money that had been flowing out of Japan for the purchase of fossil fuels has become the capital that drives domestic corporate activities to develop and disseminate low-carbon products and services. This is generating a virtuous cycle whereby such activities improve Japan’s position in the world market (see Page 116 of the Reference Materials).

Use of information and communication technology

○ Paperless operations and working at home have become common as a result of advancements in information and communication technology (ICT). Work styles that fit with individual lifestyles have become possible, and both labor productivity and carbon productivity are improving as a result. Improvements in productivity that come from using IoT, AI, and other forms of ICT are also arising in forms that contribute to carbon reduction while also producing benefits in terms of efficiency, safety, and health and longevity not only in office work but also in, for example, manufacturing, the infrastructure industry, nursing care, and welfare.

○ Due to advancements in such technologies as IoT and AI, weather data is being effectively used in industrial activity and energy supply and contributing to the building of a decarbonized society through better productivity (see Page 117 of the Reference Materials).

Financial industry

○ Carbon prices are incorporated into the market economy, and business assessments that include carbon risk have become the norm not only in investment decisions by businesses but also in investment and loan decisions by banks and institutional investors. Businesses routinely disclose carbon information together with financial information, and from institutional investors to individual investors, society as a whole is directing funds so that they contribute to significant contributions with an eye to decarbonization through “ESG” (environment social governance) investment (including green bonds and renewable energy funds) (see Page 118 of the Reference Materials).

Cross-industry technologies

○ Thorough cross-industry energy conservation is being achieved in industrial activity with the implementation of ultra-efficient components (e.g., gallium nitride semiconductors, etc.) in various devices, the use of highly efficient industrial heat pumps, and the switch to low-carbon energy sources. Conversion from coal and petroleum to natural gas is progressing for heat utilization in high-temperature areas that require fossil fuels (see Page 119 of the Reference Materials).

Materials industry

○ The development and diffusion of lightweight yet strong materials (e.g., cellulose nanofiber, etc.) to replace materials previously used in structures, cars, and other products are significantly reducing energy consumption in the life cycles of those products and delivering higher efficiency during their use. Such materials are recognized as bringing high added value and are maintaining Japan’s advantage in the materials industry (see Page 120 of the Reference Materials).

○ The effective use of recyclable resources, including those from so-called “urban mines,” is thoroughly practiced in Japan. Japan already has a large supply of resources accumulated in its social infrastructure and other artificial structures, and it has established a recycling-based society that responds to new demand by appropriately recovering latent resources. Regarding export materials that cannot be covered by recovered sources, Japan must pay attention to maintaining its international competitiveness. Thus, in addition to recyclable resources recovered domestically, Japan recycles waste imported from other countries through its sophisticated and low-carbon manufacturing processes, and the nation’s entire industrial structure is shifting toward low-carbon and recycling-based industries (see Page 121 of the Reference Materials).

○ As much as possible efficiency is being achieved in Japan’s high energy-consumption industries

with the introduction of the world's most efficient technologies, installation of innovative technologies, and thorough application of energy cascading. At the same time, the installation of carbon capture, utilization, and storage (CCUS) equipment is progressing and its operation is beginning (see Page 122 of the Reference Materials).

Service industry

○ In the service industry, which includes the restaurant and tourist industries, and local industries, productivity is rising with the supply of goods and services given high added value using locally produced materials and distinctive local resources (e.g., human resources, cultural assets, natural environments and energy, food and drinks, shopping streets, and factories). The result is the realization of regional societies with stable local economies that attract outside money (see Page 123 of the Reference Materials).

○ Businesses have evolved that provide diagnoses and specialized advice for achieving energy savings and energy creation in various situations (see Page 124 of the Reference Materials).

Daily goods

○ The low-carbonization of daily goods is progressing. For example, the use of disposable containers has been greatly reduced and bioplastics are coming into widespread use. At the same time, those containers that are disposed of are appropriately recycled. Consequently, net CO_2 emissions are on the negative side. Additionally, a style of using daily goods that is growing in popularity is one in which many people share high-quality products, using the minimum amount necessary, and each individual benefits from the products' functions and services (see Page 125 of the Reference Materials).

Non-energy-related business activity

○ Regarding GHG emissions from non-energy sources, emissions are being dramatically reduced through the development and diffusion of CFC-free and low-GWP products that achieve both energy savings and environmental performance, the low-carbonization of waste processing, and the low-carbonization of the agriculture, forestry, and fishery industries (see Page 126 of the Reference Materials).

(d) Energy Demand and Supply

○ Low-carbon power sources (renewable energy, thermal power generation with CCS,[68] and nuclear power) account for more than 90% of electricity generation.

○ The basic framework for electricity supply has moved away from "supply in response to demand" to "wise use and storage based on supply." In particular, more and more households do not purchase electricity but rather engage in "self-consumption" of electricity from renewable energy sources. Electricity is handled as a "regionally circulated" asset that is supplied within the region as needed (see Pages 127 and 128 of the Reference Materials).

[68] Technology that separates out and captures carbon dioxide in the exhaust emitted from power plants, factories, etc., for storage underground

Power grid systems

○ Based on the self-consumption model, power grid systems are operated in a stable state through the optimization and operational improvement of intra-regional and inter-regional power networks, the control of supply and demand with advanced information systems, and the utilization of the large-scale reserve capacities of pumped storage power and other hydroelectric power plants and thermal power plants that have been improved with low-carbon technologies (see Page 129 of the Reference Materials).

○ Most notably, R&D on various technologies that contribute to supply-demand adjustment and frequency adjustment (e.g., storage batteries, hydrogen, heat storage, digital grid, etc.) is proceeding for stable power supply in a society into which renewable energy has been introduced on a large scale, and those technologies are becoming widespread throughout society. Additionally, power demand in industrial activities is also managed in accordance with regional circumstances. For example, businesses that consume large amounts of power are concentrated into areas that produce power from renewable energy, minimizing the burden on the supply-and-demand system.

Diffusion of renewable energy

○ Regarding renewable energy, regional resources that are highly efficient and alleviate burden on the environment—such as solar power in close proximity to consumers, wind power having high potential, stable hydroelectric power, geothermal power, and biomass—are utilized to the maximum degree, and at the same time, power generation from marine resources is being demonstrated, developed, and utilized. Moreover, power is being generated from renewable energy in ways matched to regional circumstances, and the produced electricity is supplied via an optimized grid.

○ In terms of both physical hardware and “soft” aspects, renewable energy-related industries are maintaining price competitiveness through lower facility costs attributable to technical development of renewable energy and large-scale introduction, as well as lower construction costs related to work and maintenance to ensure safety during disasters (see Page 130 of the Reference Materials).

○ As renewable energy-related industries spread and become established throughout the country, stable employment is being generated in regional areas, the GDP share of such industries is growing, and income disparities among regions are shrinking (see Page 131 of the Reference Materials).

○ Energy systems that are matched to regional circumstances are being established in, for example, regions where renewable energy heat (i.e., solar heat, biomass, geothermal heat) is used to the maximum extent possible, and in regions engaging in cogeneration using hydrogen made from renewable energy and or supplying that hydrogen to urban areas (see page 132 of the Reference Materials).

○ Hydrogen that does not emit CO_2 at any stage, including when it is used and in all processes leading up to hydrogen manufacture (CO_2-free hydrogen), is supplied (see Page 133 of the Reference Materials).

CCS, CCU[69]

○ CCS and CCU technologies have been installed in the fossil fuel consumption in some industries and almost all thermal power generation used as reserve capacity (see Page 134 of the Reference Materials).

Fossil fuel consumption

○ Electrification and conversion to low-carbon fuels are proceeding in all sectors, and much of final energy consumption is covered by electric power, with fossil fuels being used in some industries and transport. Conversion to lower carbon-emitting fuels is also progressing in private power generation.

Research and development

○ Needing to build a stable energy supply system with even lower carbon emissions, industry, academia, and government are collaborating to promote efficient and effective R&D for creating innovation through continuous R&D investment made from a long-term perspective (see Page 135 of the Reference Materials).

(e) Region and City

○ Healthy and long-living regional societies have been built with an increase in the share of walking or bicycling that is made possible with greater urban compactness, for example, and people can enjoy safe and secure regional societies through local industry and urban development pursued with an eye to “adaptation,” resulting in continually growing urban attractiveness (see Page 136 of the Reference Materials). Additionally, energetic production activity is taking place with, for example, the creation of new innovation through the intersection and “interaction” of various people and information (see Page 137 of the Reference Materials).

Local energy

○ Energy use is being optimized not only at the national level but also the local level. For example, looking at energy supply in structures that have large energy demands, such as commercial facilities, priority is given to use of low-carbon electric power, or energy is supplied through low-carbon electricity, heat, or hydrogen from adjacent structures.

○ Because renewable energy sources have been introduced into each region as a form of independent/distributed energy resource, consistent progress has been made in terms of national resilience and low-carbonization. Such progress includes the ability to immediately supply the energy needed when disasters strike (see Page 138 of the Reference Materials).

○ Turning to waste disposal facilities, given the need to build systems that serve as regional energy centers while also lowering the carbon emissions of those facilities, initiatives that include upgrading facilities to give them high energy recovery efficiency and improving key facilities, making local use of recovered waste heat, networking power generation among disposal facilities, and using waste biomass are progressing in forms that fit optimally with local characteristics and facility size. Initiatives that make full use of the energy held by waste are also progressing.

[69] Technologies for Carbon Dioxide Capture and Utilization

Urban areas

○ The comfort of urban areas has increased as a result of, for example, alleviation of the “heat island” phenomenon through reductions of anthropogenic heat coming from higher energy efficiency and through the integration of such natural capital as waterfronts and green areas (see Page 139 of the Reference Materials).

Mountainous and rural areas

○ Society has become one in which people and nature can interact in a sustainable manner. This has been achieved through the introduction of highly efficient equipment and lighting in the agriculture, forestry, and fishery industries; practice of appropriate farm management based on the development and application of fertilizer and water management technologies with low GHG emissions; and efforts to achieve low-carbon animal husbandry by changing feeds (see Page 140 of the Reference Materials).

○ Particularly in mountainous areas, owing to forests being appropriately preserved and managed and the use of timber and other domestically produced materials being promoted, the forestry industry has been sustained and developed. Such domestically produced materials are being used in housing and buildings as well as roads and all other forms of social infrastructure (see Page 141 of the Reference Materials).

Chapter 6: Policy Direction towards Long-Term Significant Reduction

This chapter presents examples of key policies for achieving the vision that was laid out in Chapter 5 based on an examination of the basic direction of policies to be implemented.

(1) Basic direction

(a) Maximum utilization of existing technologies, know-how, and knowledge

Thorough dissemination, both domestically and internationally, of Japan's outstanding technologies and know-how can be expected to have tremendous impact at a time when reducing emissions as quickly as possible will be essential to keeping cumulative global emissions within the "carbon budget" of approximately one trillion tons.

For example, in aiming to achieve the medium-term target and, further, the target of an 80% reduction by 2050 and a decarbonized society throughout the world, significant reductions will be required in the residential sector, where it is possible to achieve zero emissions by combining existing energy-saving and renewable energy technologies, such as high-performance insulating exteriors and solar power. Moreover, there is considerable room for reductions by switching to low-carbon products and improving insulation. However, it is currently the case that such initiatives have not progressed sufficiently, in part due to people's sense of being saddled with the initial costs. This makes it necessary to show in quantitative terms the economic advantages of lower utility charges, etc., and at the same time to communicate the advantages of highly insulated homes in such aspects as comfort and health. Moreover, it will be necessary to promote the replacement of products with low-carbon products and insulation improvement in households by aggressively utilizing, for example, electricity charge payment schemes where the higher initial capital cost is recouped later via electric payments at the same level prior to introduction of the low-carbon products.

Additionally, according to the "CO_2 reduction potential consultation project" (covering roughly 1,400 cases) being implemented by the Ministry of the Environment since 2010, survey results indicate that there are measures with low implementation rates despite the fact that their additional investment can be recovered within five years, and if all measures, such as the introduction of equipment and operational improvements, were executed, reductions of approximately 28% and 9% can be expected in the commercial sector and industrial sector, respectively (see Page 147 of the Reference Materials). Various issues are thought to be behind the situation whereby low-carbonization investment is not taking place despite its existing potential. Among them are, for example, issues relating to the operation of business establishments (e.g., concerns about the effect on quality), issues relating to the energy management of business establishments (e.g., lack of human resources to implement measures), and issues relating to the effects and merits of energy conservation (e.g., low share of energy expenses in sales, etc. and low priority of investment). This makes it necessary to study further responses. In this way, even in Japan, a country in which the diffusion of low-carbon technologies is thought to be faring fairly well compared to emerging economies, there is still a great deal of room for further diffusion of existing technologies and know-how. Accordingly, Japan must make the maximum effort to spread its existing technologies and know-how, including through their overseas development.

(b) Development and deployment of new innovation

Achieving long-term significant reduction of emissions will require undertaking enormous societal changes starting now; such changes must include, for example, raising the percentage of power generated from low-carbon sources to at least 90% and bringing GHG emissions from daily living, vehicle transportation, office buildings, etc., down to as near zero as possible. Achieving such great social transformation will require the maximum possible use of existing technologies, know-how, and knowledge as well as, as seen in Chapter 4, new innovation that breaks away from conventional paths when viewed from the perspectives of technology, socio-economic systems, and lifestyle.

Innovation needed for significant reduction

The Annual Report on the Japanese Economy and Public Finance for FY2015 states the following regarding innovation: “In Japan, there is a tendency to translate ‘innovation’ as *gijutsu kaikaku* (technological innovation). This comes from the perception that innovation that can change the economy and society at their very foundation often comes from innovative science and technology. However, because innovation can also arise from combinations of existing technologies through the integration of fields or management innovation, for example, focus has come to be made on aspects of economic and social transformation that are attributable to the creation of new value. Against this backdrop, the Act on Improving the Capacity, and the Efficient Promotion of Research and Development through Promotion of Research and Development System Reform, which was enacted in 2008, is the first law in Japan to define ‘developing innovation’ as ‘creating new values and creating a major change in economic society by developing or producing new products, developing or providing a new service, introducing a new method of producing or selling products, introducing a new method of providing service, or introducing new management methods.’” In other words, “innovation” refers not only to technology but also to all goods and services that create new value and produce major changes in the economy and society.

Thus far countless innovations have been created. To give a very few examples: the Sony Walkman, which created the new value of “portable music”; Toyota’s “Kanban system,” which brought greater efficiency to production processes in manufacturing; single crystallization of gallium nitride (GaN), which opened the way to blue LED technology through industry-academia-government collaboration; “Cool Biz,” which brought new lifestyles to summertime business; “Fair Trade” for the realization of economic autonomy and fairness in the production activities of developing countries; and “crowd-funding,” a practice that sparks business start-ups and new business opportunities. Various innovations exist in all facets of the world and are so numerous that they cannot be listed here.

Innovation can exist in various situations; however, its "strength" also varies. That is to say, while the continuous improvement of existing goods and services, such as improvements in the fuel economy of fossil fuel-powered vehicles and the sophistication of toilet devices, can be called “innovation,” at the same time there also exists “disruptive” innovation that destroys conventional values and common knowledge, such as mobile phones and internet shopping.

Needless to say, innovation is necessary for decarbonization and further low-carbonization but if Japan is to contribute to the world by leading the way in building a decarbonized society throughout the world, it must, above all, take on the challenge of creating disruptive innovation that is not bound by conventional industrial structures or customary practices. When implementing future climate

change policy, Japan must thoroughly and simultaneously create innovation of all strengths—from disruptive innovation to evolutionary innovation—in every situation and place of the world.

Economic growth through innovation

The Annual Report on the Japanese Economy and Public Finance for FY2015 states, “Promoting innovation will be essential in improving Japan’s vitality. The Japanese economy has experienced low growth since the early 1990s. Reasons include sluggish investment within an environment of excessive production capacity, a shrinking working-age population, and, additionally, slowing of the total-factor productivity growth rate.”

The report further states, “It can be said that the most fundamental factor that regulates productivity is innovation. Given this, it is believed that behind the sluggish productivity seen since the early 1990s was stagnation in innovative activity; namely, tardiness in innovation creation and in utilizing the results of innovation. Japan stands on equal footing with other countries in terms of its innovation "input" (i.e., development of new physical technologies, ideas, and know-how). The problem is that it does not effectively link its input to higher "output" (i.e., the achievement of added value generated from recognition in the market of the value of those technologies, ideas, and know-how). Thus, an economic system-based viewpoint that supports activities ranging from the input side to the output side is important.” In other words, it can be said that the most fundamental factor that regulates productivity is innovation, and that improving productivity through the promotion of innovation activities is indispensable for economic growth.

The government’s role in creating innovation

In general, the promotion of “open innovation” that advances innovation through collaboration among industry-government-academia, different industries, and sector peer companies rather than in-house-only approaches; the presence of an “innovation ecosystem” as a base for promoting cooperation; the activation of local enterprises and utilization of local universities; and the development of human resources possessing a fundamental academic grounding and the desire to take on new challenges are important for the creation of innovation. Such efforts as these have been executed in various ways by concerned ministries and agencies and in the private sector, and it will be important to continue them.

Creating innovation requires capital. However, looking at companies’ investment behavior in recent years, even as cash and deposits ratios in all industries (total of manufacturing and non-manufacturing industries) rise, the ratio of capital investment and cash flow continues to show a declining trend.[70] Meanwhile, the loan-deposit ratios of city banks, regional banks, and other financial institutions have been on a downward trend,[71] while the cash reserves of private enterprises are showing an upward trend.[72] The Annual Report on the Japanese Economy and Public Finance for FY2015 analyzes these trends as follows: “Various factors are behind companies’ accumulation of cash and deposits. They include companies’ not being able to find investment opportunities under expectations of prolonged deflation and their preparation for economic upheavals. However, companies’ management mindset is also an important factor.” Thus,

[70] Annual Report on the Japanese Economy and Public Finance 2015
[71] 2016 White Paper on Small and Medium Enterprises
[72] Ministry of the Environment calculation based on Bank of Japan, “Flow of Funds Accounts.” “Cash reserves of private enterprises” are calculated as the aggregate of the cash and deposits of non-financial incorporated enterprises.

it is apparent that, although sufficient funds for investment in growth sectors exist, satisfactory investment activity has not taken place in the face of various uncertainties surrounding Japan.

As for climate change policy, we believe that, as international recognition grows that a continuous and vast "promised market" for achieving the 2°C target exists, tardiness in entering the market or postponement of investment or countermeasures due to uncertainties will lead to a deterioration of Japan's international competitiveness. Looking to build a decarbonized society in the future, the national government must unwaveringly and consistently present long-term targets and medium-term targets as waypoints for this goal and clearly spell out all manner of policies that conform to the orientation of those targets, and, based on them, companies must overcome their uncertainties, generate demand, and link that demand to the creation of innovation that simultaneously achieves significant reductions and economic growth with a view to decarbonization.

As an example of the importance of demand in the creation of innovation, the establishment of mechanisms providing information that allows consumers and investors to make choices, such as Fair Trade and socially responsible investment, can serve to drive major social transformation. As seen in Chapter 3 Section (2), the diversification of people's values and lifestyles creates service industries, such as car-sharing and experience-oriented tourism. In this way, the possibility that demand-side needs will produce new innovation must also be recognized.

Looking at climate change policy, it will also be essential to link policy to the creation of innovation from the demand side through information-based means that establish environments in which consumers can make choices. Approaches here can include improving infrastructure for socio-economic systems that directly encourage consumers to select low-carbon goods and services by, for example, making carbon prices "visible," and making it possible to grasp environmental information concerning the energy and products used in daily life. Another can be making it possible for consumers to consider energy and products also in terms of points that are outside of environmental performance, such as convenience and comfort, so that each individual can make satisfactory choices based on his or her own values.

Given Japan's achievements in the reductions it has pursued since the Kyoto Protocol's coming into force, we believe Japan must bring about simultaneous solutions by promoting climate change policy in an accelerated manner.[73] We are concerned that if Japan sticks to its conventional cognizance of the issue and simply continues with past initiatives, it will fall behind other countries. In other words, it must be stated that the initiatives taken heretofore will not be sufficient in creating the kind of innovation to achieve significant domestic reductions ahead of the rest of the world. There can be no resisting the global acceleration of climate change policy. If the government continues its domestic policies without modification, it will invite a gradually worsening situation, and, as a result, the market's unease vis-à-vis its policies may grow even stronger. If Japan is to lead the international community, it must execute measures speedily with shared awareness in the public and private sectors that climate change is an "unavoidable challenge," and it must strengthen measures like those mentioned in (2) above based on the Plan for Global Warming Countermeasures and on the evaluation of progress in climate change countermeasures in the electricity business sector.

[73] Some Japanese industries have attained the world's highest level of energy efficiency. However, when Japan is viewed as a whole, it has fallen behind other countries in terms of carbon productivity and energy productivity since 2000. This suggests the need for further action in all areas, including the commercial and residential sectors. (Pages 21 to 28 of the Reference Materials)

(c) Full mobilization of all effective policies and measures (PaMs)

Implementation of fine-tuned measures

It is difficult to imagine that significant reductions of the greenhouse gas emissions generated from humankind's many socio-economic activities can be achieved with one specific measure. For each emission source, Japan must carefully examine the forms of PaMs that will function within it and then implement PaMs. This must be based on analyses built on quantitative data having a solid foundation in scientific knowledge and on model analyses, as well as on the unique circumstances of emission sources and overseas trends, while also keeping in mind simultaneous solutions of various economic and social challenges.

Additionally, cross-cutting measures that go beyond specific sectors and industries, as well as appropriate combinations of those various measures, will also be essential. Thus, Japan must seek to realize the "full utilization of existing technologies, know-how and knowledge" that was mentioned in (a) and the "development and deployment of new innovation" mentioned in (b) through comprehensive and effective actions.

Incorporating climate change policy into other associated fields

As seen in Chapter 1, climate change presents risks to human systems, and it is predicted that those risks will manifest themselves in the future as threats to society in various areas, including health problems, increases in forced migrations of people, and impacts on national security policy. We human beings can only sustain our socio-economic activities if the environment that is the foundation of our survival is preserved into the future. Thus, it could be said that climate change, which has the capacity to fundamentally take from us the environment that supports our existence, is an issue of the highest priority that must be tackled by humankind acting in concert.

It need not be stated again that the Paris Agreement, which entered into force in November 2016, is an international framework through which the entire international community will address the threat of global warming over the long term based on the latest scientific evidence.

Realizing significant emissions reductions with a view to building a decarbonized society throughout the world based on the Paris Agreement will be essential if the environment that is the foundation of human survival is to be preserved. It naturally becomes necessary, then, to appropriately incorporate the viewpoint of climate change policy into policy fields for other areas that concern the environment, such as energy, the development of national lands, and policies targeting industries from agriculture, forestry, and fisheries, through manufacturing, to services.

In recent years, legislation and other policy measures that incorporate the viewpoint of climate change policy are being taken in various policy fields. However, the application of environmental law must not be forgotten in efforts to appropriately promote emissions reductions based on relevant laws. For example, Act 61 paragraph 1 of the Act on Promotion of Global Warming Countermeasures (Act No. 117 of 1998) stipulates, "The Minister of the Environment may ask the heads of related administrative agencies to provide needed cooperation in the implementation of global warming countermeasures with regard to programs to contribute to the control of greenhouse gases, if he finds this necessary in order to attain the goals of this Law." We believe that the application of this stipulation will be effective in promoting government-wide initiatives toward achieving long-term significant reductions.

Linking global warming policy and energy policy

As mentioned above, human beings' socio-economic activities can only be carried out in a sustainable manner so long as the environment as the foundation of human survival exists. This point is no different in any way for energy policy, which has an especially deep connection with global warming policy.

Regarding energy policy, the Strategic Energy Plan (Cabinet decision of April 2014) states the following as its "Basic Viewpoint of the Energy Policy (3E+S)": "The point of the energy policy is, premised on "Safety," to first and foremost ensure stable supply ("Energy Security"), and realize low-cost energy supply by enhancing its efficiency ("Economic Efficiency"), while at the same time making maximum efforts to pursue environment suitability ("Environment")."

Although it is thought that each of the elements of 3E+S deals with separate items when viewed in terms of energy policy, given that, as mentioned above, "Environment" is subject to the fundamental benefits and protections of Japanese law, Japan must not only respond based on relevant domestic laws (e.g., the Basic Environment Law and the Act for Establishment of the Ministry of the Environment as well as, with regard to global warming measures, for example, the Act on Promotion of Global Warming Countermeasures) but also promote initiatives that faithfully comply with agreements Japan has signed, such as the UN Framework Convention on Climate Change and the Paris Agreement.

Under the Paris Agreement, basic rules intended to drive goals at set intervals are coming into force in each country to achieve the 2°C target, with the intention of putting efforts on a consistent track toward the scenario demanded by science and based on the standpoint of cumulative emissions. Japan, too, will set goals and promote progress management so that it will make a consistent response to the Paris Agreement.

The medium-term target included in the Plan for Global Warming Countermeasures, which was formulated based on Japan's adoption of the Paris Agreement, was made to be consistent with Japan's energy policy, and the importance of promoting actions toward its achievement goes without saying. Additionally, with regard to the setting of future targets to "drive" efforts under the Paris Agreement, and to the likely setting of reduction targets beyond FY2030 with a view to a decarbonized society in the years ahead, we believe there will be a need to establish targets that pursue a path that is consistent with scientific demands and long-term significant reductions, and, as mentioned previously, that the importance of those targets will grow from the standpoint of promoting innovation.

In light of the Paris Agreement's coming into force, it will be important for Japan, in advancing its climate change policy, to vigorously promote compliance with the Paris Agreement as a nation, while at the same time closely coordinating this policy with an energy policy that has a deep connection with the content of the climate change policy.

(2) Direction of Main PaMs

Long-term significant reduction is a goal that lies beyond the mid-term target of 2030. Steady actions based on the current "Plan for Global Warming Countermeasures Plan" are the first step. Responses to further accelerate reduction while promoting actions based on the "Plan for Global Warming Countermeasures Plan" are required.

In addressing long-term significant reduction, it is first desirable to reach agreements among society and business organizations on long-term goals that spell out an intended direction and set them in writing, and then to proceed in a manner that combines flexibility and workability while building a national consensus, taking into account various possibilities in terms of Japan's society, technical trends, etc., while also considering the cases of other countries, local governments, and companies that are taking action.

(a) Carbon Pricing: Making Best Use of Market Dynamism

Climate change is a phenomenon that originates from humankind's various socio-economic activities, and awareness of this fact by all actors of the world represents the first step toward achieving significant reductions throughout society as a whole. This will require the development of a foundation that enables people to perceive the GHG emissions of various socio-economic activities.

Creating circumstances whereby all actors "perceive" emissions will be difficult in modern society, but in a capitalist society, there are economic ways of giving people "perception" and guiding their behaviors by providing them with economic incentives.

One available economic means is the use of "carbon pricing," which affixes a price to carbon emissions so that all actors in the world are aware of the cost of GHGs.

The Significance of Carbon Pricing

In addressing environmental problems, regulatory methods are necessary whereby the government sets certain goals to be achieved and then requires their achievement. On the other hand, within the scope of long-term climate change policy covering all aspects of the economy and society, mechanisms that encourage the various actors to come up with ingenious approaches as they pursue economic rationality are also effective as tools that permit flexible responses to any change occurring in society. For this reason, in addition to regulatory approaches, economic methods that draw out market strength by providing economic incentives and that guide behavior in a set direction toward emissions reduction while encouraging ingenuity on the part of the various actors are important.

One economic method is a policy approach known as "carbon pricing," which involves strengthening market competitiveness for low-carbon technologies, products, and services by offering emissions-reduction incentives to all actors of the world through the reflection of "carbon cost" in economic activity and making maximum use of market dynamism. It could be described as being based on the idea of internalizing the costs of the negative effects of climate change that are attributable to carbon emissions and making the emitter responsible for them. Because the costs borne by the emitter decrease if the emitter generates fewer emissions, it is a scheme that "rewards those who make efforts toward emissions reduction." OECD (2016)[74] refers to various advantages of this scheme, among them the following: "carbon prices are effective for reducing emissions because they increase the price of carbon-based energy, decreasing demand for it"; "carbon prices are a cost-effective policy tool to reduce emissions"; "abatement target[s] [are] reached at minimum cost"; and "carbon prices help implement the polluter pays principle and boost economic benefits." The IPPC[75] also states that carbon pricing is, in principle, a method that can bring about mitigation in a

[74] OECD (2016) Effective Carbon Rates: Pricing CO_2 through Taxes and Emissions Trading Systems
[75] IPCC Fifth Assessment Report, Synthesis Report, and Summary for Policymakers

highly cost-effective form.

Since major economic and social shifts will be demanded in achieving the decarbonization sought by the Paris Agreement, and a great amount of investment will be necessary, the question of how to approach reduction in a cost-effective manner is important. In view of this, the advantages of carbon pricing are drawing renewed attention. OECD (2016) also states that "as climate targets strongly suggest, if further reductions are pursued, then aiming for least cost strategies becomes a more important consideration, and the appeal of market-based instruments once again increases.[76]" This importance has also been mentioned repeatedly at venues of international agreement, including adoption of COP21[77] and the G7 Ise-Shima Summit[78], and is commonly recognized by the countries of the world.

It should be noted with regard to carbon pricing that it is considered best from the standpoint of reducing GHG emissions to set prices, at least in terms of economics, in proportion to carbon emissions.[79] However, there is also a way of thinking that, in addition to explicitly stated carbon prices (emissions trading system, carbon tax, etc.), this could be set as an "implicit carbon price" when real emissions reduction costs are generated by energy taxation and other policies.[80] For example, OECD (2016) calculates "effective carbon rates" that are the sum of carbon taxes, specific taxes on energy use and tradable emission permit prices and then makes comparisons among countries.

As stated in Chapter 1 and Chapter 4, achieving an 80% reduction in 2050 and decarbonization will require innovation that extends throughout the entire social structure encompassing technology, social systems, and lifestyles. Particularly important in realizing long-term significant reduction will be "destructive innovation," or forms of innovation that produce new mechanisms as they destroy current ones. It is anticipated that new actors, such as venture companies, will help bring this about. Carbon pricing that affects the behavior of each individual is effective as a tool for generating incentives for those actors. Additionally, carbon pricing has the ability to drive the diffusion and real-world implementation of innovative technologies that are born from innovation through expanded demand for low-carbon products and services.[81] On the other hand, it must be remembered that

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[76] The World Bank's "State and Trends of Carbon Pricing" (2016) also mentions that, of the Nationally Determined Contributions that were submitted to the secretariat of the United Nations Framework Convention on Climate Change, as many as some 100 included proposals for carbon pricing and market mechanisms. It also states, "Carbon pricing can play a pivotal role to realize the ambitions of the Paris Agreement and implement the Nationally Determined Contributions (NDCs)."

[77] The Adoption of the Paris Agreement by the 21st Session of the Conference of Parties to the UNFCCC (excerpt) (December 12, 2015), "[The Conference of the Parties] also recognizes the important role of providing incentives for emission reduction activities, including tools such as domestic policies and carbon pricing."

[78] G7 Ise-Shima Leaders' Declaration (excerpt) (May 27, 2016), "We recognize the important role of providing incentives for emission reduction activities, including tools such as domestic policies and carbon pricing."

[79] OECD (2013) "Climate and carbon: Aligning Prices and Policies" states that explicit carbon pricing in which prices are explicitly set per ton of CO_2 emitted is generally more cost efficient than alternative policy options.

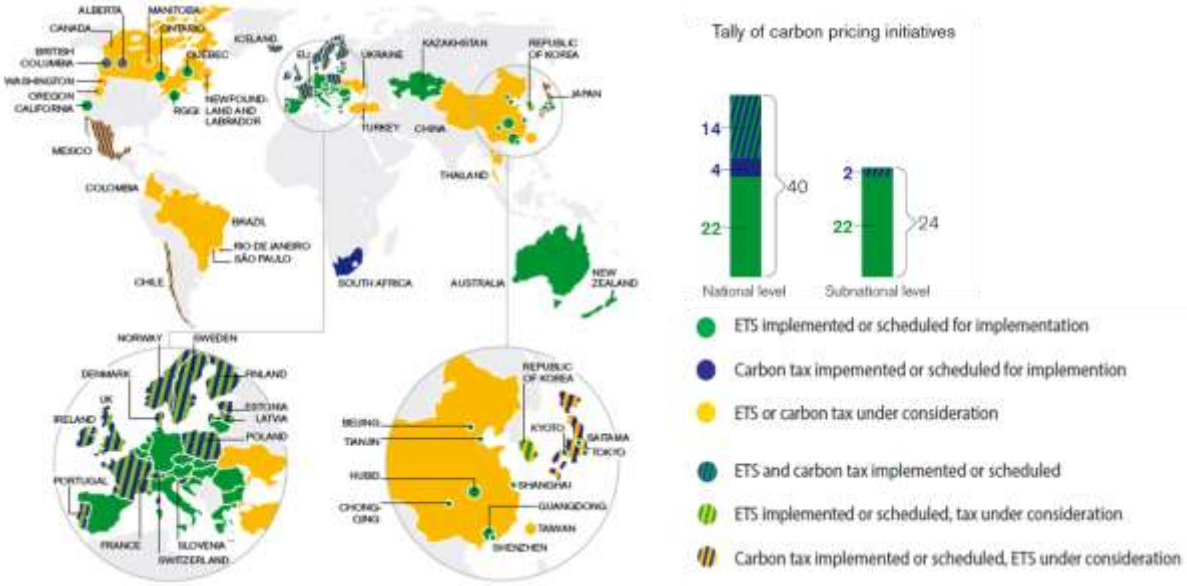
[80] Within the discussions of the subcommittee, it was pointed out that implicit carbon prices are thought not to function effectively given that a succession of plans to expand coal-fired power generation are being prepared in Japan's electric power sector.

[81] OECD (2013) "Climate and carbon: Aligning Prices and Policies" states, "Policy mechanisms that put an explicit price on the emission of CO_2 and other greenhouse gases can be effective in promoting innovation in energy-efficient technologies."

some have pointed out that carbon pricing will deprive companies of R&D resources and hinder innovation.[82]

Carbon Pricing Trends in Japan and Abroad and their Effects[83]

Looking at the status of carbon pricing introduction internationally, 40 countries and 24 local governments have already introduced or are considering carbon pricing in some form[84] (see Figure 19 and Page 148 of the Reference Materials). Due to the characteristics mentioned previously, carbon pricing has become a "global trend" among measures to combat global warming. While it is true that in countries and regions that have already introduced carbon pricing schemes there are cases of grappling with problems in terms of scheme operation, all are working toward their resolution through reforms and other means.



Excerpted from State and Trends of Carbon Pricing (World Bank, 2016)

Figure 19 Introduction of Carbon Pricing Initiatives by Countries and Local Governments

Factors that can influence differences in GHG emissions at the national level, although the degree to which they have an influence may vary, include the prices of energy in each country, prices set as a result of policy in each country (e.g., explicit carbon price, etc.), industrial structure, and differences in national land and urban structures.[85] Among them, a statistical analysis conducted

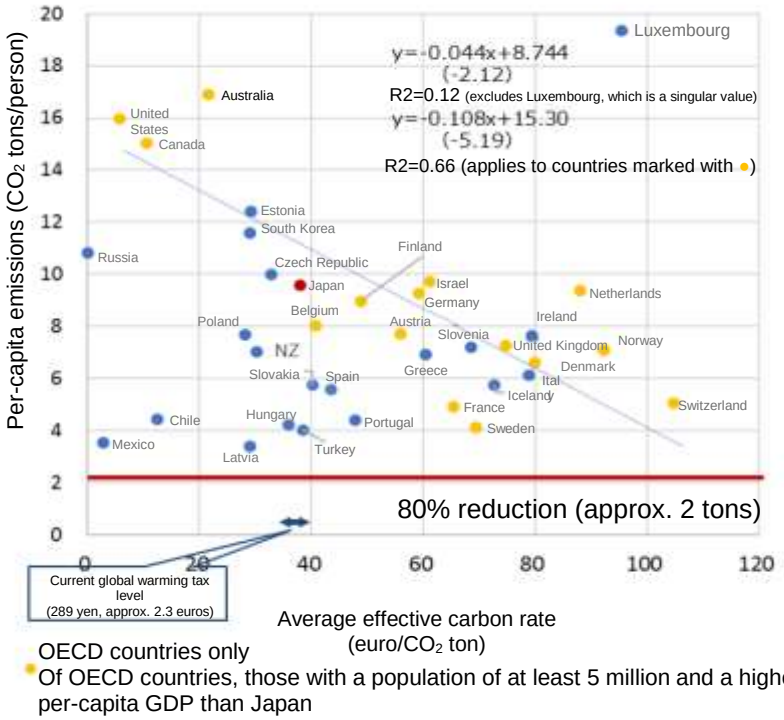
[82] Countering this view, it was mentioned in the subcommittee that carbon pricing leads to the effective use of funds needed for innovation by clarifying the direction of corporate investment.
[83] According to World Bank (2016) "State and Trends of Carbon Pricing 2016," the carbon pricing concept is also spreading into private companies. It points out that awareness vis-à-vis the costs of carbon emissions is also growing in the business world as a result of the placement of substantive GHG emission limits by the Paris Agreement and the emergence of circumstances by which GHG, which have become a limited resource, are distributed. The number of companies that are introducing "internal carbon pricing" in which the company independently sets carbon prices and reflects them on its own decision-making has been growing rapidly in the past few years. Moreover, some companies and investors are recommending the introduction and expansion of carbon pricing to national governments.
[84] World Bank (2016) "State and Trends of Carbon Pricing 2016"
[85] In discussions of the subcommittee, it was pointed out that energy sales prices, which include energy

with attention to the previously mentioned OECD “effective carbon rates” indicates a trend whereby countries with high effective carbon rates have high carbon productivity and low per-capita emissions (see Figure 20 and Pages 149 and 150 of the Reference Materials).[8687] OECD (2016) points out that this result suggests that the implicit carbon prices from non-market-based instruments (regulatory instruments, voluntary reduction plans, etc.) have not triggered the same level of abatement as market-based carbon pricing. Indeed, using Japan as a standard, countries that have a higher per-capita GDP than Japan and which are already achieving significant reductions of per-capita emissions have effective carbon rates that are considerably higher than those of Japan. If Japan is to achieve an 80% reduction by 2050 and decarbonization beyond that, it must, as mentioned previously, boost its current carbon productivity by a tremendous factor of roughly more than six. Given that improvements in Japan’s carbon productivity have been consistently lower than those of Europe and the United States since the 1990s, realizing that goal with the effects of existing systems alone will be difficult. This suggests the need for full-scale carbon pricing in Japan.

taxes, in Japan are comparable to those of European countries, and that evaluation should include this point.

[86] The report points out that countries such as Switzerland, Sweden, and Norway have high carbon productivity because hydroelectric power and nuclear power account for extremely large shares of their power generation. It is true that hydroelectric power and nuclear power contribute to improved carbon productivity to a certain extent. On the other hand, however, Switzerland’s energy productivity is the highest among the OECD countries (approximately 2.5 times Japan’s productivity as of 2015; Switzerland ranks first among OECD countries in terms of the energy productivity of its secondary industries and second in the OECD in terms of the energy productivity of its other industries). Additionally, Norway also boasts the fourth highest energy productivity among OECD countries. Sweden’s supply of renewable energy from biomass and other non-hydroelectric sources has increased three-fold since it introduced a carbon tax in 1991. This supply has come to account for 20% of Sweden’s primary energy supply (hydroelectric power accounts for about 10%). Consequently, Sweden’s carbon productivity has more than doubled since the 1990s (based on own currency real GDP) (see Pages 151 of the Reference Materials). It should be mentioned that Denmark, where wind power has a large share of energy supply, ranks second behind Switzerland among OECD countries in terms of energy productivity (Denmark’s energy productivity is roughly twice that of Japan).

[87] The OECD’s analysis of “effective carbon rates” includes energy taxes in effective carbon rates as a factor that changes relative energy prices.



Effective Carbon Rates: Pricing CO2 through Taxes and Emissions Trading Systems (OECD), Prepared based on "CO_2 Emissions From Fuel Combustion 2016" (IEA) and other sources

Figure 20 Relationship between Per-Capita Emissions and Effective Carbon Rates (2012)

Japan also has a "Tax for Climate Change Mitigation" in place as an existing carbon pricing measure. The revenue from this tax is applied to energy conservation measures, the diffusion of renewable energy, and other related measures, through which it is producing certain reduction effects (see Page 152 of the Reference Materials). The tax's revenue is also applied to the execution of model projects involving advanced initiatives and technical development, and thus it is expected that the tax will continue to play a stable role in achieving long-term significant reduction. However, it is anticipated that the tax's long-term effects will weaken as tax revenue declines with CO_2 abatement (see Page 153 of the Reference Materials). On the other hand, the tax rate (289 JPY/CO_2 ton) is extremely low compared to the carbon tax rates of other countries that are already achieving significant reductions, and its effect (the price effect) in terms of giving economic incentives to all actors to reduce emissions, something that was mentioned at the beginning of this report, is extraordinarily small. For this reason, we believe the tax is inadequate as a means of turning the entirety of Japan's economy and society toward decarbonization.

On the other hand, looking at circumstances in the Tokyo Metropolitan Government (TMG), which has required large-scale business establishments to reduce their total emissions since 2010, and which has introduced a scheme that allows the fulfillment of this obligation through emissions trading, the TMG is achieving a 25% reduction compared to the base year[88] as well as major reductions compared to the national average even as the total floor space of targeted business establishments grows. Although it must be borne in mind that the TMG's share of the business sector is high when viewed nationally, we believe that this is one case in Japan in which the

[88] The average for any three consecutive years selected by the business establishment between FY2002 and FY2007

effectiveness of carbon pricing in comparison with existing schemes is shown. Particularly in light of the fact that the business sector must greatly reduce its emissions by 40% compared to the 2013 level by 2030, the TMG's achievements here are suggestive at a time when countermeasures are urgently required.

Additionally, we believe the results of the analysis of the previously mentioned[89] "CO_2 reduction potential consultation project" showed whether or not reductions can be deepened without modification of existing schemes, while raising the possibility that some other impediments might exist to companies' engaging in investment. This result is consistent with the fact that large-scale reductions have progressed in the TMG, which introduced an emissions trading scheme.

Carbon Pricing as a Mechanism for Simultaneous Solution of Environmental Problems and Economic/Social Challenges

Carbon pricing can play an important role in the simultaneous solution not only of environmental problems but also of economic and social challenges.

First, as the relative price of fossil fuels will rise due to carbon pricing, demand for low-carbon products and services will be created. This means that for Japan, which, as Chapter 3 mentioned, is in a state whereby companies are accumulating cash and deposits due to a passive investment stance arising from a lack of highly attractive investment destinations, new investment opportunities will be generated throughout Japan; for example, companies will be encouraged to introduce low-carbon equipment, and capital investment and R&D in supply-side companies will be induced.[90][91] This is the creation of the so-called "promised market" supported by the Paris Agreement, and we believe that carbon pricing will also play a major role in growth strategies.[92][93]

Additionally, it is expected that carbon pricing will drive the manifestation of high added value in the economy. If carbon pricing is introduced, the CO_2-reducing performance of goods and services will gain appreciation, and environmental value and environmental brands will appear. On the other hand, since the costs of producing goods and services may rise, it is possible that companies will raise the unit prices of their goods and services commensurately. This may spur companies to aim to supply "even better" products and services—in other words, products and services with high added value. It may also drive them to pursue other values in addition to environmental value and environmental brands, in order to be accepted by consumers. This suggests the possibility that the kind of product innovation needed to overcome deflation will occur.

One conventional view is that carbon pricing is a factor behind rising costs and thus has an adverse economic effect, but given the issues currently facing Japan, it is vital that there be a shift in mindset

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89 See Chapter 6 (1) (a)

90 Within the subcommittee's discussions, the opinion was expressed that companies' using resources in direct R&D investment would be more effective as a global warming countermeasure than their using it to pay for carbon pricing.

91 Within the subcommittee's discussions, the opinion was expressed that R&D targeting low-carbon fields should be encouraged using carbon pricing price signals.

92 Japan Revitalization Strategy 2016 (June 2, 2016) states, "[to] realize a GDP of 600 trillion yen, it is essential for companies in Japan to have positive determination on shifting their internal reserves into future investment on facilities, innovation and human resources."

93 The added value of climate change-related industries has grown approximately three-fold in ten years and has come to account for 2% of Japan's GDP in 2014, "Kankyo Sangyo no Shijo Kibo-Koyo-to ni kan-suru Hokokusho" (report on market size, employment, etc., of the environment industry) (March 2016).

toward the aforementioned creation of high added value and new markets. Traditionally Japan, in order to maintain competitiveness and mindful of low labor cost emerging economies particularly in the Asia-Pacific region, has endeavored to control costs as a whole in an effort to provide products and services as mentioned above. However, now, as international competition is transforming to new business models that seek high added value built on intangible assets and as fusion of the manufacturing and service industries is progressing, R&D and investment in high added-value ("even better") products and services are becoming extremely important. As it becomes important to realize higher wages and expanded domestic demand and to shift to a new economy, carbon pricing deserves attention as one possible key to driving progress in these areas.

Specifically, intangible assets such as computerized information, culture and arts, and brands have been attracting attention in recent years as particularly important elements in improving Japan's added-value productivity.[94] In general, intangible assets are thought to require less energy in their production than tangible fixed assets, producing fewer emissions.[95] Consequently, it is possible that achieving high added value can be encouraged using intangible assets, as intangible assets will become relatively cheaper and investment will be encouraged as a result of carbon pricing. Although it is not easy to obtain a statistical grasp on intangible assets in their entirety, a trend is observed whereby countries with higher aforementioned "effective carbon rates" have a higher share of intellectual property products[96] among their intangible assets per capita.[97] Thus, from this standpoint as well, there is no denying that carbon pricing can have an influence not only in resolving climate change but also in building new economic models.

According to the analysis of OECD (2016), countries with a high per-capita GDP tend to have a high share of emissions with an effective carbon rate of 30 euros/ton CO_2 or higher among all emissions (see Page 154 of the Reference Materials), and a phenomenon whereby appreciable increases in effective carbon rates have an adverse effect on the macro economy cannot be confirmed. Indeed, among the countries that have achieved a higher per-capita GDP than Japan, many have high effective carbon rates[98] (see Page 155 of the Reference Materials). Additionally, consideration in scheme design can be effectively given to sectors that are exposed to international competition—such as through tax exemptions and free allocation of emission allowances.[99]

Moreover, carbon pricing can contribute to aspects other than the environment through the utilization of revenue generated by its introduction. Revenue from carbon pricing is already being

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[94] From Analysis of the Labour Economy 2016 (distributed to the Cabinet on September 30, 2016) and other sources

[95] Although it is thought that, among intangible assets, forms such as culture and art and brand assets come with low GHG emissions, it is also thought that other forms, such as maintenance and management of databases, come with comparatively high emissions.

[96] "Intellectual property products" is a concept that was introduced by 2008 SNA, which is a standard for GDP calculation of the United Nations. So-called "intangible asset" items include "computer software" and "entertainment, literary and artistic originals" as well as "research and development," which was classified as "intermediate consumption" in 1993 SNA.

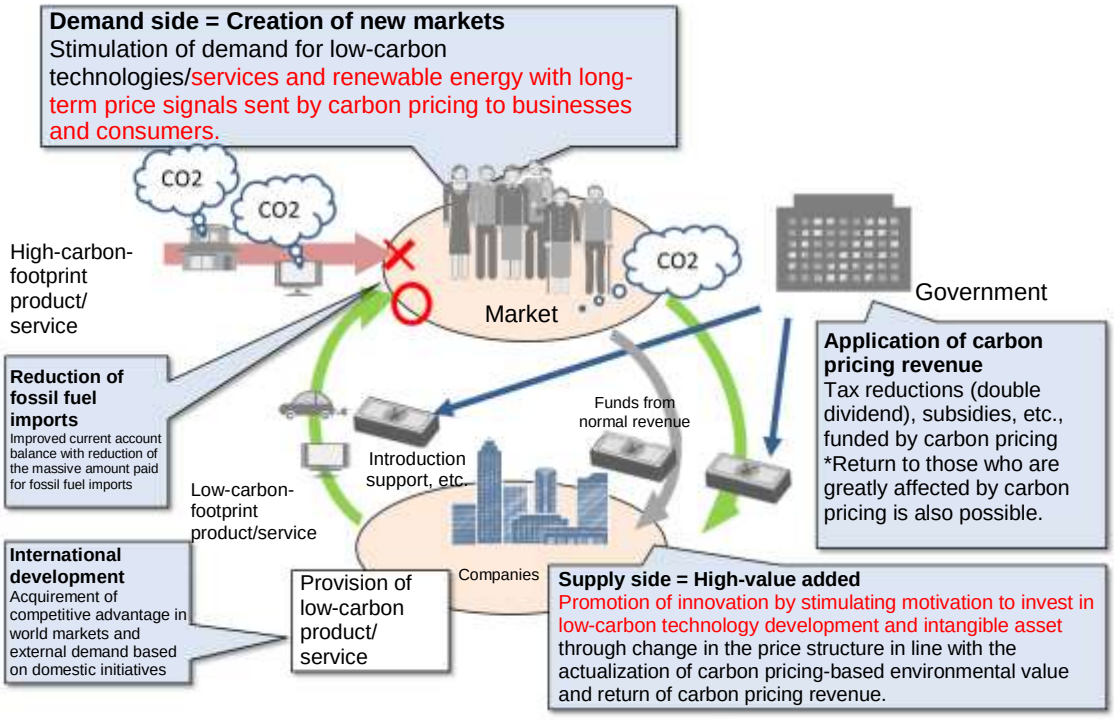
[97] However, it does not go so far as to show a causal relationship whereby rising effective carbon rates result in the formation of intellectual property.

[98] The 28 countries participating in the EU Emissions Trading System (EU ETS), nine states participating in the emissions trading scheme of the Regional Greenhouse Gas Initiative of the Northeast and Mid-Atlantic States of the US (RGGI; Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont) (as of August 2016), and the Province of British Columbia, Canada, which has introduced a carbon tax, have been simultaneously achieving CO_2 reductions and economic growth since the introduction of their schemes.

[99] World Bank (2015) "State and Trends of Carbon Pricing 2015"

applied to various policies and measures in other countries, among them reductions of corporate tax and income tax to improve competitiveness, promotion of employment, social security, programs for low-income earners, infrastructure investment, and elimination of budget deficits. Thus, carbon pricing is being used as a tool to simultaneously address climate change and resolve economic and social challenges (see Figure 21 and Page 156 of the Reference Materials).

Furthermore, it was mentioned earlier that in 80% of municipalities throughout Japan, a sum equivalent to 5% of gross regional product flows outward as energy payments. Another important characteristic of carbon pricing is that it can play a significant role in regional revitalization by expanding the regional economic cycle through the promotion of climate change policy. This can, by extension, lead to reducing payments for fossil fuel imports and to ensuring energy security.



*It must also be remembered that negative effects may be caused by cost increases attributable to carbon pricing.

Figure 21 Conceptual Image of Simultaneous Solution by Carbon Pricing

The Need for Early Study of Carbon Pricing

As demonstrated above, full-scale carbon pricing with set carbon prices, in addition to being effective and necessary for realizing a decarbonized society, can also play an important role in bringing about simultaneous solutions for climate change as well as social and economic issues, namely, economic growth, regional revitalization, and energy security.[100]

[100] The Carbon Pricing Leadership Coalition, which was launched in 2015 as a cooperative framework of companies and government organizations that are promoting the introduction of carbon pricing, also mentions that carbon pricing is (1) good for the environment, (2) raises revenue efficiently, making it possible to reduce more distortionary taxes, and (3) drives innovation and critically needed investments in clean and low-emission technologies as well as in energy efficiency (in other words, it produces a “triple dividend”). (Carbon Pricing Leadership Coalition (2016) Official Launch Event and Work Plan)

On the other hand, while a certain amount of time will be required for innovation to be triggered and for social structures to change as a result of carbon pricing, it must be remembered that some actors in society may be greatly affected by carbon pricing in the short term, depending on the level of carbon prices. For this reason, it will be important to avoid short-term and drastic impacts while maximizing long-term effects by introducing a more effective form of carbon pricing as soon as possible. Introduction of effective carbon pricing as soon as possible is also desired from the standpoint of minimizing cumulative emissions toward achievement of the 2° target.

Thus, rather than focusing on its pros and cons, the time has come to deepen the concrete consideration of which carbon pricing scheme is appropriate for Japan in terms of accelerating domestic initiatives for generating innovation for long-term significant reduction as well as analysis of what effects and influences should be anticipated, including the burden that carbon pricing will place on Japan's industries, its associated effects on employment, and international competitiveness.[101][102][103]

Some subcommittee members expressed firm opposition to the introduction of explicit carbon pricing with regard to the item "(a) Carbon Pricing: Making Best Use of Market Dynamism" in this section. Members noted that the costs of goods and services will rise and cause loss of demand and declining international competitiveness; that there is a need for final consumption-based discussion in terms of whether consumers will accept having the burden of carbon pricing shifted onto them and, if they do, how their spending behavior will change as a result; that the costs of countermeasures will be placed on companies and deprive them of sources of investment funds that could go to technical development and other activities; that the direct economic burden will be placed on companies and have a negative impact on economic vitality; that explicit carbon pricing will drain companies of resources for R&D, lessen their motivation to make investments toward society's low-carbonization, and hamper innovation, and thus carbon pricing's effectiveness as a global warming countermeasure will diminish the longer it takes; and that maintaining an international "equal footing" in terms of carbon price is important, and the lack of such equal footing will produce carbon leakage and thus not lead to global reductions.

(b) Other PaMs for Significant GHG Reduction

Preparation and Disclosure of Environmental Information

A mechanism that encourages the supply of environmental information for goods and services will be important as a means of enabling individuals and companies to choose appropriate goods and services with consideration for climate change.

Specifically, for the short term, the emissions factors of retail electricity businesses must continue to be appropriately disclosed to the public and transparency must be improved through each company's disclosure of its electricity source composition so that consumers can choose their electricity with consideration for the environment and so that local governments can appropriately

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101 It was mentioned during discussions within the subcommittee that, given international trends, Japan will be unable to secure international competitiveness by following its own rules without carbon pricing.

102 During the subcommittee's discussions, it was mentioned that CCS cost can serve as a technical standard when setting carbon pricing levels.

103 It will be necessary to give carbon pricing broad consideration from the standpoint of determining whether it is a cost-effective and practically effective policy in light of the goals of improving carbon productivity and reducing emissions, while also taking implicit carbon prices into account.

apply the PDCA cycle to confirm progress toward reduction in their jurisdictions and implement additional PaMs as necessary. Additionally, as a prerequisite for the PDCA cycle, it is essential that local governments have information on electric power consumption in their jurisdictions for calculating emissions, but area-specific information on electric power consumption is statistically ambiguous, and when local governments ask retail electricity businesses to supply this information voluntarily, a considerable number are unable to obtain it for some areas of their jurisdictions and therefore cannot calculate their emissions. Thus, an environment must be established so that such information can be appropriately obtained. Retail electric utilities must actively take action to indicate emissions factors and disclose power source composition, which are considered desired behaviors in the Guidelines Concerning the Management of the Electricity Retail Business.

It is also important to support the calculation not only of direct GHG emissions by businesses themselves but also of emissions from their entire supply chains (with the scope of calculation covering the upstream to downstream aspects of company activities and products). For the short term, the establishment of calculation methods and the diffusion of initiatives are needed. However, there is, for example, a system currently established within the Act on Promotion of Global Warming Countermeasures that requires businesses that emit a considerably large amount of GHG to calculate and report their emissions, which the government then compiles and releases to the public. An approach for the future could be to expand this system to also cover the entire supply chains of those businesses.[104] We believe this could lead to more effective and efficient reduction measures through the promotion of cooperative efforts by various businesses as well as better transparency and higher environmental responsibility ratings. Moreover, it is necessary to further promote businesses' reduction initiatives through the appropriate evaluation of their contributions to emissions reductions in Japan and abroad. We believe that initiatives such as these that make companies' contributions toward lower emissions throughout life cycles "visible" will help in the dissemination of technologies and know-how.

It is necessary to promote the preparation of various forms of information—not only information concerning the risks of climate change but also on the kinds of initiatives mentioned in Chapter 2, including the various outstanding examples of action being taken by various actors, such as C40 by local governments and SBT and RE100 by companies, as well as on the health- and comfort-related value brought by the insulating performance of houses, for example—and then to provide it to the public in easy-to-understand formats.

Statistical data are information that forms the basis of various countermeasures and PaMs. Given movement toward reinforcement of international MRV,[105] there is a need to continue making improvements that include further refinement of the methods and processes for calculating emissions factors and activity related to the calculation of emission and absorption amounts. It is also necessary to prepare demand-side data through, for example, fact-finding surveys on the status of CO_2 emissions in households, which have not been well understood heretofore.

Regulatory Instruments

Regarding regulation, in addition to "direct regulatory instruments" that present certain targets and compliance items to be achieved by society as a whole based on laws and then seek to achieve them through regulatory means, there are "regulatory framework instruments" that seek to achieve regulatory goals by setting targets and requiring the attainment of those targets or by requiring the

[104] This will require the study of conformity with related systems and other measures.
[105] Measurement, Reporting, and Verification of GHG emissions

following of established sequences and procedures. The latter, while making use of the creativity and ingenuity of businesses subjected to regulations, are regarded as effective when effectively preventing new environmental pollution for which quantitative targets and specific compliance items are difficult to clarify or when implementing advanced measures.[106] An example is a system placed on some facilities as part of mercury regulations that were brought into effect with the 2015 revision of the Air Pollution Control Act.

As seen with vehicle exhaust regulations of the past, appropriately designed environmental regulations[107] generate technical innovation. Greenhouse gases are emitted from various activities in Japan, but we believe there is no essential difference in terms of the structure of environmental burden when CO_2 emitted through the use of household appliances becomes a factor behind global warming and when exhaust emitted from the use of cars becomes a factor behind air pollution. Just as regulatory standards were achieved through reduction technologies that targeted cars as a source of exhaust, reduction technologies that focus on sources of CO_2 are similarly important. If history is a guide, then we believe regulatory instruments are one effective method for promoting reduction-related technical innovation.

Various forms of regulation are envisioned, including for example not only those that directly control GHG emissions by specifying technologies and performance but also those that concern government planning and public procurement, those that promote the dissemination of advanced technologies and innovation, and those that improve energy efficiency. It will be important to study those that are appropriate while considering the effects of their introduction and their cost-effectiveness.

Advancement and Dissemination of Innovative Technical Development

Toward the practical application and dissemination of technologies that lead to decarbonization and reduced carbon emissions, the national government must provide support continuously and in a consistent manner while remaining mindful of the RDD&D (research, development, demonstration, and deployment) flow. Specifically, it must promote various support PaMs, including economic instruments in the forms of demonstration, implementation, subsidies and leasing, interest subsidies, and funds, by applying them as appropriate according to the level of technical maturity.

Moreover, electric power supply-and-demand systems and the motorized society will be reorganized with the use of ICT, IoT, and AI, and these technologies will contribute to GHG emissions reduction, even if that is not their direct objective. The government must grasp this trend even as it pertains to technologies that are not directly intended to produce reductions, and appropriately apply those technologies to emissions reductions.

As for CCS and other countermeasure technologies that can produce effects over the long run, it is thought that the clarification of management entities and other points will require consideration from not only technical aspects but also legal and institutional aspects. It will be necessary to accumulate fine-tuned responses while shedding light on issues for each countermeasure technology.

[106] Fourth Basic Environmental Plan

[107] In the subcommittee's discussions, the view was expressed that environmental regulations that tend to brake economic activity hamper technical innovation.

Environmental Finance

Throughout the world, environmental finance is expanding rapidly. For example, investors are seeing companies' consideration for the environment as one element to consider when making investment decisions. Additionally, national governments and others are offering appropriate incentives for environmental consideration through finance, such as by sequentially developing strategic disclosure policies designed to attract private capital, and promoting initiatives for creating a green economy. Given such international trends, Japan too must create a flow whereby private capital is accurately supplied to initiatives needed for significant GHG reductions.

Land Use

In order to promote urban compactness and proper land use from various standpoints, such as reducing GHG through optimization of motor vehicle mileage and floor space, improving urban productivity, and promoting people's health through higher walking rates, support will be necessary for the promotion of initiatives that are based on action plans (area-based measures) and low-carbon city plans established by local governments.

In addition, to contribute to the furtherance of renewable energy projects in each region, it will be important to prepare and supply detailed information by region, for example, by implementing surveys on regional energy resource potential, disseminating the practice of setting areas for renewable energy that is balanced with environmental protection through zoning, and ascertaining predicted amounts of energy obtainable through the introduction of renewable energy facilities based on potential mapping. Furthermore, it will be necessary to promote local production and local consumption of regional energy and to supply excess energy to other regions, such as urban areas with large energy demand. Smoothly promoting such interregional energy cooperation will likely require the optimization of power grids and development of transport systems for hydrogen and other forms of converted energy, but it will be necessary to explore how cooperation that corresponds to the natural and social conditions of regions should look—specifically, what kinds of cooperation will be effective and efficient—among the various actors involved, including the public and private sectors.

Additionally, as mentioned previously, promoting the development of compact cities has various benefits in terms of economic and social aspects from the standpoint of climate change countermeasures. They include bundled and efficient use of energy, land use that considers "adaptation" and disaster preparedness, improvement of thermal environments with countermeasures against the "heat island" phenomenon through the greening of urban areas and the reduction of anthropogenic heat via higher energy efficiency of equipment, and promotion of low-carbonization corresponding to regional characteristics in the waste and recycling sectors. We believe that further deepening the consideration of such multi-benefits and doing more to disseminate information on them will serve to promote regional development.

Voluntary Initiatives by All Actors

On the problem of global warming, it is stated that "it is important that all humankind make efforts to actively and voluntarily address this issue" (Article 1 of the Act on Promotion of Global Warming Countermeasures). Concerned actors have executed a variety of initiatives thus far, and it will be important for them to continue actively combating global warming with awareness of their own responsibilities.

In particular as drivers of significant reductions, companies, which constitute a source of emissions through their entire supply chain and which are expected to play a major role in shouldering the burden of innovation, and local governments, which play the central role in developing human resources and communities based on regional characteristics and in developing regional industries concerned with regional energy and adaptation, are each extremely important. As seen in Chapter 2, various agreements and initiatives have been produced in recent years with an eye to achieving the Paris Agreement's 2°C target, and the number of voluntarily participating companies, local governments, and other actors is growing. Action to accelerate these trends is required.

Within the framework concerning voluntary initiatives, there are, as in the case of SBT for example, some initiatives that are being advanced in highly transparent and effective ways, such as involving conformity with scientific knowledge or the setting of paths toward target achievement as well as certification by third parties. We believe the active participation of each actor in such advanced initiatives is effective. Moreover, with regard to the existing framework for voluntary initiatives, it will be important to heighten their effectiveness still further while ensuring transparency. This should be achieved with reference to leading examples through the setting of paths leading to target achievement, upgrading of targets when they have already been achieved, and verification of the validity and effectiveness of target levels when setting targets based on criteria that can change.

In addition, Japan has experience in disseminating low-carbon products by using price to lead people to purchase household appliances, automobiles, and other products, and in achieving still higher efficiency via regulatory measures. Going forward, Japan must quickly achieve significant reductions by appropriately implementing various policies based on voluntary initiatives by concerned actors.

Additionally, further advancement of energy conservation and use of renewable energy by various actors, including locally-led renewable energy projects, will be indispensable in the years ahead. On the other hand, when expanding the introduction of renewable energy that corresponds to the natural and social conditions of regions, it is important to recognize that numerous challenges must be overcome, among them the building of a sustainable and efficient supply-and-demand system and the lowering of project costs. Particularly with regard to renewable energy, which is seen as problematic in terms of cost, it cannot be said that the problem will be resolved by simply introducing large quantities of renewable energy to bring down costs, and thus the elimination of systemic constraints and the implementation of detailed cost analyses and countermeasures that include facility and construction costs will be important. At the same time, concerned actors must work together to remove, one by one, factors that restrict its dissemination through, for example, technical development, human resources development, support for leading initiatives, and incorporation of climate change policy into institutional responses and policies for all fields. Moreover, steadily implementing initiatives connected with the previously mentioned preparation and disclosure of environmental information will be vital for the development of an environment that allows all actors to access information that is both necessary and sufficient for decision-making when they voluntarily select low-carbon activities. We believe that, with the development of an environment that encourages voluntary efforts through such steady initiatives, paths will open via which Japan can lead the world in achieving significant reduction.

Education, Human Resources Development, and Civic Participation

As mentioned previously, people's values, lifestyles, and work styles have a significant bearing on GHG emissions. It must be broadly recognized that changing the orientation of our own lifestyles, work styles, and selection of goods and services toward decarbonization will generate new demand, and that such demand will lead to innovation of new goods and services. Additionally, the recognition that climate change is an important challenge that must be dealt with as a threat to society from now and for many years into the future must be shared broadly with the general public and tied to concrete action that is based on understanding of the actions that individuals can take. Thus, given that people's level of understanding of climate change and their actions are extremely important in the achievement of significant reductions, providing high-quality and lifelong environmental education in households, schools, workplaces, communities and all other available venues and promoting in a permanent manner appropriate actions by people based on proper understanding will be imperative.

Additionally, it is necessary to increase the number of participants in the "promised market"—which should include those supporting regional renewable energy industries as well as people capable of providing energy-saving consulting in a variety of fields, including households, offices, and factories.

Moreover, because initiatives for long-term significant reduction made with the goal of achieving a decarbonized society will require the participation of all citizens, it will be important to continue advancing those initiatives while considering a broad range of opinions.

Enhancing Scientific Knowledge

Advancing long-term significant reductions and responses to the effects of climate change will require the enhancement of scientific knowledge and continual effort to grasp the latest knowledge. For this reason, Japan must actively participate in the IPCC's activities and also implement precise ascertainment of GHG emissions and absorption amounts, continuous observation and monitoring of climate change and its effects, and regular prediction of future climate change and evaluation of its effects.

While the study and implementation of PaMs and countermeasures based on scientific knowledge are fundamental, reliability is also important when applying scientific knowledge.[108] Specifically, this is thought to refer to transparency in the basis upon which assertions were made concerning the scientific knowledge, the reliability and verifiability of data used, and whether the knowledge appeared in a peer-reviewed research paper or academic journal. For assertions or data for which this point is unconfirmed, it is important to develop an environment premised on investigation that includes clarification of the grounds for the assertion or data as a precondition for fair and impartial discussion.

Reinforcing Adaptive Capability

Initiatives will be advanced based on the "National Plan for Adaptation to the Impacts of Climate Change" that was approved by the Cabinet on November 27, 2015. Above all, climate risk information concerning climate change and its effects provides the basis upon which actors take adaptive measures, and thus it is extremely important to enable actors to easily access climate risk

[108] For example, in the field of medicine, the concept of evidence-based medicine (EBM) is adopted as medical care that is based on scientific grounds rather than experience or intuition.

information and to obtain such information in an accurate and easily comprehensible form.

In particular, the development of infrastructure for climate risk information that targets developing countries in the Asia-Pacific region, which is vulnerable to the effects of climate change, raises the adaptive capabilities of those countries and leads to effective investment by Japanese companies.

Additionally, there is a need to promote adaptation measures that are based on regional characteristics so that each region can use adaptation as a springboard to the creation of a new society that takes advantage of its own special characteristics.

Contributing to Emissions Reductions throughout the World

Climate change policy must advance reductions throughout the entire world as soon as possible, and Japan must contribute to global reductions by deploying its outstanding technologies and know-how to other countries. Since superior low-carbon technologies reduce operating costs, they are economical when viewed in terms of total life cycle. However, because in developing countries it is often the case that only initial costs are considered when making investment decisions, those technologies are not being disseminated there. To overcome this problem and open a pathway toward dissemination, Japan is promoting the overseas development of low-carbon technologies within bilateral frameworks, particularly the JCM. Based on its accomplishments thus far, Japan will promote steady decarbonization-focused initiatives by developing technologies that meet the policy and technology needs of each country.

Moreover, cooperation with international networks and international organizations is also essential in reducing GHG throughout the world.

For example, if the Green Climate Fund (GCF) is to be used to achieve the Paris Agreement's long-term targets, Japan will also continue contributing as a developed country to the effective use of funds. Additionally, the key to promoting countermeasures in developing countries is, of course, support in terms of technology and funding but also the implementation of global warming measures and capacity building for human resources in those countries. Working in cooperation with international organizations and other countries, Japan will strive to improve each country's transparency-related capabilities, which are central to the Paris Agreement's effective implementation.

As efforts toward global decarbonization proceed based on the Paris Agreement, we believe that the margin for Japan to offset its emissions through other countries will gradually decrease in the world of 2030 and beyond. Although Japan is faced with various constraints in terms of geography, land, and resources, we believe that realizing major reductions through various responses in such areas as technologies and know-how to overcome such constraints, as well as lifestyle and socio-economic systems, will become a source of international competitiveness. While there may be possibilities for demonstrating and verifying new technologies abroad in the future, maintaining Japan's contribution to overseas reductions over the long term will require staged and steady efforts toward achieving significant reductions domestically beginning right now. At the same time, in its contribution to long-term overseas reductions, Japan must present its technical advantages "in a visible form." From materials to final products, Japan's contribution to overseas reductions through its diverse technologies is thought to be various and great, and making such advantages "visible" will likely serve as an incentive for companies to take action.

For Japan an important perspective is that it opportunely link its strengths to international competitiveness and appropriately reap leading benefits as a forerunner in finding answers to emerging issues. We believe effective steps here will include building domestic economic systems that correspond to a global economic market in which carbon pricing is being increasingly internalized, as well as taking steps to more effectively highlight Japan's technical strengths in such areas as energy efficiency and cost reduction during product use.

Promoting Resource Recycling

Achieving significant long-term reductions will require integration with the building of a recycling-based society. Thoroughly promoting resource recycling throughout the entire product life cycle, from the mining of resources to disposal, leads to further low-carbonization on the recovery side of the cycle, and thus it will be necessary to proceed with measures that specifically include the following: making maximum use of urban mines; substituting materials with bioplastics and other recyclable resources; promoting environment-friendly design for degradability and longer service life; improving production efficiency; promoting a sharing economy that shifts from ownership to sharing; forming favorable stocks and making long-term use of stock resources; promoting high-quality "3Rs" initiatives that include low-carbon products such as solar power facilities and other equipment; using biomass waste as renewable energy; and promoting highly efficient energy recovery and use of excess heat at waste treatment facilities.

Initiatives such as these will lead to improved resource productivity in Japan and are important for reducing Japan's risk of being affected by international circumstances or market conditions, as well as for achieving stable economic growth.

Measures Addressing GHG other than CO_2 from Energy Consumption

It will be important to steadily promote initiatives oriented toward significantly reducing the production and emission of fluorocarbons. Specifically, Japan must further promote the elimination of fluorocarbons and the shift to low GWP in the gas and product manufacturing fields in line with the Montreal Protocol's HFC amendment (Kigali Amendment) adopted in October 2016. Additionally, it must promote the prevention of fluorocarbon leaks during equipment use and the recovery of fluorocarbons at the time of equipment disposal as steps toward achieving the mid-term targets of the Global Warming Countermeasure Plan. As for methane and nitrous oxide, Japan must make steady reductions by implementing fine-tuned measures that correspond to their origin. They include reducing final disposal amounts and amounts of incinerated waste by promoting 3Rs[109] initiatives, bringing greater sophistication to the incineration of waste and sewage sludge, and changing organic matter management methods in rice cultivation and reducing the amount of fertilizer used on farmlands.

(3) Making steady progress toward long-term significant reduction

Building a decarbonized society throughout the world by the latter half of this century will require the advancement of initiatives toward substantial reduction together with the efficient use of the remaining carbon budget.[110] If we bear the carbon budget's existence in mind, then the question of

[109] Reduce, Reuse, and Recycle

[110] As seen in Chapter 1 (1) (c), according to the Synthesis Report of the IPCC's Fifth Assessment Report, limiting total human-induced warming to less than 2°C relative to the period between 1861–1880 with a probability of greater than 66% would require keeping cumulative CO_2 emissions from all

the pathway to achieving emissions targets—in other words, of how Japan will achieve its mid-term target while holding down its cumulative emissions until FY2030, for example—becomes essentially crucial. To minimize cumulative emissions based on the carbon budget, Japan must achieve its FY2030 mid-term target without fail and steadily proceed with the preparations needed to achieve its long-term 2050 goal. At the same time, it must maximize its reductions each fiscal year.[111]

In promoting initiatives, the importance of steadily reviewing progress to ensure that appropriate PaMs are being flexibly implemented in accordance with social trends, scientific knowledge, and technical advancements scarcely needs saying. Japan must, based on progress reviews, proceed with responses such as reexamining the Plan for Global Warming Countermeasures, with attention to the above-stated concepts. Additionally, whenever the government separately formulates a plan concerning long-term efforts based on this Vision in the future, it must steadily implement efforts based on that plan and, at the same time, strictly manage progress and conduct continuous reviews so that specific efforts are advanced more effectively as a plan.

Regarding progress management, we believe that, in addition to result indicators showing the degree to which reductions have been achieved, there is a need to study functional mechanisms that also confirm the progress of countermeasures and PaMs, for example.[112] It deserves noting that this Vision is not intended to cover in its scope the formulation of concrete action plans and road maps for efforts and initiatives. Nonetheless, we believe that the vision and major PaMs it presents should also be reviewed in a timely and appropriate manner.

Furthermore, this Vision presents a vision and direction for PaMs in Japan's effort to achieve its 80% reduction target. In this respect, it will be important, in light of current circumstances, to calculate and verify whether excesses or deficiencies exist in countermeasures and PaMs and whether significant reductions can be realized while making integrated improvements to the environment, economy, and society. It will also be important to study paths toward an ideal future—specifically, what measures should be taken, and how long should they be implemented—with a clear view of what must be achieved. These steps must be understood as tasks for the future.

It is expected that local governments, which are one of the drivers of significant emissions reduction, will also promptly begin studying plans and initiatives that take a long view and incorporate regional characteristics based on this Long-term Low-carbon Vision.

For the short term, it is established that individual countermeasures and PaMs will be rigorously reviewed each year to ensure that actions based on the Plan for Global Warming Countermeasures are steadily implemented. Moreover, regarding global warming countermeasures in the electric utility sector, it is established that progress toward the achievement of the medium-term target will be evaluated each year and, when it is deemed that the target will not be achieved, that reviews of PaMs and other actions will be considered.

In promoting efforts to build a decarbonized society throughout the world in the future, it is important

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anthropogenic sources since 1870 below roughly 2.9 trillion tons. Given that roughly 1.9 trillion tons had already been emitted by 2011, achieving this will require controlling global cumulative emissions to about 1 trillion tons in 2012 and beyond.

111 One opinion expressed within the subcommittee was that controlling cumulative emissions is naturally important and therefore there is no need to go so far as to quote the concept of the carbon budget.

112 It was pointed out in the subcommittee that it is also important to use the 230 indicators established to monitor the 17 goals and 169 targets of the Sustainable Development Goals (SDGs).

to consider the standpoint of cumulative emissions.[113][114] Although the path to achieving the target can take various routes depending on, for example, the speed at which reduction technologies are disseminated and the arrival (or non-arrival) of innovation, executing progress management by establishing a "guide" presenting a path toward target achievement will at the very least help in confirming, for example, whether emissions are moving downward toward the target or moving upward. Thus, we believe such an approach to be effective, particularly in the case of initiatives having a long time-frame. If, after a value is set as a “guide” for progress management, a discrepancy emerges between the actual value and the guide value, more effective means of progress management should be explored, taking a flexible approach, by using the discrepancy as an opportunity for close communication concerning interpretation of the discrepancy and responses to it among concerned actors. The study of progress management methods should be accelerated within studies of carbon pricing and other approaches, particularly in sectors that require significant emissions reductions.

[113] Some within the subcommittee raised concerns that, if the carbon budget concept were applied, reduction of greenhouse gas emissions would become the sole concern and economic growth and energy security would be disregarded.

[114] In consideration of the carbon budget that was presented in the IPCC based on scientific knowledge, and bearing in mind the importance of the cumulative emissions viewpoint, careful discussion with attention to the simultaneous solution of issues is, naturally, a prerequisite in the study of concrete countermeasures and PaMs that are based on progress reviews.

Conclusion

Population decrease and societal aging, restoration of fiscal health, handling of social security benefit expenses, and problems in regional and urban structures. While it is difficult to accept such challenges with a real sense of urgency in daily life, they are linked to Japan's very foundation as a nation, and the importance of promoting long-term initiatives to tackle them right now has been pointed out in various venues and countermeasures are underway to combat them.

Climate change is similarly positioned within the same context as these challenges. Moreover, in addition to a long-term time axis, climate change also has a spatial axis in the sense that it must be addressed on a global basis. As various movements toward the building of a decarbonized society throughout the world gain momentum based on the Paris Agreement, this subcommittee has engaged in repeated discussions concerning the basic philosophy, vision, and orientation of PaMs with respect to the kind of society Japan should aim to achieve as it looks to the year 2050 and beyond.

In our discussions, we endeavored to hear a broad range of views from domestic and foreign experts, local governments, companies, NGOs, and student organizations covering a wide variety of fields, among them global trends, overseas developments, the formulation of long-term strategies, scientific knowledge, technology, the impacts of global warming, lifestyle, buildings, transportation, business, energy demand and supply, regions and cities, and financial systems. Additionally, we strove to hear broad and diverse opinions by conducting local interviews in Okayama City and Nagoya City.

This Vision, which is the product of repeated discussions based on those views and opinions, shows the direction that Japan's environmental policy should take in the years ahead. It seeks to be a vision of the kind of future Japan should aim to achieve and a "trigger" for climate change policy by, for example, presenting the ideal of Japan's "becoming a problem-solving forerunner nation that grapples with simultaneous solutions to global warming and socio-economic issues, and leads the world in realizing significant GHG reductions and prosperity at the same time."

Furthermore, the government must consider the formulation of a long-term low-GHG-emission development strategy for the mid-century that is being called for under the Paris Agreement. Based on the commitment Japan made at last year's Ise-Shima Summit to formulate and communicate a long-term strategy "well ahead of the 2020 deadline," the government must begin by promptly indicating its intention, both domestically and internationally, to have Japan lead the international community so that major emitters will take steps to reduce their emissions in accordance with their abilities, with the goal of building a decarbonized society throughout the world.

On the other hand, regarding the challenges that Japan must tackle with a view to the long term, various opinions were presented in the subcommittee's discussions. When formulating a long-term strategy that lays out the general direction of Japan's future, deliberations should be advanced with careful discussion that takes into account various viewpoints. Formulating a long-term strategy will require a combination of speed and thoroughness.

"The best way to predict the future is to invent it." These are the words of Alan Kay, who is considered by some to be the "father of the personal computer."

It is true that, in our modern society marked by extraordinary change and the complex intertwining

of various elements, there are many uncertainties on the path toward achieving the targets agreed upon in the Paris Agreement. Nonetheless, the targets of the Paris Agreement are based on scientific knowledge and therefore unavoidable. To fulfill our responsibilities to the future, efforts toward the building of a carbon-free society throughout the world are our duty as people living today. Japan's endeavor to become a "problem-solving advanced country that leads the world in simultaneously achieving both tremendous GHG reduction and prosperity" will, by its very nature, accomplish the duty that the nation must fulfill to overcome uncertainties and "to pass on our environment as a foundation for human beings to future generations and contribute to global sustainable development through climate change policy, and to be a country that is looked to with expectation and trust by international society."

We look forward to seeing the further acceleration of initiatives toward significant GHG reduction by all actors based on this Vision.