The Long-term Strategy under the Paris Agreement

June 2019

(Cabinet decision, June 11, 2019)

The Government of Japan

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2. Long-term Vision

Proclaiming a "decarbonized society" as the ultimate goal and aiming to accomplish it ambitiously as early as possible in the second half of this century, while boldly taking measures towards the reduction of GHGs emissions by 80% by 2050. (an unconventional vision of an "ideal future model")

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- Renewable energy: Economically self-sustained and decarbonized major power source (e.g. drastic cost reduction, overcoming power grid constraints)
- Thermal power: Reducing CO_2 emissions from the thermal power generation, in line with the long-term set out in the Paris Agreement (e.g. reducing reliance

on thermal power as much as possible) , promoting CCS&CCU/ Carbon Recycling(e.g. establishing the first commercial scale CCU technology by 2023/early adoption of CCS&CCU in the society)
- Hydrogen: Realizing a “Hydrogen Society”
- Energy efficiency/distributed energy system: e.g. efficient use of heat/ development of distributed energy system

2. Industry

(1)Future vision

Establishing new production processes to achieve decarbonized manufacturing with disruptive innovation

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- Utilization of CO_2-free hydrogen (e.g. a challenge towards “zero-carbon steel” with technologies such as hydrogen reduction)
- Feedstock change(e.g. CCU including artificial photosynthesis, Carbon Recycling and biomass)
- Achieving drastic improvement of energy efficiency, development and introduction of low-GWP and non-fluorocarbon refrigerant technology towards complete transition from fluorocarbons in longer term, promotion of decarbonization in corporate management

3. Transport

(1) Future vision

Challenging for “Well-to-Wheel Zero Emission”

（e.g. achieving the world’s highest level of environmental performance of Japanese cars supplied worldwide by 2050）

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Enhanced international policy coordination on electrified vehicles, including automotive environmental performance assessment on ”Well-to-Wheel“ base, promotion of open innovation for the next-generation electrification-related technologies, road/transport systems using big data and IoT.

4.Community and Living

(1)Future vision

Creating the “Circulating and Ecological Economy” advanced local decarbonization, and achieve the SDGs with integrated improvements on the environment, economy and society, thereby achieving a carbon neutral, resilient and comfortable community and living by 2050.

Capable communities and companies to achieve carbon neutrality even before 2050.

(2) Direction of policies and measures for the future vision
- Shift to carbon neutral living (facilitating technological development and wider usage to bring the stock average of energy consumption in houses and offices to approximately net ZEH/ZEB equivalent/ lifestyle shift)
- Carbon-neutral community building (urban city building, farming/forestry/fishing villages building, and development of distributed energy systems)

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Promoting innovation for practical application and wide usage of cross-sectoral decarbonizing technologies leading to drastic reduction of GHG, achieving the cost to enable adoption in the society. Continuous reviewing the technologies based on latest scientific knowledge.

(1) Progressive Environment Innovation Strategy

Setting clear targets such as costs, maximizing provision of the resources from both the public and private sectors, seeking out and creating potential technologies in Japan and abroad, setting challenges based on the needs, strengthening support for making it to the business case
- Seeking out and Creating potential technologies in Japan and abroad, Setting challenges based on needs
  - Technical assessment based on cost required by users and GHG emission reduction effect with the LCA (life cycle assessment)
  - Accelerating public R&D and challenging R&D with ambitious goals
  - Hosting an international conference inviting leaders in science and technology from G20 to create disruptive innovations in the clean energy technology field gathering the wisdom of the world, and enhancing alliances among R&D institutes with facilitation of international joint R&D activities

［Research and Development 20 for clean energy technologies（RD20）］

• Stronger initiatives leading to business

- Providing knowledge-based support (e.g. NEDO Pitch) for companies selected by public organizations and ”visualize”, so that potential technologies and human resources owned by the start-ups with superior environmental energy and other technologies will be made a case for business.

• Target setting and visualizing of issues for commercialization

〔Energy efficiency/energy transformation〕 Maximum implementation of energy saving technologies with promising cost-effectiveness

〔CCUS/negative emission〕 Realizing products utilizing CCU/carbon recycling at the level equivalent to existing products in terms of cost

〔Hydrogen〕 Realizing hydrogen cost equivalent to existing energy: e.g. lowering manufacturing cost of CO_2-free hydrogen to 1/10

〔Renewable energy〕 Establishing technology contributing to large-scale expansion of capacity of renewable energy; Using demand response (DR) to the level comparable to the USA

〔Nuclear〕 Pursuing reactors with excellence in safety, economic efficiency, and flexibility; Technology development for solving backend problems; Nuclear fusion

(2) Innovation in Economic and Social Systems/lifestyle

Section 2: Promotion of Green Finance

〔Basic Directions〕

Appropriately “visualizing” corporate initiatives in innovation etc. and mobilizing finance for innovation by financial institutions.

(1) Mobilizing finance through Disclosure including TCFD* and dialogue

* TCFD : Task Force on Climate-related Financial Disclosures

• By utilizing TCFD, a global framework for climate-related disclosures, leading discussions on disclosures through which strength and contributions of companies are visualized while highlighting industry-specific characteristics, thereby developing financial flow to capture opportunities from climate change.

- Industry: Expanding on the TCFD Guidance/Scenario Analysis Guide, e.g. broadening the range of industries covered by TCFD Guidance and by adding more best practices.

- Financial sector: Formulating a guidance on green investment for financial institutions regarding the direction of corporate assessment

- Creating TCFD Consortium as a venue for dialogue between industries and financial sector

- Holding a TCFD Summit in fall 2019, to discuss and share the above initiatives with the world

(2) Promoting initiatives to expand ESG finance

- Aiming to brand Japanese capital market, including through support to the issuance of green bonds, and promoting ESG finance in direct finance
- Encouraging effective dialogues on environmental information and corporate value assessment, through the development of ESG Dialogue Platform
- By encouraging local ESG finance, facilitate ESG finance in indirect finance which has an overwhelming presence in Japan
- Maintaining and creating momentum for ESG finance among investors and financial institutions, by enhancing ESG finance literacy, development of platform for environmental information disclosure as well as through ESG Finance High-Level Panel with commitment from the top management of financial sectors

Section 3: Business-led International Application and International Cooperation

〔Basic Directions〕

Promoting international application of products and goods with high environmental performance contributing to global GHG emission reductions as much as possible; promoting co-innovation benefiting participants from both countries; adopting Japanese decarbonizing technology suitable to the partner country, while contributing to creating market, human resource development and institutional development; internationally advocating the ”Circulating and Ecological Economy” and supporting other countries for its development; effectively using public finance and mobilizing private funds in climate change areas

(1) Promoting international application of decarbonizing technologies together with policy and institutional support and rule-making

- Working for institutional development in partner countries on frameworks to compare and assess energy efficiency, energy efficiency labeling and international standardization; improving business environment and promoting wider application of decarbonizing technologies with Joint Crediting Mechanism(JCM), establishing public and private-sector initiatives in ASEAN, and sharing best practices at public-private workshops.
- Leading international rule-making and creating appropriate framework for using market-based mechanisms
- Reducing fluorocarbons emissions internationally by encouraging developing countries to prevent the leaks of fluorocarbon refrigerants in the use and

emissions upon equipment disposal

(2) Strengthening Development and Investment of infrastructure contributes to reduction of CO_2 emissions

- Promoting development and investment of energy and urban/transport infrastructure abroad in order to contribute to the global reduction of CO_2 emissions consistent with the long-term goals stipulated in the Paris Agreement (e.g. renewable energy such as offshore wind power and geothermal power, hydrogen, CCS&CCU, Carbon Recycling, smart cities)

(3) Building basis for decarbonized society on a global scale

- Supporting partner countries in the formulation of Nationally Determined Contributions (NDCs) and mitigation plan, as well as enhancing transparency in the entire supply chain

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(1) Human resource development

Further promoting Education for Sustainable Development (ESD) and enhancing human resource development for innovation.

(2) Enhancement of an Integrated Approach in Building a Resilient Society to Adapt to Climate Change

Promoting measures that bring about positive effects on both mitigation and adaptation (e.g. introduction of self-sustained and distributed energy, ecosystem-based approaches such as green infrastructure） as well as improving knowledge platforms for adaptation.

(3) Just Transition

Providing vocational training to the workforce in order to achieve the transition of the workforce to a decarbonized society smoothly and without delay with the Government, local authorities and companies working together.

(4) Government's Own Efforts to Lead the Society

The Government will lead the way in carrying out initiatives to create a decarbonized society, while working for the comprehensive introduction to the entire society.

(5) Carbon pricing

Professional and technical discussions considering the perspectives of international trends, conditions in Japan and international competitiveness are

required.

Chapter 5：Review and Implementation of Long Term Strategy

(1) Review

Reflecting on the vision established in this strategy, revisit the policy measures referred to in this Strategy flexibility about every 6 years with reference to situations, and review this Strategy as may be required.

(2)Implementation

Analysing relevant factors taking future situational changes into account / collaborating and having dialogues with stakeholders including younger generations etc.

Introduction

Recent Situation on Climate Change, Economy and Society

Introduction: Recent Situation on Climate Change, Economy and Society

This "The Long-term Strategy under the Paris Agreement" (hereafter "Long-term Strategy") is formulated by the Government of Japan as long-term low greenhouse gas emission development strategy in accordance with the provision[1] of the Paris Agreement[2].

(1) Situation on Climate Change

In recent years, extreme weather events which are thought to be partially attributed to climate change have been happening around the world[3]. Some studies have assessed that these events are the result of the expansion of human activities that are about to exceed the earth's limitations. It has become an urgent task to take climate change measures throughout the world.

In 2018, Japan suffered from the "Heavy Rain Event of July 2018" and the extremely hot conditions, which marked the highest temperatures in the national record, and 1,843 people, including a toll of 252 people[4], were affected by the torrential rains and typhoons. It is also reported that the economic damage from these climate-change-related disasters[5] amounts to US$27.5 billion[6]. The responses to these disasters have placed a considerable economic burden to the central and local governments.

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[1] Article 4, Paragraph19 of the Paris Agreement: [a]ll Parties should strive to formulate and communicate long-term low greenhouse gas emission development strategies, mindful of Article 2 taking into account their common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.

[2] Adopted in December 2015 (Signed in April 2016)

[3] According to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report, it is very likely that human influence has contributed to the observed global scale changes in the frequency and intensity of daily temperatures extremes; it is likely that human influence has significantly raised the probability of occurrence of heat waves in some locations; there is high confidence that the intensity of extreme precipitation events will increase with warming at a rate well.

[4] Total amount of human damages from the Heavy Rain Event of July 2018, Typhoons Jebi, and Typhoon Trami, according to Cabinet Office. In addition, material damages including houses ware generated.

[5] August 10, 2018: Japan Meteorological Agency, "Characteristics and Primary Factors of the 'Heavy Rain Event of July 2018' and the Subsequent Heatwave in Japan from Mid-July Onward"

[6] Total amount of damages from Heavy Rain Event of July 2018, Typhoon Jebi and Typhoon Trami of that year. According to "Weather, Climate & Catastrophe Insight 2018 Annual Report" (Aon plc, 2019).

(2) Trends in Climate Change in the International Community

Considering the current trend in international conferences, including the Conference of Parties to the United Nations Framework Convention on Climate Change (COP), there seem to be major changes in the world's perception of climate change.

Based on the scientific findings regarding climate change presented by the Intergovernmental Panel on Climate Change (IPCC), the Paris Agreement was adopted at COP21 in December 2015, and came into force in November 2016. The Paris Agreement stipulates its objective to hold that while holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, and for this purpose, achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gas (GHG) (worldwide carbon neutrality) in the second half of this century.

According to the "Special Report on Global Warming of 1.5°C[7]" adopted by the IPCC Session in October 2018, climate-related risks to health, livelihoods, food security, water supply, human security and economic growth are projected to increase with global warming of 1.5°C, and increase further with 2°C. In limiting global warming to 1.5°C, anthropogenic CO_2 emissions are expected to reach net zero around 2050.[8] Furthermore, it is suggested that emission pathways limiting global warming to 1.5°C would require rapid and far-reaching transitions in energy, land, urban and infrastructure, and industrial systems. These transitions are said to be unprecedented in terms of scale, but not necessarily in terms of speed.

The international community takes note with concern the findings of the IPCC Special Report on Global Warming of 1.5°C and shares the necessity of strengthening international responses to the threat of climate change.

(3) Changes of Situation in Business including Finance

With regard to climate change measures, significant changes that have not been experienced before are now taking place. Energy transition with low-cost renewable energy and the trend of companies and financial sectors that aim at

[7] The Special Report on strengthening the global response to the threat of climate change, the impact of a 1.5°C temperature rise from its pre-industrial level and related worldwide greenhouse gas emission pathways in the context of sustainable development and poverty reduction.

[8] In the emission pathways that contains global warming to 1.5°C with no or limited overshoot using multiple models, the net CO_2 emissions from anthropogenic sources worldwide are expected to reach net zero around 2050 (interquartile range between 2045 to 2055).

zero GHG emissions are the characteristic changes. There is a growing possibility that the evaluation and assessment of a company will depend on whether or not it can promptly make transition to decarbonization. It could well be said that climate change measures are no longer a cost, but a source of competitiveness among companies.

The International Renewable Energy Agency (IRENA) estimates that the additional investment needed for decarbonization of the energy industry, such as investment for energy-saving measures, renewable energy, carbon dioxide capture and storage (CCS), building renovations and storage batteries, could reach approximately more than $29 trillion by 2050, which will drive new economic growth, and increase GDP worldwide by 0.8% in 2050[9]. In Japan, the amount of new investment in renewable energy has also increased significantly since 2012.

In the financial sector, there is a growing movement to regard corporate environmental efforts as one of the criteria for investment, such as ESG investment that places emphasis on the Environment, Social, and Governance. Global ESG investment in 2018 increased by more than 2,000 trillion yen compared to 2012, and ESG investment in Japan has grown more than four times from 2016 to 2018. In addition, there are also moves that can lead to restraining the use of fossil fuels that emit large amounts of CO2, including coal, through engagement (holding constructive dialogues with invested companies to encourage actions), divestments (withdrawing investment on assets related to fossil fuels, including and especially coal-fired thermal power plants) and others. Divestment alone cannot address climate change. It is viewed that ESG investment to positively evaluate capital investments and innovation for decarbonization will attain further importance.

Under such circumstances, in order to obtain significant finance required for capital investment and technological innovation to address climate change, competition could arise for access to ESG funds, which evaluates the efforts of climate change measures in a positive way.

For ESG investment as well, it is important to attempt growth in a longer term and improvement of corporate value in a sustainable manner through constructive dialogue and engagement between companies and investors based on the information disclosure.

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[9] "Perspectives for the energy transition"(2017,IEA and IRENA). Many models which are reported to the IPCC estimates negative effects on GDP, and the model taken in this report shows a different result.

(4) Adoption of Sustainable Development Goals (SDGs)

The “2030 Agenda for Sustainable Development” (2030 Agenda) was adopted by the United Nations General Assembly in September 2015 in order to recognize various problems arising from human activities as urgent issues and let the international community work together to solve them. The 2030 Agenda was adopted as a universal goal for the entire international community, among which 17 goals and 169 targets were set as “Sustainable Development Goals, SDGs.” In addition, the 2030 Agenda clearly states that “no one is left behind” on the earth to achieve the goal. Climate change could be a factor that can influence the achievement of other SDGs. In order to achieve the whole SDGs, it is necessary for Japan to promote climate change measures in line with elements of SDGs other than climate change.

Chapter 1

Basic Concepts

Chapter 1: Basic Concepts

1. Intent and Purpose of Formulating this Strategy

In response to the urgent challenge of climate change, efforts to balance emissions and removal of the GHGs in the second half of this century have been accelerated all over the world. Against this backdrop, the Paris Agreement stipulates that all parties should strive to formulate and communicate long-term low GHG emission development strategies. Determined to lead global decarbonization, Japan will demonstrate its high aspiration and its stance to actively promote efforts for decarbonization both in and out of Japan. In particular, pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels is set as a global target in the Paris Agreement, and, especially since the IPCC Special Report on Global Warming of 1.5°C was published, it has attracted a great interest and discussions, including in the COP process. This is an extremely difficult target that should be pursued worldwide; as a member of the international community, Japan will contribute to the world by formulating this long-term strategy and sharing the experiences out of its implementation, thereby contributing to achieving the aforementioned target set forth in the Paris Agreement. Furthermore, Japan will share these ideas and efforts with the world and promote them globally as the G20 presidency at the time of the formulation of this strategy in 2019.

For these reasons, bearing in mind the changing situation described in the previous chapter, Japan formulates its long-term low GHG emission economic and social development strategy as a growth strategy.

2. Japan's Long-term Vision

In its Intended Nationally Determined Contribution submitted in 2015, Japan set forth feasible reduction targets for the fiscal year 2030 by bottom-up calculation with concrete policies, measures and individual technologies taking into adequate consideration, *inter alia*, technological and cost constraints. On the other hand, for a long-term climate change policy, the Government should present a clear vision as an "ideal future model" and show a policy direction towards it, thereby encouraging all stakeholders to make efforts for its realization through the pursuit of all possibilities.

For this reason, Japan proclaims a “decarbonized society[10]” as its ultimate goal and aims to accomplish it ambitiously as early as possible in the second half of this century. Toward that end, Japan has set a long-term temperature goal of reducing GHG emissions by 80% by 2050[11], and will boldly take measures towards its realization.

Japan will achieve a virtuous cycle of environment and growth with disruptive innovation that is heretofore unconventional, thereby greatly reducing GHG emissions domestically. At the same time, Japan will contribute as much as possible to global emission reductions and achieve economic growth. This is in line with the aspiration of the Paris Agreement. Japan will manifest its contribution towards realization of the long-term goal in the Agreement: holding the increase in the global average temperature to well below 2°C above the pre-industrial levels, and pursuing efforts to limit the temperature increase to 1.5°C above the pre-industrial levels.

This strategy sets forth a long-term vision as an “ideal future model” in each area. These visions will provide directions for all stakeholders to pursue possibilities towards the realization of these areas. At the same time, together with policy directions, they will improve the predictability of investment and serve as the basis for expanding the investment in Japan. At the same time, it identifies areas which need disruptive innovation to promote corporate R&D and investment. Furthermore, by setting forth this vision, we will take the lead in future international discussions including the formulation of frameworks and standards in the area of climate change.

3. Basic Principles in Policy towards the Long-term Vision

(1) Achieving a Virtuous Cycle of Environment and Growth

It is difficult to overcome climate change challenges through a mere extension of conventional efforts; both global efforts and disruptive innovation will be essential. In order to achieve these, it will become important to make the

[10] Achieving a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century (carbon neutrality throughout the world).

[11] In the Plan for Global Warming Countermeasures (Cabinet decision on May 13, 2016), Japan has committed to lead the international community so that major emitters reduce their emissions in accordance to their abilities under the fair and effective international framework in which all major countries participate, based upon the Paris Agreement. It has also committed to working on 80% reduction of reducing greenhouse gas emissions by 2050 as a long-term goal, while balancing global warming countermeasures and economic growth.

maximum use of the power of the business sector which has significant finance and technologies.

As mentioned in the previous chapter, with climate change aggravating, the behavior of the business -- including the financial sector -- is beginning to change. In the longer term, it is certain that global demand for addressing climate change will grow; Japan will carry out policies to uphold and ensure the emergence of changes in the business sector, while involving citizens at all levels, realize a virtuous cycle of environment and growth through business-led disruptive innovation and contribute to the solution of the climate change problem.

In order to achieve such business-led disruptive innovation, it is necessary to explore all possible options and review them in a flexible manner. It is also necessary to identify concrete targets in terms of costs and efficiencies in the key areas for decarbonization such as hydrogen, carbon dioxide capture and storage (CCS), carbon dioxide capture and utilization (CCU), renewable energy, storage batteries and nuclear energy, as well as challenges and systems including collaboration both in Japan and overseas. Policy and corporate resources will then need to be boldly utilized in close collaboration between public and private sectors. Likewise, as the climate change problem cannot be solved by one country alone, it is necessary to gather wisdoms of the world, to aim for “promotion of innovation,” and to advance technological development and its usage.

Furthermore, in order to secure necessary finance for such innovation, and to promote investment for further innovation and measures, it is important to direct the flow of global finance towards companies that work on innovation through “visualization” of their efforts in climate change actions, and to build a system in which financing for decarbonization circulates through “promotion of green finance.”

In addition, in order to achieve a virtuous cycle of environment and growth, it is necessary not only to reform the supply side, but also to create new demand consistent with the trend of decarbonization both inside and outside Japan. Given the circumstances of Japan with scarce fossil fuel resources of its own, energy efficiency improvement and renewable energy can also lead to growth in terms of improved trade balance. Therefore, it is important to review the market, infrastructure and institution in the light of newly created innovation. Furthermore, it is also important to promote “business-led promotion of international application and international cooperation” with a view to offering products and technologies of excellent environmental performance globally.

Through these efforts, a virtuous cycle in which companies challenging for disruptive innovation raise capital from the world and in turn enable further growth and actions. A mechanism whereby the business leads a virtuous cycle of

environment and growth, making climate change more of a chance than a burden, leading global decarbonization and achieving growth, thus driving the transition to decarbonization is required.

To serve for such a mechanism, this strategy comprises of three major pillars of measures: the "promotion of innovation" to realize a business-led virtuous cycle of environment and growth; the "promotion of green finance" to direct financial flow into innovation; and the “business-led international application and international cooperation” as a means for sharing the outcomes of innovation world-wide.

In addition, in order to realize a virtuous cycle of environment and growth, Japan will prepare an environment that promotes and utilizes innovation for decarbonization at all levels, including companies, investors, financial institutions, consumers and local governments and brings about changes in lifestyle.

(2) Swift implementation of actions

Infrastructure such as urban structures and large-scale facilities will, once introduced, have a long-term impact on GHG emissions. Therefore, upon the development infrastructure, we need to take into account the long-term environmental impact.

Also from the viewpoint of business, the timeliness of innovation will be a key for capturing markets that emerge from the global climate change measures advancing in a longer term.

In the light of climate change measures and relevant situations, Japan will henceforth make rapid efforts for decarbonization.

(3) Contribution to the World

Climate change is not an issue of one country; it is a global issue. Consistent with the principles of the Paris Agreement, reduction in GHG emissions is required all over the world. In particular, it is expected that a country like Japan, trusted worldwide for the quality of industrial products and the high standard of science and technology should contribute globally through the implementation of its long-term strategy.

In order to realize a business-led virtuous cycle of environment and growth, as well as to drive global decarbonization, Japan will take the lead in providing a model and will embark on national efforts proactively. In order to contribute to reductions in GHG emissions worldwide, including in emerging and developing countries where economic growth and population explosions are expected,

Japan aims to expand business opportunities for global decarbonization and to become the hub of technology, human resource and investment.

4. Toward a Bright Society with Hope for the Future

A decarbonized society for which this strategy aims should also be a bright society with hope for the future. It is important to create an environment to work voluntarily and actively by sharing the model of such a society with as many stakeholders as possible.

A bright society with hope for the future may differ depending on the generation, position and location. For that reason, it is important for each individual to envisage a model of society of its own, taking into account the following factors and to take actions.

(a) Achievement of SDGs

Japan will aim to maximize the co-benefits with other SDGs in its transition to a decarbonized society.

(b) “Co-creation” as a basis for continued innovation

Sharing the need for long-term social reform, repeated interactions between various types of knowledge are expected to create innovations in a “co-creative” manner.

(c) Working with Society 5.0

Society 5.0, a society that solves social issues and creates value through the digital revolution and the integration of imagination and creativity of various people, is expected to contribute to climate change measures with cross-cutting interactions including in energy, mobility and digitalization.

(d) Circulating and Ecological Economy

For Japan, where the population declines and the society ages with fewer children, it is important to set a growth strategy to strengthen the vitality of local communities. Therefore, Japan will aim at creation of the “Circulating and Ecological Economy”, where each regional community makes the maximum use of regional resources in a sustainable manner to become self-reliant and decentralized, while connecting with a broader network of communities and striving for decabonization and SDGs with integrated improvements on the environment, economy and society in the region. This concept of sustainable regional community will also be presented to the world with a view to providing a role model for the international community.

(e) Leading country in solving problems

Japan aims to become an “leading country in solving problems" by sharing and applying the best practices from communities including cities and rural areas.

Furthermore, the Government will support each stakeholder including companies and local communities in sharing awareness for a decarbonized society, forming a future vision of the society and taking proactive action. At the same time, the Government will facilitate the shift in minds of Japanese citizens at all levels to lead them to take action with capacity building and public awareness campaigns to disseminate and share the knowledge of climate change and specific actions to solve the problem.

Chapter 2

Long-term Vision of Each Sector and Direction of Policies and Measures

Chapter 2. Long-term Vision of Each Sector and Direction of Policies and Measures

Section 1. Policies and Measures for Emissions Reductions

1. Energy

(1) Current status

a. Progress in the reduction of energy-related CO2 emissions

Energy-related CO_2 accounts for approximately 90% of Japan's GHG emissions. Actions of Japanese energy sector is crucial to significantly reduce GHG emissions.

The current level of energy-related CO_2 emission reductions is 1.24 billion tons in FY 2013 and 1.11 billion tons in FY 2017 respectively, a decrease at the pace of approximately 30 million tons per annum.

To reduce energy-related CO_2 emissions, there is a need for low-carbonization in energy supplies -- increase of the non-fossil power ratio in electricity supplies, improvement in the electrification rates, the shift to low carbon fuels in fossil fuel use -- and there is a need in energy efficiency (improved energy consumption efficiency). The state of progress for the particularly important non-fossil power ratios and energy efficiency is as follows:

(a) Non-fossil electricity

The non-fossil power ratio is expected to reach approximately 44% of the energy mix[12] in FY 2030 by promoting the introduction of renewable energy and restarting nuclear power plants that are recognized to have met the world's strictest regulatory standards set by the Nuclear Regulation Authority (NRA). The non-fossil ratio in FY 2013 was approximately 12%, meaning an increase of about 2 percentage points a year is necessary to meet the level set out in this energy mix; in FY 2017, it was approximately 19%, which means the current pace of increase is about 2 percentage points a year.

[12] "Long-term Energy Supply and Demand Outlook" (Ministry of Economy, Trade and Industry, July 2015) provides an outlook for demand and supply in 2030, based on the principle of 3E + S and taking measures such as thorough energy efficiency, maximum introduction of renewable energy, higher efficiency of thermal power generation and the reduction of nuclear energy dependency as much as possible.

(b) Energy efficiency

In the above-mentioned energy mix, the final energy consumption in FY 2030 is forecast to be approx. 330 million kl: a reduction of about 50 million kl expected with rigorous energy efficiency measures. The final energy consumption in FY 2013 was 360 million kl. Therefore, to achieve the level indicated in this energy mix, an annual reduction of approximately 2.8 million kl is required. However, the reduction up to FY 2016 was 8.8 million kl, which means that the current annual reduction is approximately 2.2 million kl.

Thus, although efforts have been steadily made, there is still a long way to go. It is important that relevant policies and measures are further developed and strengthened according to each energy type, thereby securing the achievement of the afore-mentioned energy mix.

b. Circumstances and future of energy in Japan

It is important for Japan, envisaging a decarbonized society for its future, not only to have ambitious visions, but also to take effective measures on the circumstances it faces. Japanese energy sector is faced with a lack of domestic fossil resources such as oil, natural gas and coal, and is not equipped with international pipelines or interconnections. Dependence on the Middle East is extremely high among major economies. Both domestic household and industrial electricity rates have been higher than international standards due to the higher cost resulting from the increase in fossil fuels procurement, following the shutdown of the nuclear power plants due to the accident at Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Plant. There has thus been concerns that Japan's international competitiveness in terms of energy costs will be deteriorated further. Although, due to a decline in the Japanese population, a quantitative growth in energy demand is not expected in the long-run, the quality demanded for electricity must be maintained. Japan is a mature economy with energy infrastructure (transmission lines, gas conduits, gas stations etc.) already in place nationwide. Energy efficiency is also extremely high, especially in the energy intensive industry. This has resulted in highly reliable energy technology, on which our supply chains are based. However, the planned power outages and fuel supply stagnation resulting from the March 2011 Great East Japan Earthquake and the large-scale power outages linked to the September 2018 Hokkaido Eastern Iburi Earthquake were a reminder of vulnerabilities in the existing energy infrastructures, posing risks to livelihoods and our economy.

Given the points outlined above, it is important that measures are taken to address them under the Strategic Energy Plan based on 3E + S[13] as the basic principles on energy policy.[14] Furthermore, it is important that efforts be made to achieve a decarbonized society, which is the ultimate goal.

(2) Future vision

Following is the directions for each energy type towards 2050:

- Renewable energy will become an economically self-sustained and decarbonized main power source;
- Japan is reducing its dependency on nuclear energy as much as possible, while giving the top priority to nuclear safety and making efforts to expand renewable energy;
- Efforts to reduce CO_2 emissions from thermal power generation, in line with the long-term goals set out in the Paris Agreement, will be made towards realizing a decarbonized society;
- A "hydrogen society", in which hydrogen is utilized in everyday life and in industrial activities, will be realized.
- Promotion of energy efficiency, including efficient use of heat, and a distributed energy system that contributes to wider renewable energy usage and resilience of the energy system will be sought.

The long-term, until 2050, is more complex and uncertain. Under such circumstances, it is important that all possible options and innovations are explored, with ambitious and multi-track scenarios in all directions, including renewable energy, storage batteries, hydrogen, nuclear energy and the CCS and CCU. It is imperative that the realization of a decarbonized society as the ultimate goal be thus sought.

(3) Direction of policies and measures for the future vision

a. Renewable energy

The Government will continue to actively promote smooth and large scale

[13] The principle of ensuring stable supply ("Energy Security"), and realizing low cost energy supply by enhancing its efficiency ("Economic Efficiency") on the premise of "Safety," while making maximum efforts to pursue environment suitability ("Environment").

[14] The fifth Strategic Energy Plan is a Cabinet decision on July 3, 2018.

installation of renewable energy — solar energy, wind power, geo-thermal, hydro power[15], biomass etc. — so that it will be sustainable as a stable main power source in the long-term, reducing prices to the level comparable to the international standards and working towards self-reliance from the Feed-in Tariffs (FIT). In specific, the Government will work steadily on efforts to make renewable energy a stable power source in the long-term, including cost reduction, self-reliance from FIT, and regional ecology, to overcome power grid constraints and to secure appropriate flexibility. Moreover, looking toward 2050, the Government will squarely address issues requiring a breakthrough by innovation.

Aiming to reduce the cost, the Government will promote innovative research and development. At the same time, the Government will work towards appropriate operation of FIT, by utilizing auction system to reduce costs and lowering tariffs with the top runner approach to achieve the price target in specific. At the same time, the Government will consider how the system should be to facilitate self-reliance from FIT. Furthermore, the Government will promote renewable energy for self consumption and regional renewable energy supply, which also contribute to regional revitalization and disaster risk reduction.

Furthermore, in order for renewable energy to become a stable main power source in the long-term, the Government will take measures to ensure that used solar panels, which will amass on a large scale in future, are reused, recycled and/or properly disposed and treated. With regards to offshore wind power generation, which requires the occupation of sea area for a prolonged period, the Act of Promoting Utilization of Sea Areas in Development of Power Generation Facilities Using Maritime Renewable Energy Resources (Act No. 89 of 2018) will be appropriately implemented to realize a “long-term, stable and efficient” power generation business, in the light of the importance of introducing a reliable and cost-competitive power source to reduce the national burden. At the same time, comprehensive measures will be taken to deal with power grid constraints, measures for base ports, efforts to speed up related procedures and the provision of information.

The Government will also make early implementation of the “Japanese version of Connect & Manage,” which utilizes the existing power grids to the maximum extent, with a view to overcoming power grid constraints. Moreover, in order to

[15] In the Fifth Strategic Energy Plan, the hydropower is described as “play[ing] a central role of excellent energy source of stable supply except for drought-related problems, it will keep an important role in the energy supply structure” and “[r]egarding ordinary hydropower, in addition to developing large-scale hydropower, which has already been promoted to a substantial extent, GOJ promotes effective use of existing dams through cooperation among relevant parties. For example, it will install power generation facilities at existing dams which do not have such facilities and increase output by replacing existing power generation facilities of existing dams.”

switch to a next-generation transmission and distribution network taking into account the large-scale introduction of renewable energy and the expansion of distributed energy and other environmental changes, the Government will reduce the costs related to power grid upgrading. The Government will also consider how the consigned transmission system should be amongst other issues, in order to develop an environment that secures predictability so that the necessary investments are made. In addition, the Government will also enhance the capacity and the use of interregional interconnections and other transmission lines.

At the same time, in order to secure appropriate flexibility, the Government will take measures including utilization of pumped storage power generation, flexible utilization of thermal power generation, utilization of renewable energy itself as a flexibility source and revitalization of power interchange between areas utilizing interconnections in the meantime. Furthermore, the Government will take initiatives for future decarbonization of flexibility sources, utilizing the next-generation flexibility sources, such as Virtual Power Plant (VPP) that utilizes distributed energy resources installed on customers' side (stationary storage batteries, cogeneration, electric vehicles etc.), Vehicle-to-Grid (V2G) which controls the reverse power flow from electrified vehicles, storage batteries for system stabilization, cogeneration, and, in the long-term, hydrogen and fuel cells. Moreover, towards 2050, the Government will squarely address issues requiring a breakthrough with innovation for renewable energy to be further introduced in the mass, and become an economically self-sustained and decarbonized main power source. Specifically, the Government will collaborate with local communities to immediately begin strengthening the human resources, technologies and industrial foundations that will enable the resolution of fundamental issues such as: drastic enhancement of power generation efficiency to overcome spatial constraint; development of high-performance, low-cost storage batteries and hydrogen systems aimed at decarbonization of flexibility sources; sophistication of power electronics technology and development of digital technology to conduct supply/demand adjustment more precisely; reinforcement of transmission networks taking into account the distribution of renewable energy, and; the development of distributed network systems.

b. Thermal power

To realize a decarbonized society, the Government will work to reduce CO_2 emissions from thermal power generation, in line with the long-term goals set out in the Paris Agreement.

(a) CCS and CCU -- Carbon Recycling

As the efforts to overcome the environmental challenges of fossil fuels are important, there is a necessity to significantly reduce CO_2 emissions associated with their use. It is also important that challenges be made towards technological development to achieve both improvement in energy access and implementation of climate change measures with disruptive innovation in developing countries. Japanese industries and research institutes have global competitiveness not only in the capture technology of CO_2 associated with emissions from the combustion of fossil fuels, but also in elemental technology and material technology to efficiently use them in CO_2 utilization with solar energy and methanation; much expectation is on the initiatives in these areas.

The Government is starting to regard CO_2 as a resource, and in collaboration with the industry, academia and government of other countries, competently facilitate innovations required for realizing Carbon Recycling – the CCS and CCU that reduces CO_2 emissions in the atmosphere by separating and capturing CO_2, and through mineralization, artificial photosynthesis and methanation, reusing it as fuel and material. In addition, through activities such as those of the Carbon Recycling Council and others, the Government will be engaged in dissemination to the society. In more specific terms, the Government will accelerate the efforts of a wide range of stakeholders, aiming to establish its first commercial scale CCU technology by 2023 as a trigger for wider usage in view of full social adoption in 2030 and thereafter.

Moreover, because it is also necessary to achieve the storage of CO_2, study on suitable sites for storage will be conducted. At the same time, public-private cooperation will be sought in this area to achieve optimal CO_2 transportation from the source of capture to the site of utilization/storage, and will be sought early adoption of the CCS and CCU in the society. In particular, introduction of the CCS by 2030 in the coal-fired power generation will be considered, with a view to commercialization.

Furthermore, consideration will be given to the export of the CCS and CCU applied in the society through such initiatives.

(b) Natural gas

Natural gas is characterized by the lowest CO_2 emission factor among fossil fuels, and is one of the main energy source pending realization of a decarbonized society. The Government will steadily promote the shift to natural gas in the industry and other areas by diversifying its forms of usage, such as local level distribution of power sources through cogeneration systems, harmonious with renewable energy, and its utilization as a source of hydrogen source. In addition, the Government will promote advanced usage of natural gas such as combined cycle thermal power generation, taking advantage of renewal opportunities.

Currently, Japan is procuring natural gas at a high price compared to international standards, and it is essential to promote cost reduction by diversifying the supply sources. In driving the shift to gas utilization[16], the Government will make strategic efforts to procure in a stable and competitive manner. More specifically, the Government will particularly proceed with: multi-faceted resource diplomacy, including with the new LNG supplying countries, especially in the light of growing LNG exports from the United States, which has significantly impacted on the supply structure of fossil fuels following the shale revolution, and Russia, with abundant resource potential in the Arctic Circle; forming a highly flexible and transparent international LNG market by, for example, introducing more flexibility into commercial practices such as destination restraints; securing more active participation of Japanese companies in the global LNG business, and; development of domestic resources, especially in natural gas and methane hydrate reserves in the seas surrounding Japan.

Over the longer term, in order to realize decarbonization of gas itself, the possibility of decarbonization with moderate social costs will be sought using existing LNG / city gas infrastructure and consumer-side equipment. This will be made possible with development and usage of technologies such as: Carbon Recycling technology including methanation, which enable utilization and storage of surplus renewable energy; mixed combustion of hydrogen in natural gas-burning thermal power plants; hydrogen technology, and; biogas technology.

In addition, in order to make efficient use of the sea side land, such as those left vacated with the consolidation of the industry, the Government will encourage the investment from the energy industries, such as the LNG and hydrogen industries that are affiliated with the seaside.

(c) Coal

The Government will work to reduce CO_2 emissions from thermal power generation to realize a decarbonized society and consistent with the long-term goals set out in the Paris Agreement. In this regard, the Government will work

[16] Examples of gas utilizationare: high-efficiency LNG thermal power plants; environmentally friendly boilers; energy-efficient industrial furnaces; natural gas cogeneration that achieves substantial energy-saving by using combined heat and power; fuel cells; natural gas air conditioners that lessen the peak load on power grids, and; the transportation sector, including ships. The Government will make particular efforts for its utilization in the fields in which electrification and hydrogenation is difficult, such as industrial high-temperature heat and super-large-scale transportation like ships.

to reduce reliance on coal-fired power generation as much as possible by fadeout[17] inefficient coal-fired thermal power generation.

c. Hydrogen

Hydrogen is a secondary energy that can be produced from a wide variety of energy sources, including renewable energy, and can be stored and transported. It can also be turned into a fully decarbonized source of energy by utilizing the CCS and CCU technology and renewable energy technology in the production stage. On top of that, the combination with fuel cell technology that extracts electricity and heat from hydrogen with high efficiency, enables the ultimate decarbonization in a variety of fields, not only in the electric power and transportation sectors, but also in industrial use and heat utilization. In this context, it is expected that hydrogen can be used as a new decarbonized alternative energy.

In order to move ahead of the rest of the world in realizing a “hydrogen society” -- a society where hydrogen with these characteristics is used in everyday life as well as in industrial activities -- it is essential to bring down the procurement and supply costs of hydrogen, including the environmental value, to levels that compare favorably with those of conventional energy sources. To that end, pursuant to the Basic Hydrogen Strategy[18] (determined by the Ministerial Council on Renewable Energy, Hydrogen and Related Issues in December 2017), the Government will accelerate an expansion of demand for hydrogen in mobility, centering on fuel cell-powered vehicles in the immediate future. The Government aims to build an international hydrogen supply chain on a commercial scale and achieve a hydrogen cost of 30 yen per Nm3 by 2030, by building an international supply chain across the full range of “production, storage, transportation and utilization” of hydrogen for longer term reductions of hydrogen costs and proceeding with technology development for the introduction of hydrogen-based power generation that consumes a massive amount of hydrogen

Furthermore, towards 2050, the Government aims to bring down the cost of hydrogen to 20 yen per Nm3, including the environmental value: the level equivalent to that of existing energy sources in terms of cost competitiveness. To that end, the Government will collaborate with the industry and academia for research and development for innovative technologies that provide low-cost,

[17] For example, measures under Act on Rationalizing Energy Use (Law number: Act No. 49 of 1979), such as regulatory measures, strict operation of environmental assessments and shifting to cleaner gas usage will be taken.

[18] A policy for the entire government in taking measures to realize a hydrogen society, regarding hydrogen as a new option for carbon-free energy.

stable and mass production of hydrogen, and the development of technologies for supply infrastructure. The Government will also look into potential demand of hydrogen as a decarbonized energy source in various areas including transportation, power generation and industries as well as ambitious deregulation under global collaboration.

d. Nuclear energy

It is necessary for the Government to make comprehensive and responsible efforts, based on the Strategic Energy Plan, concerning a variety of issues surrounding activities related to nuclear power including resumption of nuclear power plant operations, measures to deal with spent nuclear fuels, nuclear fuel cycle, final disposal, and decommissioning of nuclear power plants with a view to gaining social trust from the public and to enabling stable operation of nuclear power plants while ensuring nuclear safety as a prerequisite since it is required to address long-term issues, such as the inexpensive and stable electric power supply and global warming.

The Nuclear Regulation Authority (NRA) is entrusted with the professional judgement with authority over the safety of nuclear power plants under the premise that safety is prioritized over all other matters, and all efforts are made to alleviate public concerns. When the NRA confirms the conformity of a nuclear power plant with the strictest level of regulatory standards in the world, the Government respects the judgment and proceeds with the restart of nuclear power plants. The Government will continue to make best efforts to obtain the understanding and cooperation of relevant parties including the municipalities.

Moreover, towards 2050, it is essential first and foremost to recover the public trust through efforts such as the reduction of the risk of accidents through further safety enhancement and the handling of backend issues including decommissioning reactors and processing and disposing of waste. To this end, the Government will immediately begin developing human resources, technology, and industrial infrastructure and be engaged in with the pursuit of reactors with superior safety, economic efficiency, and flexibility, as well as in technology development and international collaboration for the resolution of backend problems.

e. Energy efficiency/ distributed energy system

The Government will support energy efficiency inprovementin the industrial, transport, business, and household sectors, both in terms of regulation and assistance measures.

Additionally, the construction of a distributed energy system, or IoE (Internet of Energy), that combines distributed energy resources, such as renewable energy, storage batteries and cogeneration widely in use, with advanced energy management technologies, such as power electronics technology, is important not only for the promotion of energy efficiency that includes the efficient use of heat and the further use of renewable energy, but also for its contribution to more efficient energy supply structure and enhancement of resilience on energy system. Furthermore, it contributes to regional revitalization and to the formation of the Circulating and Ecological Economy. Also, it is expected that the cost required for high voltage and extra high voltage transmission infrastructures can be reduced by constructing a distributed energy system on the low voltage side. Therefore, the Government will proceed with necessary technical development and preparations for the construction of the efficient and stable distributed energy system in which power, heat and transport systems are integrated.

(a) Energy efficiency

The improvement in the efficiency of energy consumption has been stagnant in recent years, particularly in the industrial and business sectors. In order to further advance energy efficiency, the upgrading and replacement of equipment with high energy efficiency effects need to be enhanced. Given the considerable progress made at the individual company level, the Government will encourage collaboration among companies. In an ongoing effort, the Government will continue to improve its supporting system including assistance for investment in energy efficient equipment and facilities and comprehensive assistance starting from diagnosis on the room for energy efficiency improvement to actual measures and feedbacks, thereby accelerating investment in energy efficiency from the business in line with regulations.

Towards 2050, the Government will promote innovative improvement of energy efficiency efforts in each sector and on the demand side. In the industrial sector, the Government will promote electrification and hydrogenation with technology innovation, and will improve energy efficiency, including thorough utilization of unused heat, especially in difficult areas. Especially in the energy-intensive manufacturing industry, the Government will endeavor to update the targets and benchmarks to reflect such development as the international standards in the Industry Top Runner program (benchmark system), which sets the target of the energy consumption per unit in each industry, and align it effectively with other assistance measures. Furthermore, the Government will promote net Zero Energy House (ZEH) that uses advanced energy management system based on personal consumption of energy, and also seek innovative energy usage to respond to the new business modalities and social

systems characterized by Artificial Intelligence (AT), Internet of Things (IoT), sharing economy and digitalization.

(b) Distributed energy system

With the aim of achieving wider use of distributed energy system, the Government will make best use of the results of demonstration projects such as the supply and demand management systems that enable advanced energy management and standard interfaces. At the same time, the Government will share expertise such as how to coordinate relevant parties for the construction of the energy system. Furthermore, the Government will create an environment that is friendly to new business forms using the VPP —energy resource aggregation business.

Towards 2050, the Government will develop the downsizing and efficiency improvements in renewable energy, technological innovations in storage batteries and fuel cell systems, power electronics technology and wireless power supply technology, electric transport systems and progress in digitalization technology and smart grid technology that make supply-demand control at the local level possible and digital technology that enables regional level control of supply and demand with such initiatives as a foundation. In doing so, the Government will build an efficient, stable and economical distributed energy system that integrates power, heat, gas (including hydrogen) and transport systems in a compact manner.

2. Industries[19]

(1) Current status

GHG emissions from the Japanese industries include energy-originated CO_2 from power generation and heat generation, non-energy-originated CO_2 emitted from industrial processes and product use, methane, nitrous oxide, and fluorinated gases (HFCs, PFCs, SF_6, NF_3).

Energy-related CO_2 accounts for the majority of industry emissions. The final figure for FY 2017 stands at 413 million tons, reduced by 11.2% compared to FY 2013. The industries have taken voluntary efforts based on their Action Plan for the Commitment to a Low Carbon Society and energy consumption at large.

At the same time, among the GHG emitted from industrial processes and product uses, the figure for the four fluorinated gases in FY 2017 amounts to 51 million tons (CO_2 equivalent), an increase of 30.4% compared to FY 2013. This is attributed to an increase in emissions of HFCs resulting from the substitution of refrigerant from ozone-depleting substances.

a. Characteristics of the industrial sector

Because Japanese industrial sector is broad-based and production volumes are large, it has two major characteristics from the perspective of GHG emissions. The first is the existence of a large amount of CO_2 emissions generated by the utilization of high temperature heat and chemical reactions such as reduction reactions. Numerous emission intensive industries, including the metal, chemical and cement industries, require extremely high-temperature heat, from several hundred to over a thousand degrees Celsius. In many cases, fossil fuels provide the source for such energy, and they are not easily replaceable by the likes of CO_2-free electricity. Furthermore, for chemical reactions such as reduction reactions, the generation of the GHG is, unavoidable as a matter of principle if existing industrial processes are followed. The second is the scale of emissions resulting from production volumes. For present-day living standards to be maintained and improved, a certain amount of production is considered necessary for many products. For example, over 100 million tons of steel is produced in Japan, while global production amounts to more than ten times of that. Therefore, attempts to replace steel with other existing products, may not be feasible due to supply-side restrictions. Even if it were possible, the problem of

[19] "Industries" here refers to manufacturing and mining, quarrying, and gravel extraction.

GHG emissions would still arise from the production process of alternative products. Furthermore, since it is possible to trade steel with foreign countries in terms of imports and exports, even if Japan reduced its manufacturing and the accompanying GHG emissions, it could merely increase overseas production and corresponding GHG emissions therein, effectively transferring them to another country. Such a case would not help solving the fundamental problem on a global scale, and the continuation of domestic production with further effective emission reductions could be a more valid option.

b. Voluntary initiatives by the industries

Japanese industries have been taking initiatives since Keidanren (the Japan Business Federation) formulated the “Keidanren Voluntary Action Plan on the Environment” in June 1997, and each industry group has voluntarily set reduction targets prior to the development of national goals and taken measures. By March 2019, 115 sectors formulated the "Low-Carbon Society Action Plan". They have taken measures in their own sector, and not only contributed to domestic emission reductions, but also to reductions in other sectors and overseas with eyes on global warming measures worldwide.

c. Contributing to reductions through the global value chains (GVCs)

For effective climate change measures, it is not only important to focus on the GHG emitted in the manufacturing and supplying phase of products and services, but also consider reduction contribution through global value chains (GVCs), which cover all phases from the initial stage of procurement of resources and materials to distribution, usage by consumers, disposal and recycling.

It is important to contribute to GHG reductions throughout the worldwide supply chains by promoting a “visualization” of the above-mentioned initiatives for emission reductions in GVCs and accelerating the development and usage of products and services with superior environmental performance. The Ministry of Economy, Trade and Industry (METI) considered basic approaches to visualizing the industries’ contributions to GHG reductions on their provision of goods and services, and formulated the “Guidelines for Quantifying GHG emission reductions of goods or services through Global Value Chain” in March 2018.

Currently, the industries quantify their own contribution to reduction based on this Guidelines and send out information to stakeholders such as investors and consumers. Furthermore, the industries have shared the above concept of contribution to reductions with the industries of the world, and through such

sharing and cultivating of this concept, are making efforts to contribute to the reduction in global emissions and further economic growth in Japan.

d. Company initiatives based on long-term perspectives

Keidanren has called on its member companies and organizations to consider their own long-term vision and provide information thereof. By March 2019, over 250 companies and organizations have either formulated or are considering the formulation of their "long-term vision."

Furthermore, with the progress in ESG finance, efforts are ongoing to identify and reduce GHG emissions throughout the entire supply chains and to encourage the active use of renewable energy.

For example, recently there has been an increasing number of companies that set SBTs (Science Based Targets) focusing on reduction targets across the entire supply chains in line with the goals of the Paris Agreement and those participated in RE 100, aiming to achieve business operations with the 100% usage of electricity of renewable energy origin.

(2) Future vision

For the industrial sector to aim for emission reductions in line with the long-term goals of the Paris Agreement, it is necessary to take actions based on the perspectives in (1).

To that end, challenges will be made to overcome the difficult problem that in many industries, there are no existing alternative processes that can be realistically adopted from technological and economic standpoints; new alternative production processes will be established with disruptive innovations that is heretofore unconventional and "decarbonized manufacturing" will be achieved. The following two directions will be considered for this:

Firstly, emissions that have been so far unavoidable will be reduced by utilizing CO_2-free hydrogen on a large scale to substitute for existing chemical reactions, including combustion (heat utilization);

Secondly, on the premise that there will remain some cases where GHG emissions are unavoidable, the introduction of the CCS and CCU technologies for GHG to be separated, captured, and stored or utilized as a resource for production of valuables before their atmospheric diffusion.

In addition, possible options include developing world-leading improvement of technology in energy efficiency, thereby achieving drastic efficiency improvements in energy use by industrial sectors that are emitting CO_2, and the promotion of emission reductions throughout value chains.

(3) Direction of policies and measures for the future vision

a. Utilization of CO_2-free hydrogen

Through the utilization of CO_2-free hydrogen, supplied inexpensively and stably in large quantities, CO_2 emitted in industrial manufacturing processes such as heat utilization and reduction reaction could be reduced.

For example, in Japan, the mainstream method in steel production is via the blast furnace route, not only for economic efficiency but also from the viewpoint of quality and quantity, and this generally holds true throughout the world. With current blast furnace methods, coke is used to reduce iron ore (oxygen to be removed from iron oxide), but in theory, hydrogen can be used as a reducing agent instead of coke. Presently, research and development on the technology to reduce CO_2 emissions by partly replacing coke in blast furnace with hydrogen generated in steel works (COURSE 50: CO_2 Ultimate Reduction System for cool Earth 50) are being conducted, aiming to be commercialized by 2030.

However, reductions in CO_2 emissions consistent with the long-term goals set out in the Paris Agreement are not achievable with this approach alone. Ultimately, challenges will be made to achieve "zero-carbon steel" with super-innovative technology, such as hydrogen reduction steel production that reduces iron ore only with hydrogen without using blast furnaces. Therefore, on the premises of CO_2-free hydrogen supplied at low-cost and stably, technologies will be pursued for further reduction of CO_2, such as the expansion of hydrogen reduction in the blast furnace methods with external hydrogen and ultimately hydrogen reduction steel production that does not use blast furnace methods, with the COURSE 50 technology development led by steel industry as the first step.

b. Feedstock change with CCU, Carbon-Recycling and biomass

By separating and capturing CO_2 emitted from manufacturing activities and recycling it as feedstock, it will be possible to achieve CO_2 emission reduction from industries, and secure a stable supply of natural resources.

Although most primary chemical products are currently derived from fossil resources, it will be possible to reduce dependence on fossil resources and make CO_2 valuable through utilization of carbon contained in various other substances, etc. It is especially important to achieve carbon cycles in industries by utilizing CO_2 such as that emitted in the manufacturing process of chemical products and the biomass absorbing CO_2.

Moreover, it is also important to more efficiently separate and capture CO_2 by taking advantage of the particular characteristics of each industry. In addition to this, achieving effective and efficient CCU technologies that suit the characteristics of each industrial process is conceivable.

Using wastes, such as plastic wastes, as a carbon source, and using biomass not only for primary chemical products but also for cellulose nanofiber and other highly functional materials are also important. In order to do this, it is necessary to achieve not only CO_2 capture technologies but also a society in which carbon sources, such as biomass and waste, can be stably and efficiently provided.

More specifically, the Government will proceed with measures such as the following:

(a) Mineralization

The Government aims to mineralize CO_2 by reaction with magnesium, calcium and the like, and utilize it in future construction materials. Therefore, the Government will examine low-cost and CO_2-free extraction of magnesium and calcium as raw materials, and carry out research and development for efficient CO_2mineralization.

(b) Application onto chemicals and fuels (artificial photosynthesis, etc.)

The Government aims to use CO_2 that is emitted from chemical plants and waste incinerators as a raw material to produce methanol and methane with water and hydrogen, and then use those in chemical raw materials, city gas and so on. Demonstration projects and other initiatives will be considered to this end.

In addition, research, development and demonstration on artificial photosynthesis to manufacture primary chemicals (ethylene, propylene, methanol, etc.) with the hydrogen made with solar energy will be sought, with a target of 2030 for commercialization (i.e. manufacturing some part of primary chemicals by artificial photosynthesis).

(c) Biomass utilization technology

The Government aims to manufacture plastics and biofuels by using biomass resources such as microalgae and plants absorbing CO_2, as well as waste and sewage. To achieve this, the Government will implement, inter alia, projects to demonstrate breeding algae and establish optimal cultivation environment.

In addition, the Government will develop technologies comprehensively to produce various products such as plastics and cellulose nanofiber products from non-edible biomass and aim to achieve energy efficiency at the manufacturing and utilization phase.

(d) Utilization of unused exhaust heat in steelworks

The technology to separate and capture CO_2 generated in the process of steelmaking with unused exhaust heat from steelworks will be developed. In addition, it is aimed that CO_2 will be given a positive value by utilizing the captured CO_2 as a raw material to synthesize organic compounds.

c. Achieving drastic improvement of energy efficiency

It is essential for Japan, which has already achieved high levels of energy efficiency, to develop innovative technologies to achieve significant improvement of energy efficiency that targets manufacturing processes in each sector with high levels of energy consumption in order to achieve drastic improvement of energy efficiency in the industries. The technology that can be applied to numerous manufacturing processes is also important even if its impact on energy consumption in each process is limited. The examples of such technologies are given in Chapter 3 Section 1. The Government aims to further improve its energy efficiency levels by driving the development, implementation and wider usage of these technologies.

More specifically, the Government will proceed with measures such as the following:

(a) Technological development for highly efficient steelmaking processes utilizing innovative reducing agent to substitute coke (ferro-coke)

The technology for highly efficient and low temperature reduction of iron ore in blast furnaces, using as a catalyst the metal iron contained in ferro-coke which is produced by the briquetting and sintering of low grade coal and low grade iron ore will be developed. In this way, ahead of the establishment of hydrogen-driven reduction technology, which faces high technological and economic challenges to overcome, significant improvement of energy efficiency will be achieved in the blast furnace steelmaking processes, currently in wide use.

(b) Technological development of innovative chemical manufacturing processes, etc.

By replacing the batch method which needs separation and purification in each reaction step with the flow method for continuous precise synthesis in the process of manufacturing fine chemicals such as electronic chemicals, dyes, pigments and pharmaceutical intermediates, etc., energy efficiency at manufacturing and use phase will be achieved. To that effect, the Government

will continue to take measures including development of reactants and new catalysts, highly efficient reactors and monitoring technologies, and continuous separation and purification technologies.

The Government will also continue to study innovative manufacturing process technologies, such as membrane and separation by membrane/absorption that will enable significant improvement of energy efficiency in comparison to conventional separation by distillation.

(c) Technological development of innovative cement production processes

For cement production, the Government aims to develop and promote usage of technology to reduce the thermal energy intensity for clinker production. Additionally, by changing the clinker mineral composition used currently and increasing the amount of mixed materials used, the Government aims to develop and promote usage of technology that can reduce the energy intensity in cement production.

d. Complete Transition of fluorocarbons in the longer term

The Government intends to proceed with measures based on international frameworks and domestic laws for the control of fluorocarbons emissions which is an important issue, not only for the protection of the ozone layer, but also for combating climate change. First, based on the international framework of the Montreal Protocol and its domestic legislation, the Act on the Protection of the Ozone Layer through the Control of Specified Substances and Other Measures (Act No. 53 of 1988), the Government will reduce production and consumption of hydrofluorocarbons(HFCs) by 85% compared to the reference value (calculated from the average in period 2011-2013) by 2036. To achieve this, the Government intends to develop a cutting-edge low-GWP and non-fluorocarbon refrigerant which does not deplete the ozone layer and causes a low greenhouse effect, as well as the equipment for its use, thereby leading the world in measures against the fluorocarbons through such technology.

And further still, based on the Act on Rational Use and Proper Management of Fluorocarbons (Act No. 64 of 2001; hereafter "Fluorocarbons Emission Restraining Law"), the Government will continue to curb fluorocarbons emissions in the environment. The Government will also consider significantly reducing leakage of fluorocarbon refrigerants during equipment usage by promoting integrated management of equipment and refrigerant information using the IoT, and establish the world's best emissions control measures by raising the refrigerant recovery rate upon equipment disposal.

Through the measures outlined above, the Government will steadily and incrementally reduce fluorocarbons, including reversing the rapidly increasing tendency of HFC emissions to a decreasing tendency in the short term, and aims to eventually complete transition from fluorocarbons in the longer term. Until the complete transition, the Government will take measures to curb emissions.

Regarding the amount of PFCs, SF6 and NF3 emissions, the industrial Voluntary Action Plan has already achieved extremely high levels of emissions control, and the Government intends to maintain that level.

More specifically, the Government will proceed with measures such as the following:

(a) Development and introduction of low-GWP and non-fluorocarbon refrigerant technology

The Government will steadily promote the development of technology for the introduction of low-GWP and non-fluorocarbon refrigerants, and the equipment that uses them, in order to achieve significant reductions in production and consumption of hydrofluorocarbons (reduction of 85% compared to reference values by 2036). In addition, the Government will accelerate the conversion of products using fluorocarbons to low-GWP and non-fluorocarbon refrigerants with implementation of regulation on designated products based on the Fluorocarbons Emission Restraining Law, aiming to create the world's first low-GWP and non-fluorocarbons refrigerants market.

(b) Leakage prevention of fluorocarbons in refrigeration and air conditioner usage

The Government will consider combined advanced initiatives such as integrated management of equipment / refrigerants information using the IoT and measures against leaks during usage on regular inspection of equipment in order to make large reductions of fluorocarbon refrigerants leakage during equipment use.

(c) Recovery and proper management and adequate processing of fluorocarbons from refrigeration and air conditioners

The Government will establish a system in which related stakeholders, such as equipment users, waste and recycling entities, fluorocarbons recovery entities and dismantling entities mutually cooperate and verify information with each other, so that the recovery of fluorocarbons as the user disposes the equipment will be ensured, and thus the fluorocarbons refrigerants emissions upon equipment disposal will be significantly reduced.

e. Driving decarbonization in corporate management

To achieve “decarbonized manufacturing,” it is important not only for technologies such as those mentioned above to be introduced, but also initiatives for decarbonization to be taken by the industries. The Government will continue to support voluntarily reduction targets and subsequent implementation by each industry. Furthermore, the Government and industries will work together to identify the challenges and measures to quantify contributions to reduction through the value chains, and facilitate the understanding of the international community with awareness campaigns on the concepts and specific cases.as well as to share with the international community this approach to achieve reduction in the entire value chain as well as efforts at quantification, aiming for wider adoption. The Government will also promote the setting of ambitious goals consistent with the long-term goals set out in the Paris Agreement and the formulation of business strategies that incorporate climate-related risks and opportunities, including in their supply chain among the business community, including small and medium-sized enterprises. The Government will thereby increase the number of companies that incorporate decarbonization into corporate management, and facilitate wide acceptance in the society.

3. Transport

(1) Current status

Energy-related CO_2 emissions from Japan's transport sector were 213 million tons in FY 2017, a reduction of 4.9% compared to FY 2013.

The Government has promoted the usage of next-generation vehicles, road traffic flow measures, public transport usage, and efficiency in logistics.

a. Status of the transport sector

Japanese domestic passenger transport volume decreased in 2011 primarily due to the Great East Japan Earthquake, but the falling trend ceased in FY 2012 and remained at that level since. Domestic freight transportation fell until FY 2012, due to the Great East Japan Earthquake that occurred in 2011 and a shortage of truck drivers for automobile freight transportation. From FY 2012 onward, automobile freight transportation levelled off, and freight transportation volume remained at that level. As the population declines with declining birthrate and aging population, public transport networks, especially in rural areas, shrank. A labor shortage in the logistics also affects the amount of activities.

Although the volume of the aforementioned activities contribute to the decrease of CO_2 emissions, motorization, especially in rural areas, is a contributing factor to the increase of emissions.

b. Structural change in the automobiles industry

The automobiles sector has seen a wave of major technological innovation called “CASE”[20] in recent years. These major structural changes can be welcomed as enabling more efficient, safer, and free movement, and opening up new potentials in the relationship between automobiles and society.

c. Dynamic contribution to climate change measures relaying to automobiles

The global sales of automobiles are expected to continue to grow especially in emerging countries, so expectation and demand for improved environmental performance of automobiles are rising on a global scale. The key to dynamic contribution to climate change measures from the automobiles sector is to improve their environmental performance by electric. Batteries, including storage

[20] Connectivity, Autonomous, Shared & Service, and Electric

batteries and fuel cells, which are the key to being electrified, have undergone rapid technological innovation in recent years, and their prices continue to come down. Although further technological innovation is required for electrified vehicles to achieve specifications at an affordable price to match those of internal combustion engines, there are potential breakthroughs. Japan is one of the most advanced electrified vehicle countries in the world (approx. 30% of new car sales[21]). In particular, Japan is at the world's top level when it comes to academia, technology, industry and human resources for batteries and other electrification. Using its strength in diverse electrified-vehicle technology, it is possible for Japan to continue actively leading the world and contribute to the solution of the environmental problem, not only in Japan but globally, by making best use of its experience and technology gained thus far.

d. Trends of GHG reductions in international shipping and international aviation

Measures to reduce GHG emissions in the international shipping are entrusted to the International Maritime Organization (IMO) because they are not suited to the framework of country-specific reduction measures under the Paris Agreement. It was agreed at the IMO in April 2018 to reduce GHG emissions by half (compared to 2008) by 2050 and to ultimately aim for zero GHG emissions as early as possible within this century.

Similarly, measures to reduce GHG emissions in the international aviation are entrusted to the International Civil Aviation Organization (ICAO) because they are not suited to the framework of country-specific reduction measures under the Paris Agreement. Though CO_2 emissions from international civil aviation are expected to increase significantly, ICAO has agreed to improve fuel efficiency by 2% annually and no increase in total emissions from 2020.

(2) Future vision

It is important to evaluate CO_2 emissions from automobiles from the perspective of "Well-to-Wheel," including the process of producing gasoline and electricity. The potential of the electrified vehicles cannot be fully realized without such zero emissions initiatives; the degree of dependence on fossil fuels at the power generation varies heavily depending on the circumstances of each country, though it continues to be high mainly in emerging countries. Zero emissions as promoted by “Well-to-Wheel” base is ultimately the path the world should take,

[21] Hybrid vehicle: 33.2%, Plug-in hybrid vehicle: 0.5%, Electric vehicle: 0.5%, Fuel cell vehicle:0.01% (FY2018)

including Japan. As such, in a long-term goal by 2050, Japanese cars supplied worldwide will achieve the world's highest level of environmental performance; specifically, GHG emissions will be reduced by approximately 80% per vehicle compared to 2010. Furthermore, as the ultimate goal, with innovations in how vehicles are used (autonomous drive, connected, etc.) and in collaboration with the global efforts to achieve zero emissions from energy supply, Japan will contribute to realize Well-to-Wheel Zero Emission. The Government also reduce further GHG with a virtuous cycle of improved traffic flows and enhanced productivity of the traffic industry, including initiatives such as the wide usage of systems that support eco-driving using connected technology, digital technologies and collaboration among business operators.

With regard to coastal shipping, further decarbonizing will be aimed at, in the light of the globally agreed IMO reduction targets of halving the GHG emissions from international shipping by 2050 and zero GHG emissions as early as possible within this century, as Japan is a major shipping and shipbuilding country. Regarding domestic aviation, significant CO_2 reductions will be achieved in the light of the agreed ICAO targets of improving fuel efficiency by 2% each year and not increasing total emissions from 2020, while maintaining and strengthening the aviation network. Further CO_2 reductions for railways will also be achieved.

(3) Direction of policies and measures for the future vision

a. Basic stances on Well-to-Wheel Zero Emissions Challenge

(a) International collaboration on global issues

The Government will clarify the policy for improving corporate average fuel efficiency and a comprehensive CO_2 reductions on Well-to-Wheel base, while encouraging technology-neutral investment in corporate electrified vehicles and investment in fuel combustion efficiency. Additionally, the Government will promote harmonization in institutional environments of respective countries in the world.

The Government will promote the harmonization of infrastructure and institutional environments of respective countries through cooperation and coordination with other governments, to create environments in which the vehicles equipped with the latest environmental technology will be used worldwide, based on the needs of each region.

(b) Establishment of a social system

The Government will realize a social system in which environmental technologies such as electrification and LNG are introduced to the maximum

extent, depending on a variety of applications (short-distance delivery, route buses, long-distance buses, long-distance trucks) of commercial vehicles (buses and trucks). Large-sized vehicles (trucks and buses) are mainly for commercial use, and there are strong demands for "usability in line with previous models" and "securing economic competitiveness." However, given current battery prices and the volumetric energy density of the batteries, it is not possible to keep prices economical by simply replacing the power source of the existing vehicle with batteries, and a model which could be sustainably put to a wide use is hard to envisage at this stage. Through collaboration among the industry, academia and Government, the Government aims to develop electrified vehicle technology and improve the environmental performance of internal combustion engines, both indispensable for further reductions of CO_2 emissions, by encouraging the development and usage of next-generation large vehicles. In addition, the Government will particularly encourage the use of large electrified vehicles, which are currently expensive and limited in choice, starting with the type of usage to meet the requirement of transport operators seeking economical and convenient options.

Focusing on the social value of cars as part of the energy infrastructure, and in order to promote the use of the power storage and power supply functions of the electrified vehicle, the “Council for Electrified Vehicle Society” is established to facilitate collaboration among energy companies, user companies and local authorities together with the automobiles manufacturers. The Council will promote the use of Business Continuity Plan (BCP) for vehicles, Vehicle to Home, and residential and industrial reuse of automobile batteries. While establishing a decarbonized regional transportation model that utilizes CASE, initiatives to build a coupling model with independent and distributed regional energy systems will be sought. Furthermore, technology to store surplus electricity is important in expanding the future use of renewable energy. The potential for hydrogen to enable large-scale and long-term energy storage is significant. Therefore, together with the wider usage of hydrogen-fueled mobility such as fuel cell cars, buses and trucks, the Government will look into the possibilities to make use of excess renewable energy in the transportation sector.

The Government will make efforts for Japanese automobile manufacturers to enjoy stable procurement in the long-term of key mineral resources such as cobalt, which are indispensable in the manufacturing of batteries and which are concentrated in limited areas such as in the Democratic Republic of Congo. More specifically, in view of the needs on the demand side and market conditions in the longer term, the Government will be engaged in resource diplomacy, including finance to upstream development, together with the

private sector to achieve stable procurement of resources necessary for batteries.

(c) Promotion of open innovation

Using open innovation that goes beyond the collaboration among the industry, academia and Government and beyond the confines of a company, the Government will strive to achieve early commercialization and improve the productivity of next-generation electrification-related technologies, which hold a key, such as storage batteries, fuel cells, power semiconductors, motors, inverters, material weight reduction, wireless power supply, and automobile solar charging systems. Furthermore, the Government will also promote maximum efficiency of internal combustion engines, the key to streamlining corporate average fuel efficiency, and the development and early utilization of biofuels and alternative fuels that can be commercialized and have the capacity for significant CO_2 reduction.

The Government will create an open development platform that uses model bases and an advanced development platform that uses the AI, which enable the response to structural changes such as electrified and autonomous driving. The Government will also create an environment in which human resources and suppliers are trained based on collaboration between companies and between the industry and academia.

b. Road and traffic systems

The Government will make efforts, while recognizing the induced and converted traffic arising from road development, to ensure the smart use of roads such as the improvement of ring roads and other arterial road networks, which also help reduce CO_2 emissions, and pinpoint measures to reduce traffic bottlenecks based on scientific data such as the big-data gathered with ETC2.0 and AI camera. The Government will also pursue the possibility of CO_2 emissions reduction through the promotion of area-wide measures including price based measures for adjusting traffic demand by utilizing the ICT and AI at tourist spots.

The Government will work towards traffic system improvements to help reduce CO_2 emissions through the promotion of Intelligent Transport Systems (ITS), such as the centrally controlled signals.

c. Long distance transportation methods

With regards to long-distance transportation methods such as railways, ships and aviation, the Government will facilitate the introduction of energy-efficient

vehicles through weight reduction and high insulation, the operational efficiency using IoT technology and satellites and CO_2 emission reductions at related facilities. The Government will also facilitate the conversion of power sources to those using decarbonization technologies, such as the introduction of hydrogen and e-fuel derived from renewable energy and biofuels.

The Government aims to decarbonize coastal shipping with the use of alternative fuels, fuel cell ships and vessels with innovative energy efficient technologies, as well as the efficient operation, departure and docking of vessels utilizing the IoT. As the regulation for the emissions from ship exhausts has been strengthened by the IMO, the Government will promote the use of LNG fueled vessels of a lower environmental impact by establishing LNG bunkering bases in Japanese ports and conducting technical assessment during actual operation. At the same time, the Government will proceed with the optimal placement of delivery bases that can accommodate large-sized vessels carrying fuels that contribute to decarbonization. Furthermore, to improve the efficiency of transportation of energy and other material, the Government will take measures to increase the size of vessels and diversify suppliers, as well as to facilitate coordinated transportation by using the ICT.

With regards to aviation, the Government will work to reduce CO2 emissions in all the related fields: aircrafts, operations, facilities and fuels; introduction of aircraft with significantly improved energy efficiency using new materials and technologies; advanced air traffic control systems including the use of satellites; promotion of Eco-Airport, and; introducing energy that contributes to decarbonization, such as sustainable aviation fuels.

d. Mobility revolution and compact planning

The maintenance of local daily transportation becomes more challenging as the population declines and ages and the birthrate continues to decline. In order to secure and maintain daily transportation networks against this backdrop, the Government will promote the revitalization of private bus services through restructuring of the bus routes of the operators in the private sector and the effective introduction of community buses and demand responsive public transport. The Government will also promote CO_2 emissions reductions in these new public transportation methods.

Additionally, the Government will promote the use of micro mobility vehicles that enables energy efficient transportation according to various needs of all generations.

The Government will also take measures to improve services and convenience with new mobility services and to achieve seamless public transportation with:

improving public transport such as railways; improving connection between transport modes through public-private partnership for development of transport hubs (modal connectiveness); utilizing existing public transport; computerization; improvements in transfer points, introducing park and ride, and; Mobility as a Service (MaaS).

e. Logistics revolution

The Government will facilitate the modal shift from automobile transportation to coastal shipping or rail transportation to reduce CO_2 emission and measure labor shortage in the logistics. In order to shorten onshore truck transportation distances to ports, the Government will promote the development of international marine container terminals and international logistics terminals, and high standardization that incorporates the ICT and IoT technology. Additionally, the Government will develop AI terminals for practical use, and pursue the reduction of CO_2 emissions by dissolving the queues of trailers waiting outside terminal gates.

The Government will aim to reduce CO_2 emissions in and streamline logistics by utilizing new technologies such as drones, together with platforms for sharing and setting information among operators.

The Government will also take initiatives to reduce CO_2 emissions by encouraging cooperation between shippers and logistics companies carrying out deliveries, to improve efficiencies in transportation and loading. The Government will also work to establish low CO_2 emission transportation and delivery systems, with the collaboration of operators by combining freight and passengers on existing transportation capabilities, such as passenger railways, express buses and route busses as well as the use of the IoT.

The Government will pursue the possibility of reducing CO_2 emissions on highways with the commercialization of truck convoys and using double-trailers. In conjunction with this, the Government will aim to improve the efficiency of truck transportation with operations management support using ETC 2.0, as well as reviewing the special vehicle-priority permission system that enables route changes according to traffic conditions. The Government will also seek efficiency through specific studies on expressway infrastructure that supports new logistics systems. In light of the progress in autonomous driving, the AI, and the IoT related technologies, the Government will strive to optimize shipping services from an environmental perspective, in addition to promoting efforts to reduce CO_2 emissions through vehicle dynamics management in vehicle operation. To accelerate the use of environmentally friendly (eco-drive) vehicles, such as trucks and buses, for business, the Government aims for wider use of support systems

that uses the ICT technology amongst transportation companies. Furthermore, the Government works to reduce the GHG emissions in automobile air conditioning and refrigerated containers such as those for fresh food.

Through the aforementioned initiatives to reduce CO_2 emissions and improve efficiency in the logistics sectors, the Government will simultaneously achieve energy efficiency and a reform in the working habits.

4. Community and living[22]

(1) Current status

Energy-related CO_2 emissions in the residential sector were 186 million tons in FY 2017, a drop of 10.7% compared with FY 2013. Energy-related CO_2 emissions in the commercial and others sectors were 207 million tons in FY 2017, a drop of 12.2% compared with FY 2013. Methane emissions were 30.1 million tons (CO_2 equivalent) in FY 2017, a drop of 6.9% compared with FY 2013. Nitrous oxide emissions were 20.5 million tons (CO_2 equivalent) in FY 2017, a drop of 5.2% compared with FY 2013. The Government has thus far convened nationwide campaigns, encouraged the improvement of energy efficiency of housing and building and accelerated introduction of facilities and devices of high energy efficiency.

Improvement of energy efficiency and renewable energy in a local community can contribute to the development in that local economy. When looking at the local balance of energy costs, approximately 80% of local authorities see funds of 5% or more of gross regional production flowing out of the community and the figure is more than 10% in 379 local authorities[23].

Japan now faces an inevitable decline in the population in the coming decades as the birthrate declines and population ages. In addition to this, the population, especially the youth, continues to move from rural areas to cities, and accelerates a geographical imbalance in the population. The young population and the working-age population are decreasing in regions, including rural areas.

There are also challenges such as urban sprawl, increased vacant houses and abandoned farmland, maintenance and management cost of social capital, growing automobile dependence, and the impact on households from soaring energy prices.

While each community faces numerous challenges, they all have diverse resources. Local resources include the locality's energy, natural resources, urban infrastructure and industrial clusters. Furthermore, there are also numerous other resources, such as the culture, climate, organizations and communities, and biodiversity. The progress of the digital revolution may well contribute to overcoming geographical constraints and moving towards a decentralized society.

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[22] "Community and living" refers to the residential sector, commercial and others sectors, agriculture, forestry and fisheries, the construction industry and the related energy conversion sector and urban planning sector. It also deals with methane and nitrous oxide emissions, from agriculture and waste.

[23] Estimated figures as of 2010, Ministry of the Environment's Regional Economic Circulation Analysis Database 2013

It can also contribute to regional revitalization by forging connections between localities and metropolitan hubs.

For problem solutions and improved sustainability into the future, it is important that the services and technologies required by each locality are provided and widely shared through innovation, which in turn will lead to the development of the entire nation.

Local communities endowed with diverse resources alongside economic and social challenges are actually suited to become a model of a decarbonized society: a bright society with a hope for the future.

(2) Future vision

In the course of bringing about a shift in the social system towards a decarbonized society, a change in the minds based on natural and societal ideals that take inspiration from the historical, cultural, geographical and economic characteristics of Japan, or, in other words, based on the concept of "sustainable coexistence," is important at the individual, residential and regional levels.

Additionally, a growth strategy that enhances community power is important. As the population decline with decreasing birthrate and aging society, it is important that the regional economic cycle is enhanced to lead to the regional revitalization so that those who wish may develop and sustain their communities. It is also necessary to look at the issue from the other end, to take measures to respond to the climate change in line with the will of the people to develop and sustain their communities notwithstanding the constraints of depopulation, thereby achieving the change in the minds. In addition, it is important to uplift socio-economic activities by creating business in the local community. Furthermore, it is important for the cities and rural areas to form a broader network for symbiosis and exchanges, complementing and supporting each other with their resources, by not just in its own community.

Therefore, the Government aims at creating the “Circulating and Ecological Economy,” where each regional community utilizes regional resources in a sustainable manner, and formulates a self-reliant and decentralized society while building broader networks, in order to advance local decarbonization, and achieve the SDGs with integrated improvements on the environment, economy and society, thereby achieving a carbon neutral, resilient and comfortable community and living by 2050.

Especially in rural areas, under local leadership, full advantage will be taken of abundant and diverse resources: renewable energy including biomass, photovoltaic solar panels built above the farmland (Farming-photovoltaics), and hydrogen. Furthermore, by supplying those energy sources to outside the rural

areas will contribute to significant reduction of GHG emissions on a wider scale in Japan.

It is envisaged that capable communities and companies achieve carbon neutrality even before 2050.

Examples of initiatives to achieve local decarbonization and SDGs include the following:

- Housing with high insulation performance to reduce CO_2 emissions and contribute to comfortability and good health;
- Increase in walking and cycling to curb CO_2 generated from transportation, and contribute to good health and less congestion;
- Introducing telework and flextime systems utilizing the ICT, to reduce CO_2 emissions from commuting transportation, also providing an environment for a better balance of work and childcare / nursing care, and improve productivity;
- The construction of distributed energy systems using renewable energy to contribute to securing a decent amount of power for that region in case of disruption in the power sources. Regional initiatives to this end to also contribute to upholding and strengthening the local community;
- New jobs to be created by projects related to renewable energy, together with such projects as improvement of energy efficiency and elderly care to contribute to the upholding and developing of the local vitality;
- Including “Farming-photovoltaics”, installing photovoltaic equipment above farmlands, such as those abandoned, in a manner that allows farming to go along, renewable energy to be expanded and businesses to be profitable and contribution to be made the sustainability of the local community;
- Agricultural regeneration, cultivating symbiotic fuel crops on abandoned farm land, to contribute to the preservation of the ecosystem unique to each region, and;
- Establishment of a hydrogen supply chain incorporating regional renewable energy and unused resources to contribute not only to climate change measures, but also to the regional energy self-sufficiency rate and the creation of new regional industries.

(3) Directions policies and measures for the future vision

a. The shift to carbon-neutral living

(a) Initiatives for housing and buildings

Initiatives for housing and buildings are necessary in order to shift to carbon neutral living.

The facilities and equipment that accelerate energy efficiency, together with existing technologies, commercialized new materials (high efficiency semiconductors, etc.), design and control technology will be used as widely as possible. New energy efficient products with the AI, IoT, big data technology and coordination between devices will also be promoted for wider usage. As the average lifespan of home appliances is approximately 10 years, the market for these goods need to be formed by 2040 at the latest, for use by 2050. In the meantime, to limit the increases in energy consumption by using the ICT, the communications systems which contribute to the decarbonization will be promoted.

It is important to promote the integrated use of demand and supply in photovoltaics in housing and buildings. The Government aims to make the use of photovoltaics a common features in houses and buildings. As the operating time of solar power generation is limited, the Government aims to achieve the sector coupling of electricity, heat, and mobility in general, using electrified vehicles, heat pump-type water heaters fuel cells and cogeneration, and according to local characteristics, as well as the Home and Building Energy Management Systems (HEMS, BEMS) and the ICT for the supply and demand adjustment of photovoltaics power generation. In addition, electrified vehicle charging stations will be set up considering the synchronism between the operating time of the photovoltaics power generation and the parking time. With such measures in housing and buildings, a balance between supply and demand across the entire power system will be sought.

The Government also facilitates the use of underground and biomass heat, not easily affected by outside temperatures, to houses and buildings according to local characteristics with proposed utilization models as well as improvement of heat energy efficiency such as heat pump. In addition to the decarbonization of power supply, electrification and hydrogenation are effective in improving energy use efficiency in living.

The Government has already decided that approximately net zero or less average energy consumption for new houses and buildings (ZEH / ZEB) will be sought by FY 2030. Furthermore, for new housing, the Government will avail the housing that contribute to a negative net emission in its entire life-cycle, from material production and construction, to dismantling and reuse for wider usage. For existing houses and buildings, the Government will facilitate renovations and efforts of the residence to contribute to energy efficiency improvement based on local characteristics. The Government will further facilitate innovative technological development and wider usage of building materials and equipment necessary to bring the stock average of energy consumption in houses and offices to approximately net zero or less (ZEH and

ZEB equivalent) as early as possible in the second half of this century. To achieve these measures, the Government will facilitate the enhancement and diffusion of evaluation and labeling systems related to comprehensive environmental performance, including energy for rented houses and buildings; this will be pursued in full view of the underlying problem that the investor / owner of the energy efficient equipments is not the beneficiary / tenant. Additionally, by supporting the training on energy-saving construction techniques for carpenters in small and medium-sized construction company, the Government facilitates the development and strengthening of the energy efficient housing construction system for small and medium-sized local constructors.

(b) Lifestyle shift

The behaviors and choices of each individual are also important in making a shift to carbon-neutral living. By changing daily living, local residents can be involved in a social change, creating a great force for change. In making living as a consumer and/or a producer, it is important to be involved in decarbonizing the society through the choice of products and services as well as the lifestyle.

There is a rapid increase in “servicizing,” such as leasing and renting of products and the ESCO (Energy Service Company), focusing on the function of a product and providing that function of the product as a service, rather than selling the ownership of the product, making use of the IoT and AI. The sharing economy (e.g. car sharing, cycle sharing, private lodging services and shared houses), which is one form of such a service is also rapidly increasing. The Government will pursue the possibilities of lifestyle shifts through “servicizing,” especially by “visualizing” the emission reduction effects and taking decarbonization initiative based on the findings therein.

For a consumer, preference for local production for local consumption can lead to reducing CO_2 emissions from logistics and to the opportunities for local industries. Bearing this point and the circumstances in each locality in mind, the Government will pursue the possibility of decarbonization through local production for local consumption, in view of the entire life-cycle of products, starting with the securing of resources, and including production, distribution, using, reusing, recycling and disposal.

For a producer, the introduction of the telework and flextime system by making use of the ICT can reduce CO_2 emissions from commuting traffic. Additionally, shared office space, together with reduced use of air conditioners and space, can further contribute to improvement of energy efficiency in the office. While reducing CO_2 emissions, the environment and productivity will be improved to make it easier for people to balance work with childcare / nursing

care. The Government will support a reform in the working habits by "visualizing," demonstrating the effects of reducing CO_2 emissions. Expanding the use of remote access services such as virtual reality may also contribute to reducing CO_2 emissions from commuting and business trips. The Government will pursue the possibilities of decarbonizing through such approaches.

Through initiatives such as commuting traffic management by the operators and public awareness activities, the shift to public transportation of low CO_2 emissions, such as railways and buses, and further use of bicycles will be promoted, instead of privately owned passenger vehicles. Additionally, the Government aims to reduce CO_2 emissions in logistics and distribution by reducing redelivery with cooperation among shippers and logistics and deliver companies, diversification and improved convenience in delivery methods for courier services, and improving the environment for active participation of consumers.

The Government will also shed light on corporate activities as a consumer, such as the use of renewable energy, and promote the introduction of renewable energy and energy efficiency initiatives.

For these lifestyle shifts, The Government will carry out a nationwide campaign to encourage "COOL CHOICE", such as the use of goods and services that contribute to decarbonization, while putting together the scientific knowledge (citizen science) through public involvement. The Government will also promote the use of environmental information for decarbonization by companies and individuals, such as the diffusion of methods for understanding GHG emissions throughout the entire supply chain, which includes local small and medium-sized enterprises, for the environment-conscious products and business activities to be highly valued by society and the market. Furthermore, through behavioral science knowledge including nudge and its integration with advanced technologies such as the AI and IoT, the Government will encourage decarbonizing behavior that can be practiced voluntarily and in an enjoyable way.

b. Shaping carbon-neutral communities

(a) Cross-sectoral initiatives to create local self-sustaining and decentralized societies

It is important that farming, forestry and fishing communities as well as cities become a carbon-neutral region, by complementing and supporting each other; each community is encouraged to make use of its characteristics, create a self-sustaining and decentralized society, while becoming part of a broader network. Additionally, it is important that a community in which power generation

becomes a local industry with renewable energy is developed, and the construction of distributed grids is formed to support new forms of demands such as smart mobility.

The distributed energy system will not only contribute to energy efficiency improvement and wider use of renewable energy, but also to local revitalization and to the formation of the Circulating and Ecological Economy. On the other hand, as this is also a part of Japanese entire energy system, the Government will promote the following initiatives while considering the cost and stability of the system as a whole.

For the introduction of renewable energy symbiotic to the locality and its ecosystem, the Government will prepare a ground for community-based initiative including the local authority, enterprise, and residents and consensus building with local communities. Through these initiatives, the Government will promote the use of abandoned farmland, on which further farming is challenging, for large-scale photovoltaics to reflect local symbiosis. The Government will work to achieve shorter timeframe and smoother introduction of wind power generation. The Government will take initiatives to reduce costs for geothermal power generation, small and medium-sized hydroelectric power generation, biomass and renewable heat from the Sun, the underground, snow, hot spring, sea, river and sewage, and encourage their use, including consideration on their various values. The Government will also facilitate the creation of a business environment in which future reinvestments can be made.

Moreover, in order to enable the use of self-sustained power sources, such as local renewable energy, even in the event of disasters, the Government will work on building models for regional energy supply grids that use digital technology, storage batteries, fuel cells, cogeneration, etc.

When introducing renewable energy into local regions, securing the flexibility is challenging. To this end, the local community is encouraged to come together to make the demands of local residents function as flexibility sources. In this regard, the Government aims to smoothly expand the energy resource aggregation business, in which the “aggregator,” the information management and operation entity using the demand response (DR) and virtual power plant (VPP), facilitates the customers in controling and creating their demands of energy at the request of the retail electric power companies and power transmission and distribution companies, who will pay fees for the adjusted demands. The Government will also look into the potential flexibility of heat storage type air-conditioning equipment, heat pump water heaters in facilities with large demand for hot water supply, cogeneration, refrigerated storage, water supply and sewage systems and back-up generators in large buildings. In addition, the Government will encourage smooth renewable energy

installation by matching the supply and demand of renewable energy by tracking the power and environmental value with block chain technology.

Recently, there are cases in which a facility with high demand for power consumption, such as a data center, relocates to the area with a large supply of renewable energy. The Government will also look into such possibilities of geographical shifts on the demand side.

In order to move such initiatives forward, the Government and local authorities will cooperate towards establishing an exemplary energy system that serves for wider use of the distributed energy systems. The Government will improve the information and communications infrastructure and institution for "prosumers"—those who do not only consume but also produce energy such as personal photovoltaics and local production of energy for local consumption by a local energy supplier. The Government will also encourage the formation of business entities that promote regional self-sustaining diffusion of decarbonization, thereby accelerating the development of the Circulating and Ecological Economy. Furthermore, the Government will utilize emissions information platforms and make efforts for “visualization” to facilitate the smooth implementation of community and enterprise initiatives.

In addition, the Government will support local activities that aim to create and spread innovations for a decarbonized society by engaging in dialogues with various relevant parties, including a consultative meeting. Local authorities, taking their own initiatives and setting examples for the local entities and population, will play a central role in establishing the Circulating and Ecological Economy by cooperating and working together with various stakeholders in and out of the locality.

(b) Carbon-neutral development in urban areas

As the population declines, birthrate decreases and the society ages, and the infrastructure ages in urban areas, it is increasingly important to review urban development, including infrastructures such as transportation, in order to cope with these challenges. It is important that these issues are dealt with a view to decarbonization.

In terms of the urban energy system, a significant reduction in CO_2 emissions can be expected by achieving efficient use of energy through flexible exchange of energy such as electricity and heat amongst numerous facilities and buildings. Therefore, the Government will take such opportunities as urban development and facilitate the area-wide use of energy. If a heat source and heat demand are appropriately concentrated in a city of a compact size, the availability of unused renewable heat will be increased. The Government will promote the use of such heat, in accordance with the economies and the

characteristics of each district. The Government will also promote initiatives that utilize energy management technologies such as the demand response (DR). Additionally, The Government will facilitate measures to reduce urban CO_2 emissions with the improvement of the environment by taking measures against the heat island.

Together with the initiatives to make urban areas more compact and to promote the use of public transport, the development for attractive space and environment to enable safe and comfortable walking and cycling will increase the proportion of walking and cycling, and thus reduce travel associated CO_2 emissions. The Government will take the initiatives for further use of bicycles, together with safety measures based on the Act on Promotion of Use of Bicycles (Act No.113 of 2016), thereby reducing CO_2 emissions; the initiatives include the development of bicycle lanes, promoting combined use of bicycle trains, cycle sharing, the development of bicycle parks according to local needs, and the increase in bicycle commuting.

In existing infrastructure such as public facilities, including water supply and sewage systems and waste treatment facilities, transportation infrastructure and energy infrastructure, the Government will promote energy efficiency and make them a regional energy center, together with wide-area integration, improved durability and better development of disaster reduction functions, thus contributing to reducing CO_2 emissions. Construction machinery is one of the challenging areas to achieve zero emissions. The Government facilitates the introduction of facilities and equipment with high energy saving performance in the construction sector. In addition, the Government will aim to increase construction efficiency by encouraging active introduction of facilities and equipment that utilizes the ICT, and improving productivity relative to energy consumption.

Alignment with the land use policy, urban policy, and the regional development policy are indispensable in achieving flexible exchange of electricity and heat amongst numerous facilities and buildings, more compact urban areas and the use of local biomass in sewage treatment plants. The Government will align these related policies and climate change measures.

(c) Developing carbon-neutral rural areas

Rural areas play an important role in supplying resources to sustain Japanese society and economy, including food and healthy natural environment. With this in mind, it is important for these regions to be revitalized and overcome challenges associated with declining populations and birthrate and aging, so that they can contribute to the decarbonization of the society through local production for local consumption of renewable energy and

biomass resources, such as the utilization of locally distributed wood for housing, as well as supplying such resources outside these villages.

The Government will promote the introduction of local energy companies and the development of the energy system suited to local production for local consumption, in order to make the best use of the abundant renewable energy sources rural areas offer, which in turn will lead to the vitality and sustainable development of the areas. This will include the introduction of the Village Energy Management System (VEMS). In terms of “Farming-photovoltaics,” the Government will take initiatives while working towards making good use of farmlands by appropriately continuing farming on the one hand, and activating community by supporting the reusing of the abandoned farmlands as well as settlement and farming in disadvantageous area on the other.

In the agriculture, forestry and fisheries industries, the Government aims to reduce GHG emissions by achieving “smart agriculture, forestry and fishing” that leads to better efficiency with the ICT. The Government will also promote the introduction of energy efficient facilities, converting fuels to woody biomass and using underground heat in horticultural heating facilities, the using of livestock manure for energy, using electrified agricultural and forestry machines and fishing boats, including those with hydrogen fuel cells. Through these initiatives, the Government aims to achieve zero CO_2 emissions in agriculture, forestry and fishing.

In agriculture, the Government will reduce methane emissions through the improvement of rice varieties and their use, as well as improving materials and production technologies and using them. The Government will reduce nitrous oxide emissions by controling the amount of applied fertilizers including with a combination of drone and sensing technology and the AI, and the improvement of materials. In addition, the Government will utilize the ICT and AI to monitor GHG emissions, and facilitate the introduction of a production system that reduces emissions. In the livestock industry, the Government will limit methane emissions with the improvement of feed and its use and the control of livestock numbers to go along with productivity improvement measures with the improved breed. Moreover, with the improvement of feed and its use, emissions of nitrous oxide from livestock manure will also be reduced. The Government will also reduce methane and nitrous oxide emissions through the composting of livestock manure, and the improvement of purification treatment facilities.

The use of sustainable biomass resources can play an important role in decarbonization, especially in the areas where decarbonization through the use of CO_2-free electricity is challenging. The Government will pursue the establishment of a biomass resource supply chain.

In carrying out these measures, the Government will promote decarbonization in the entire supply chain through production, processing, distribution, consumption and disposal (recycling) of agricultural, forestry and fishery products and food, as well as the visualization of measures related to the reduction of GHG emissions, such as certification and labeling. Moreover, the Government will promote organic agriculture to improve the natural cyclical function of agriculture and reduce the load on the environment, while raising the awareness of the consumers on organic agricultural products.

c. Material circulation in regions

In order to achieve significant reduction of GHG emissions in local regions, promoting energy efficiencyand renewable energy alone will not be sufficient, and require alignment with material circulation. For a sound material-cycle society, it becomes more important to achieve an optimal scale of recycling according to each region and type of resources. Ultimately, material flow needs to meet three preconditions: firstly, wood and other such renewable resources should be used at a pace that does not exceed that of the renewal of the nature; secondly, metal, fossil and other such non-renewable resources should be used at a pace that does exceed the pace of development of sustainable renewable resources to replace them to avoid depletion, and; thirdly, substances that may affect the natural circulation and the delicate balance of ecosystem in the nature should be emitted into the natural world at a pace that does not exceed the pace at which the nature renders them harmless[24]. Through past economic and industrial activities, the humanity has spent huge amounts of energy to produce metal, plastic and other products; these can be regarded as existing resources. As such, recycling in all fields will not only resolve the constraints of the limited resources, but also contribute to the reduction of GHG emissions. The establishment of a circular economy has become an important policy issue in the Western societies, and it is important for Japan to achieve a sound material-cycle in both the technical and institutional terms. While building a sound material-cycle society, the Government will promote decarbonization with resource recycling measures.

By optimizing production volumes and timing with the analysis of the weather and consumption using the AI, and by optimizing the inspection, repair, replacement and reusing of products using the IoT, goods and services can be provided to the person in need precisely when and as required, reducing the energy demand. The Government will pursue such possibilities, and make efforts

[24] The 4th Fundamental Plan for Establishing a Sound Material-Cycle Society (Cabinet decision, June 2018)

for the best use of the “urban mine[25]” and minimum extraction of natural resources, contributing to decarbonization with such efforts.

The reduction of food loss and waste throughout the supply chain, can contribute to the reduction of GHG emissions in terms of less food distribution and manufacturing, as well as from less transportation and processing for disposal. The Government will facilitate decarbonization with such efforts. Additionally, the Government will promote the use of food waste as feed to facilitate food recycling.

The Government will advance resource circulation of plastics by reducing, reusing, thorough recovery, recycling, energy recovery, proper treatment and the promotion of the use of recycled materials and renewable resources — paper, biomass-based plastics, cellulose materials , etc.

While promoting initiatives related to the 3Rs (reduce, reuse, recycle), for waste which still remains, the Government will make every effort to promote efficient recovery of its energy, such as the heat recovery by waste power generation and the recovery of methane from raw waste. Additionally, waste treatment facilities will also aim to serve as a self-sustained distributed regional energy center, including in the event of disasters. Furthermore, the Government will facilitate the introduction of the AI and IoT to reduce GHG emissions across the entire waste treatment system, from collection and transportation to final disposal.

To promote the recycling of resources in a wider area to recycle the waste which cannot be treated locally, the Government will designate “recycling ports”, which will be a base for reverse logistics and recycling, and provide a comprehensive support for such facilities such as: maintenance of port facilities; improvement in the operations for handling recyclable resources, and; public-private partnerships. The Government will also work towards the establishment of a reverse logistics network within and out of Japan, centered around such recycling ports.

The Government will promote to introduce energy efficient and renewable energy technologies nationwide in sewerage facilities. In particular, small and medium-sized sewage treatment plants will accept locally generated biomass, enabling efficient energy recovery throughout the locality. With these efforts, the Government aims to halve the power consumption in sewage treatment plants within approximately 20 years. Advanced wastewater treatment is effective not only for improved local water quality and the recycling of water resources, but also for the reduction of nitrous oxide emissions. The Government will promote advanced treatment of local water according to the local environment. However,

[25] Metaphor to refer to the mass of the waste products that contain useful metals as a mine.

advanced water treatment increases energy consumption; therefore, energy efficiency measures are promoted together.

d. Decarbonization starting with capable communities and businesses

As an island nation, Japan has accumulated technologies for the self-sufficient energy system on remote islands. In addition, Japan is developing smart cities that adopt the energy management system made possible by the digital revolution. Furthermore, in rural areas, energy innovation that makes the best use of abundant resources is achievable.

In the business community, numerous companies have announced their aim to use 100% renewable energy in their electricity consumption by 2050. In conjunction with this, companies have increasingly set out individual long-term vision, some of which envisage carbon neutrality by 2050.

Bearing in mind the contribution to the 1.5 °C target, the Government will support ambitious communities and companies to work towards carbon neutrality and achieve it even before 2050 where possible. The Government will eagerly disseminate such efforts and aim to broaden the participation. As corporate activities greatly contribute to local decarbonization, the Government will facilitate ambitious goal setting, reduction initiatives and awareness campaign by companies, including small and medium-sized local companies. These measures will also help Japanese companies competing globally amidst the strong current of decarbonization.

e. Reconstructing and building a decarbonized society in Fukushima

The accident at the Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Station in March 2011 caused considerable injury to the people of Fukushima Prefecture and many others. It is important that Fukushima, which sustained heavy damage of the nuclear disaster, takes a lead in showing the shape of a future energy society and lead global decarbonization. The Government will thus strongly steer Fukushima's recovery and revitalization. Fukushima Prefecture promotes the expansion of renewable energy, the accumulation of related industries and research and development in order to make Fukushima a "pioneer of the renewable energy," which will be a major driving force for its reconstruction. Fukushima Prefecture also set the target to generate renewable energy for more than 100% of primary energy demands in Fukushima Prefecture by around 2040. To accelerate such efforts and give support the recovery of Fukushima from the energy sector, the Government, Prefecture and related companies work together to move forward with the

initiatives, including the Fukushima Renewable Energy Institute, AIST (FREA) established in 2014. The Government will also provide human resource development for local companies related to renewable energy. With the aim of creating the world's innovation hub for renewable energy in Fukushima the Government will disseminate creative renewable energy technologies and new social model across Japan and abroad, and accelerate further initiatives and accumulation of industry clusters in Fukushima.

Section 2. Measures for Carbon Sinks

(1) Current status

The amount of carbon removal through land use, land-use change, and forestry activities in FY 2017 under article 3.3 and 3.4 of the Kyoto Protocol was 47.6 million tons[26] for forest sink measures, and 8.1 million tons[27] for cropland management, grazing land management, urban revegetation, etc.

It is important to promote relevant policies for sustainable land management, considering the issues such as: declining population and birthrate and aging population; emerging impacts from climate change; energy challenges; intensifying global competition; aging infrastructure, and; the increase of land that is difficult to maintain properly.

In particular, forests, which account for approximately 70% of Japanese land, supply timber among other forest products, provide public benefits such as land conservation, and play an important role as carbon sinks.

Moreover, cropland and grassland soils are internationally recognized as carbon sinks that contribute to the securing of the removal of GHGs, along with forests.

(2) Future vision

The Future vision is to establish a decarbonized society, which secures sufficient carbon sinks in place to achieve the balance between the GHG emissions by anthropogenic sources and removals by sinks. Therefore, the Government will promote conservation of the natural environment and activities in sustainable agriculture, forestry and fisheries industries that create new values.

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[26] The amount of forest removal is estimated based on the Rules for the second commitment period of the Kyoto Protocol, by combining emissions and removals from afforestation, reforestation, deforestation and forest management in FY 2017 (values adjusted for baseline emissions derived from changes in carbon accumulation in harvested wood products)

[27] The difference between the amount of emissions and removals in FY 2017 (emission of 3 million tons) and the amount in FY 1990 (emission of 11 million tons)

(3) Direction of policies and measures for the future vision

a. Forests and urban revegetation

The Government will facilitate appropriate forest management, such as thinning and reforestation among other forestry activities, to enhance the sinks of the forests. In doing so, the Government will promote the wider and enhanced use of improved varieties for expedited growth and fast-growing trees.

The Government will also promote urban revegetation, the most familiar form of sink measures for the daily life of the public, and not only benefit from the carbon removal, but also raise the awareness on the effects of these carbon sink measures.

b. Cropland

The Government will promote carbon storage in cropland soil with the application of organic matter such as compost and green manure on the soil. The Government will assess the impact on growth of crops of using charcoal (biochar) as a soil improvement material.

c. The natural environment

The Government will enhance the functions of healthy ecosystems to remove CO_2 by carrying out the conservation and restoration of forests, grasslands, wetlands and such as peat swamps as well as ecosystems such as those in soil and coasts, which fixate much carbon. In addition, The Government will promote appropriate wildlife control, such as prevention of damage and population management, in order to reduce the damage by wildlife causing significant impact on ecosystems such as forests. This management will continue to contribute to emissions removal by a healthy ecosystems. The Government further accelerates the reduction of stress on ecosystems other than climate change — land use change, environmental pollution, overuse, invasion of alien species, etc.— together with the maintenance of ecological network that is the way used by wildlife for their move and disperse, in order to enhance the adaptability of ecosystems on climate change.

Regarding "blue carbon", the carbon fixated in coastal areas and marine ecosystems, the Government will explore the possibilities of blue carbon as a CO_2 carbon sink, such as conservation and restoration of algae beds using useful aquatic plants found nationwide. In addition to this, the Government will facilitate the creation of new industries from marine resources with new materials

development and innovation, such as functional foods and biomass-based plastics that use aquatic organisms as raw materials.

d. Carbon storage and substitution of fossil fuels using biomass products including wood

While working on the development of necessary technologies and their diffusion to promote wood use in low-rise non-residential and middle-rise buildings, the Government will realize innovation to further expand wood use in high-rise buildings in urban area as well. In addition, the Government will promote the expansion of the application of materials derived from woody biomass, including in automobile parts.

Chapter 3

Cross-sectoral Measures to be Focused

Chapter 3: Cross-sectoral Measures to be Focused

Section 1: Promotion of Innovation

In order to tackle the global challenge of climate change and to achieve a decarbonized society, which is the ultimate vision of the future, the creation of disruptive innovation beyond a mere extension of conventional efforts is important.

In order to realize a decarbonized society, it is important to overcome the simplistic view of “innovation is technological,” and to promote “innovation for the practical application and wide use” for the technology to be adopted in the society, putting together the cutting-edge technology with the use of the existing technology of much excellence. From this viewpoint, performance and efficiency are important, but as the performance cannot be shown unless chosen by the user, innovation that derives from actual needs and the vision of the future society is also important.

Today, we are seeing the waves of global change and innovation as a result of cross-sectoral interactions including those between energy, mobility, and digitalization. This also means the promotion of wide-ranging innovation towards the realization of “Society 5.0,” while ensuring the security of the ICT, can lead to technological innovation necessary for significant reductions in GHG emissions. In the midst of the evolution in the AI, IoT and block chain technologies, the public and private sectors need to come together to make best efforts for cross-sectoral innovation. In a society with rapid changes in digitalization, data usage, decentralization and globalization, communities and open venues where diverse ideas can actively interact with each other have become more important for innovation.

I. Technological Innovation

1. Current Status

(1) Trends in Japan

In order to achieve the long-term goals set out in the Paris Agreement, the Prime Minister’s instruction was issued at the Global Warming Prevention Headquarters (November 26, 2015) and COP21 (November 30, 2015), for the Government to formulate a National Energy and Environment Strategy for Technological Innovation towards 2050. The National Energy and Environment Strategy for Technological Innovation towards 2050 was subsequently

formulated and decided by the Council for Science, Technology and Innovation under the Cabinet Office on 19th April 2016. This Strategy, assuming that the entire energy system will be optimized and looking ahead to 2050, approached the issue from the viewpoints of: technologies that are innovative and not the extension of the existing efforts but discontinuous and impactful; technologies with the potential for widespread adoption and significant emission reductions; technologies that require medium-to-long-term investment and combined forces among the industry, academia and government, and; technologies in which Japan can take the lead or provide excellence. The Strategy further identified the following fields as promising: energy systems integration technologies; core technologies for systems (next-generation power electronics, innovative sensors and multipurpose superconductivity); innovative production process; ultralight and super heat-resistant structural material; next-generation storage battery; the production, storage and use of energy carriers such as hydrogen; next-generation photovoltaics; next-generation geothermal power generation, and; the capture and effective usage of CO_2. Out of 30 billion tons of CO_2 reductions that are necessary to meet the 2 °C target, several billion tons to 10 billion tons or more of reductions are expected through this strategy (N.B. Based on the figures estimated by the International Energy Agency (IEA). The application of innovative technologies is added to the application of technologies whose development and demonstration have already been advanced in the selected technological areas). In September 2017, a roadmap for the National Energy and Environment Strategy for Technological Innovation towards 2050 was formulated, requiring relevant ministries and agencies united in their cooperation.

The Integrated Innovation Strategy approved by the Cabinet on 15th June 2018 presents future directions towards the achievement of the 2°C target of the Paris Agreement: building a new framework for a world-leading energy management system; international application of energy creation and storage technologies; leading the world in realizing a hydrogen-based society, and; research and development assessment for achieving the target.

The Fifth Strategic Energy Plan approved by the Cabinet on July 3rd 2018 mentions the year 2050 in an unprecedented manner, and, based on the global momentum for decarbonization as shown in the entry into force of the Paris Agreement, rises to the challenges of energy transformation and decarbonization and presents the stance to pursue all possible options.

The Government has since 1974 formulated several strategies and plans for technologies in the fields of energy and environment such as those mentioned above and including the Sunshine Project, the Moonlight Project, and the New Sunshine Project and invested significant amounts of budgets for research and development in these fields. There are successful cases of long-term investment

on research and development coming into fruition; for example, in photovoltaics, Japanese companies provided much of the global production of solar cells for a certain period of time, making significant contribution to the world's effort in tackling global warming. At the same time, in order for a certain technology to be adopted in the society, scientific values such as high-efficiency is not sufficient; low cost is the essential condition. There still remains a significant gap between the cost of decarbonizing technology and the cost afforded by the market. In the light of this reality, a mechanism to further reduce costs, taking into consideration the environmental values, and facilitates introduction of technologies to be applied into the society on a large scale needs to be established.

In the field of technology development, disruptive innovative technologies of an unconventional nature that offer a sweeping solution to the challenges, including the cost, on the one hand, and technologies to be developed in a shorter time framework, albeit less groundbreaking and owing much to the existing research and development, going on for some time, to aim for adoption in the society with high confidence on the other hand will be both required. In seeking these technologies, it will not serve the purpose unless the selection of technology and subsequent provision of resources for its development are made based on the disclosure of relevant pre-conditions and an objective life-cycle assessments (LCA), including the introduction to the market, of the GHG reduction effect. Currently, LCAs are often not carried out on GHG emissions, and even when they are, they are often conducted separately from cost analyses, making comparative analyses difficult. Furthermore, innovation in terms of scientific values is not enough; constant scrutiny from the viewpoint of users and in terms of the vision of future society, so that the pursuit of unnecessary technological goals will be prevented and the feasibility of timely entry in to the market will be taken into account. A high level of aspiration to contribute to the society will also be required, rather than simply focusing on values such as impact factors.

(2) Global Trends

Climate change is a global challenge, and it requires the wisdom of the world to gather together to create innovation. Mission Innovation was launched in 2016, following the Paris Agreement, as an initiative to promote expanded public and private sector investment in research and development in the clean energy field. Japan has participated in the initiative since the first session. There are currently 24 member countries including the G7 and the European Union. Participating countries are committed to seek to double their public investment in clean energy research and development. In addition, there are eight Innovation Challenges, in which interested members collaborate to promote research and development in

each area.

Japan has also hosted since 2014 the Innovation for Cool Earth Forum (ICEF) as an intellectual platform for global leaders in the industry, academia and government to discuss and promote cooperation for the importance of innovation in energy and environment field, towards the solution of climate change problems. ICEF held its fifth annual meeting in 2018 with the attendance of over 1,000 people from approximately 70 countries to discuss key challenges for the promotion of innovation and future strategies as well as specific technological fields, and the outcome was announced as a statement by ICEF steering committee. It is hoped that ICEF and its outcomes will lead to concrete activities of international collaboration in order to create innovation.

2. Directions of Policy Measures

(1) Basic Directions of Policy Measures

Towards the realization of a decarbonized society, scientific values such as high efficiency do not suffice; achieving the cost to enable adoption in the society is required, and so is innovation in technologies to reduce their “cost”. For this reason, it is necessary to induce as many disruptive innovations as possible. The Government will set targets for the cost to enable the technology to be adopted in the society, provide maximum resources of the public and private sectors, seek and create potential technologies in Japan and abroad, work towards necessary infrastructure development and strengthen initiatives aimed at the actual business opportunities.

Reducing GHG emissions has to deal with future uncertainties, and therefore is an extremely broad, complex and difficult problem. Changing the entire world with just one type of innovative technology would be difficult, and private investment for technologies requiring lengthy research and development is also difficult. Where there are several technologies and methods proposed, each of them has its own strengths and constraints, which make the assessment vary depending on the preconditions, making it practically impossible to single out a technology or method.

It is therefore necessary to enhance the foundation of latest scientific knowledge in and out of Japan, continuously review the technologies and the state of the development of technology, including government supports to be received. In particular, the knowledge and financial resources in the private sector will be used as much as possible for research and development to realize a decarbonized society in 2050 and beyond. At the stage of basic research and feasibility studies, efforts will be made with a wide range of expertise, with a

priority given to the promising technology for further development aimed at practical application. Furthermore, in order to encourage public and private sector investment and introduce decarbonizing technology in the society on a large-scale, promoting research and development on promising technologies is not sufficient; it will be important to constantly review the practical use and potentials of technologies in the light of the needs of the society, “visualize” the needs of the users and the bottlenecks to be resolved, and objectively present the feasibility and limitation of technologies currently under consideration. In the light of all these, the public and private sectors will scrutinize the technology worthy of continued investment.

On selecting the prioritized technology, whether or not that technology can lead to significant reductions of GHG emission is an important viewpoint, together with the scale of impact concerning the scope of applicability, such as the cross-sectoral potentials for wider industries, not limiting itself to a single process. Hydrogen, for example, can be used in so many ways, not only as an alternative to fuels for automobiles, which depend heavily on fossil fuels, but also for: a substitute power source for coal and LNG-fired thermal power generation; a reducing agent in steel manufacturing in place of coke, and; by reacting with CO_2, as an alternative to crude oil and naphtha used in the petrochemical industry and natural gas used in the city gas, the leading cause of global warming. Power electronics technologies reduce energy consumptions of the entire power grid by improving power conversion and control, and further contribute to improving distributed and digital control technologies, such as the Virtual Power Plant (VPP) that functions as a flexible power regulator and enhances the stability of the grid and demand response (DR) to cater for the fluctuation of power generation from renewable energies. Similarly, energy storage technologies such as storage batteries are also extremely important in accelerating the wider use of renewable energy, the large scale introduction of which has been held back due to fluctuation in output. Energy storage technologies can serve as the power source for electrified vehicles, and increase the capacity factor of water electrolysis devices for hydrogen production connected to fluctuating renewable energy, playing a major role in a shift from the fossil fuel-dependent society to the eletrified society. These technologies will also help achieve “Well-to-Wheel Zero Emissions” in the transportation sector.

The key to large-scale reduction in GHG emissions is a widespread usage of such technologies throughout the society. The biggest problem, however, is the extremely wide gap between the cost that users can afford and that achievable with existing technologies. Efforts to reduce costs through technology development will need to continue, but if such development cannot keep pace and significant cost reduction is unlikely in a timely manner, some other way of

achieving large-scale reductions in GHG emissions may become necessary. Additionally, it is important to continue building platforms for research and development for technologies of excellence. Furthermore, long term research and development to make use of prominent ideas of the individual will be promoted.

Once a technology has been established to a certain extent, the demonstration of the technology at an optimal location — the market or production base — becomes necessary. The optimal location may well be abroad in terms of available resources. Technology demonstration will be carried out in the best location be it in or out of Japan and including with international collaboration.

Proceeding with attempts for practical application of technologies in the society and industry in view of the cost, rather than simply waiting for the development and demonstration stages to conclude, is also important. In the case of hydrogen, for example, it may be worth considering to establish a market in the first place with the following measures: while the market is in infancy, targeting on high value-added products with comparatively low impacts on the manufacturing cost, albeit with low CO_2 reduction effect; secondly, making maximum use of the existing infrastructure — for example, adding a tolerable level of hydrogen and methanation gas as the energy carrier[28], in the existing gas supply systems and adding biofuel into the fuels (fossil fuels) for power generation and automobiles; thirdly, preparing the markets using the means which can achieve low prices albeit with low CO_2 emissions reduction effect in terms of the LCA — for example, the use of hydrogen derived from fossil fuels, and; provide policy support for the introduction.

Technologies might enable large-scale reductions in GHG emissions and the use of fossil fuels might decrease; however, in the process of establishing a decarbonized society, emissions of the GHG such as CO_2 will still be unavoidable. Therefore, the capture, storage and effective use — recycling — of CO_2 will be necessary. In addition to this CCS and CCU or recycling of CO_2, the humanity has spent considerable energy to produce metal, plastic and other products in the past economic and industrial activities, and these can be regarded as existing resources. Promoting the circulation of resources in all fields will be useful in overcoming the resource constraints and, further, contribute to the reduction in GHG emissions. The establishment of a circular economy has become an important policy issue in the Western societies, and it is important for Japan to achieve a sound material-cycle society in both the technical and institutional terms.

[28] The method to efficiently store and transport hydrogen as liquid, while hydrogen, gaseous at normal state, is difficult to handle.

(2) Enhancement of Scientific Knowledge

Various changes, including the world situation, technology trends and life-styles can take place in the long-term, and prediction on the long-term future is difficult. In order to achieve large-scale reductions in GHG emissions in the face of uncertainties, it is necessary to constantly review technologies, in the light of the situations at the time and technological trends, under ambitious and multi-track scenarios in all directions. When taking climate change measures from a long-term and global viewpoint, latest scientific knowledge in and out of Japan will need to be continuously gathered to serve as a basis for such reviews.

Further survey and research, including observation, need to be conducted on such issues as further unravelling of the climate change mechanism, improvement in the accuracy of the projection and assessment of the adverse effects and risks; and it is important to furnish the system for these. For further unravelling of the climate change mechanism and improvement in the accuracy of the projection, the modeling and simulation technologies will be sophisticated, including the use of supercomputers, thereby improving the time and spatial resolution and generating data for climate change projection, including the likelihood of occurrence and degree of certainty. Japanese climate change projection data based on the needs of each sector will be enhanced. GHG observational data will be put to greater use in the assessments of adverse effects and risks of climate change, with the use of the Data Integration and Analysis System in particular. The Government will strategically support researches to unravel the mechanisms of climate change and assess the environmental, economic and social impacts of climate change, aiming for international cooperation where appropriate. With regard to the observation and monitoring related to climate change, comprehensive observation and monitoring to keep track of the GHG, climate change, and their effects will be continued. The Government will continue to observe the GHG in particular on a global scale from the space with the Greenhouse Gases Observing Satellite (GOSAT). GOSAT-2, launched in October 2018, is able to identify CO_2 from anthropogenic sources, and the observational results will help refine climate change projections, improve the transparency of emissions reporting in accordance with the Paris Agreement by the state parties, and contribute to follow how far each country has reached its targets in the global stock-take. In addition, the Government will continue its observation on land and with vessels and aircraft, summarizing and analyzing the resulting data to fill out the knowledge, and disseminating the findings both domestically and internationally. Japan will also carry out international cooperation by making use of the above-mentioned strengths.

(3) Cross-Sectoral Initiatives in Technology Development -- Progressive Environment Innovation Strategy

The Government will formulate a Progressive Environment Innovation Strategy and make efforts in the medium term to facilitate disruptive innovation at the level of cost which enables it to be adopted in the society. This Strategy will be formulated during 2019 and disseminated to the world, in order for technologies to make the business case and contribute to the global reduction in emissions with: setting clear targets such as the cost as a signal from the Government; maximum provision of the resources from both the public and private sectors; long-term commitment including the size of investment; seeking out and creating potential technologies in Japan and abroad; setting challenges based on the needs; flexible support system for bold challenges for innovative themes, to avoid excessive risk-aversion; strengthened support for making it to the business case, and; setting up institutional promotion and comprehensive support for the business. The Government has so far held a committee to study the potentials and feasibility of energy and environmental technologies in order to assess the demand and potentials of technologies that the society in 2050 will need, and to identify and "visualize" the bottlenecks for the realization of a decarbonized society. The findings of these committees will be utilized.

a. Seeking out and creating potential technologies in Japan and abroad and setting challenges based on the needs

The Ministry of Economy, Trade and Industry (METI) began the Unprecedented Challenge 2050 from 2017 to search out and create potential innovative low carbon technologies primarily in fields shown in the National Energy and Environment Strategy for Technological Innovation towards 2050. The program is aimed for young researchers at universities and other institutions under 40 years of age, to become prospective leaders in the front lines of their fields at around 2050. The Ministry of Education, Culture, Sports, Science and Technology (MEXT) has also started JST-Mirai program, specifying technological issues by back-casting from the goal of a large-scale reduction of CO_2 in 2050 and facilitating high-risk but high-impact research and development utilizing academic ideas. METI and MEXT have collaborated to connect the academia with the academic issues arising from corporate research as part of Commit 2050 and to act as intermediaries on academic research topics close to usage in the society.

In addition to this, research and development also need to place more

emphasis on the perspectives of the users, such as the “cost,” for decarbonizing technologies to be introduced to the society. For national research and development projects, a mechanism to identify technological issues required by the society and users and to facilitate competition among technologies by adopting a multi-track research and development approach will be considered. For research and technology development, it is important to objectively assess the potential of a technology on costs and CO_2 emissions with the LCA.

In order to create disruptive technology innovation, the Government will look towards the future society, set ambitious goals for difficult yet highly impactful societal challenges, and promote stimulating research and development, soliciting progressive and provocative research ideas from a wide range of researchers both in and outside Japan.

The international joint development of leading-edge technology using the strengths of Japan and the partner country towards the technology targets of the National Energy and Environment Strategy for Technological Innovation towards 2050 has been conducted so far on innovative energy technologies with the G7 and other countries. The Government will continue to promote the joint research and development. From the viewpoint of gathering the wisdom of the world, the Government has participated in Mission Innovation and the ICEF activities. Furthermore, as a new initiative, the Government will also invite leading figures in science and technology from major countries (G20) to the international conference held in Japan, drawing together diverse types of knowledge to create disruptive innovation for large-scale reductions of CO_2. Specifically, an international conference (RD20: Research and Development 20 for clean energy technologies) will be held in Japan to gather leaders in research institutions in the clean energy technology field in major countries (G20) to join forces to create innovation while utilizing the results of ICEF. Together with Mission Innovation, the RD20 is expected to strengthen the alliance among research institutions, paving the way to enhanced international joint research and development and generate concrete innovations from the wisdom of the world. Japan will take the initiative in setting up such an opportunity.

b. Stronger initiatives leading to business

Young researchers and start-up companies, who are the key to the introduction of technologies to the society, will be in the front lines of research and technology development in the future, as the climate change further progresses, and therefore are extremely important players in research and development. This means that policies need to focus not just on seeking out potential technologies but also on identifying key human resources. The Government will seek to

“visualize” this search for potential technologies and key human resources with research and development in the energy and environmental fields, in order to make this a case for business. Superior technologies on energy and environment owned by the start-ups are a source of innovation and a mechanism to bring funds to such technologies will be sought. Furthermore, in order to facilitate the research and technology development as well as capital investment by companies in the energy and environmental fields, such activities will be “visualized” to the market and incentives will be designed to expand private sector investment. As an example, The Government continues to provide knowledge-based support (NEDO Pitches, etc.) for companies selected by public organizations. For the startups engaged in innovation in the energy and environmental fields in particular, the Government will provide infrastructure allowing for the maximum use of private sector capabilities. The research and development as well as business development of the start-ups and small and medium-sized companies will be supported in such ways.

The Government also aims at international contributions with the commercialization and diffusion of technology through support to demonstration for initial market creation, international application and standardization starting with the initial stages of national research and development projects.

(4) “Visualization” of Issues in Individual Fields for Commercialization

The Government has already indicated the direction of various policy measures for technological innovation in a number of fields. The following describes the bottlenecks in introduction of key innovative technologies much expected to contribute to large-scale CO_2 reductions to the society. It is to be noted that the list of technology shown in this section is the illustration of potentials necessary to achieve targets in the light of current knowledge in each field. Careful examination by the public and private sectors are required when making investments.

a. Energy efficiency technology and energy transformation

Energy efficiency technology provide a cross-sectoral foundation required not only for the sectors using fossil fuels but also for the sectors that have been transformed from fossil fuel use. A great deal of technology development investment has already been made here, and the first thing necessary is a thorough effective use of the heat, the majority of which is generated by the combustion of fossil fuel as the final energy consumption. The electrification at the demand-side is also expected to go along with initiatives to decarbonize

power sources.

(a) Efficient use of heat

Various efforts have been made in the effective use of waste heat generated in the industrial production process with ingenious ideas developed by Japanese companies. However, low temperature waste heat under 200 degrees disperses on a small scale, making it difficult to be collected and used effectively, despite the vast amounts available overall. High temperature waste heat over 500 degrees is used in some areas, but its gaseous nature requires durable materials, which results in high costs, restricting effective utilization in some areas. The sites where waste heat is generated have yet to fully recognize the potential of heat, such as the amount of waste heat created in each specific process, leading to mismatches between waste heat and heat utilization. The development of technologies to use heat at low cost and free of location or time constraints is a major challenge in terms of energy efficiency and full utilization of heat generated. In addition to recognizing the actual amount of heat, specific technology issues include: nonmetal — plastic or ceramic — heat exchangers; heat-driven heat pumps; heat transport techniques such as slurry; heat rectification; techniques to store heat with safe substances enabling controlled nucleation, and; heat-blocking and heat insulation techniques. Secondary use of heat energy, such as conversion to electricity, is also an important area.

(b) Electrification

Furthermore, combined with initiatives for decarbonization of power sources, there are potentials for reduction of fossil fuel consumption in the industrial process, such as heating and drying, in its final energy consumption, while there are fields and processes where application of electrification is difficult. Improving process controls can not only lower energy consumption but also provide added value for high-mix and low-volume small-lot multi-model production and autonomous production processes. Furthermore, the ability to flexibly use part of the power for the production processes consuming large amounts of energy offers the potential for flexibility to contribute to grid stabilization. Some degree of progress has been made in the adoption of equipment with high energy efficiency, such as heat pumps and infrared drying devices for efficient heating, as well as the equipment of much added value, such as induction heating equipment devices in metal processing, which significantly improve the work environment. Further application will require technogical and economic solutions such as reducing the cost of equipment that tends to be high because of tailor-made nature and adding higher value on

processes and products with electrification.

(c) Power electronics

The application of power electronics instruments from power supply to the customer site contributes to maximize the energy saving effects of electrification. Power electronics is a cross-sectoral technology that can lead to mush more energy saving for electrical equipment. Silicon semiconductors currently have over 90% market share, but development of next-generation power semiconductor materials, such as fabrication of novel structure silicon devices, silicon carbide and gallium nitride, to cater for automotive and industrial applications requiring higher pressure resistance and telecommunications equipment requiring faster operations. However, as the cost for next-generation power semiconductor materials still remains high, development in large-diameter wafer manufacturing processes and efficient and high quality crystal production technology is in progress. Moreover, the total design of power electronics systems, not just materials and devices but also versatile power modules including peripheral equipment, magnetic substances, heat design and noise control, is important for improving the energy saving performance of power electronics. Research and development need to focus on each application area to identify the desirable overall design, optimizing the cost, efficiency, reliability, size and other factors to facilitate introduction to the society. It is important that aspects where to reducible costs and achievable standardizations are achieved with existing technologies. Development of technologies for saving energy can also be extended to areas where electrification has not been applied but semiconductors can be applicable, such as mechanical circuit breaker.

○ **Target: Maximum implementation of energy saving technologies with promising cost-effectiveness**

○ **Examples of technologies relating to energy saving / energy conversion**

- **Designs for energy saving:** Designing of products and services where CO_2 emissions are zero or minimal over the life-cycle
- **Utilizing unutilized heat:** High temperature heat pump; heat exchange technology; heat storage / transport technology; thermoelectric conversion technology; heat blocking and insulation technology
- **Energy conversion:** Electrification technologies for heating and drying — shift from the use of fossil fuels; smart cells — using bio technology
- **Cross-sectoral:** High efficiency motor; power electronics; next-generation lighting; light, strong, and heat-resistant material; high-

performance insulation material

- **Individual fields:** Alternative membrane separation technology in the distillation process / chemistry; motor; resource recycling — plastics, light metals, etc.; heat management — automobiles, etc.

b. CCS and CCU / Negative Emissions

(a) CCS

A report of the IEA looks to carbon capture and storage (CCS) as a drastic measures to capture and store large volumes of CO_2, to make up 14% of cumulative CO_2 reduction by 2060 (reaching an annual 4.9 billion tons/16% reduction of CO_2 in 2060)[29]. The CCS is also deemed necessary if fossil fuels, generating CO_2 emissions in the process, are used to produce CO_2-free hydrogen. In these and other ways, much is expected of the CCS, and demonstration projects continue inside and outside Japan. The CCS involving enhanced oil recovery (EOR) has been in commercial use in the United States since the 1970s, with economic incentives in the form of tax credits and subsidies. The CCS not involving EOR has yet to produce self-sustained economic profits, and those countries that have already introduced the CCS adopt incentives such as subsidies, taxation and other regulations.

The cost of the CCS therefore needs to be reduced further. The proportion of the energy cost for CO_2 separation and capture is particularly large, as the CCS requires the heat input to capture the separated CO_2. More CO_2 separation and capture methods need to be explored for lower costs. This will involve careful examination of the scale and features of each CO_2 source — CO_2 concentration, pressure, temperature, other substances in exhaust gases — as well as addressing the requirement from the demand CO_2 use and storage, such as using the heat and pressure of exhaust gases.

The social adoption of the CCS requires both the public and private sectors to address the issues such as: further surveys on suitable locations for CO_2 storage; securing such locations; transportation of CO_2 if the sources are distant from the storage locations, and; securing social acceptance for carbon storage.

In view of the need to identify solid geological structure suited to CO_2 storage and the time and cost required for building the infrastructure to properly store CO_2, the location for the site will need to secure an area as large as possible to achieve economy of scale. Further, a business model will have to be a comprehensive one, including transportation from the sources of CO_2 to the

[29] Energy Technology Perspectives 2017 (IEA, 6 June 2017)

site of storage. In Japan, large-scale CO_2 sources are primarily located on the Pacific coast. Taking into account the results of past surveys of suitable site for CO_2 storage, the locations of sources and suitable CO_2 storage sites are not necessarily close to the other. Therefore, an adequate business model to safely and economically transport CO_2 will need to be developed to enable the private operator to consider investment. For CO_2 storage below the seabed, the monitoring period and methods are stipulated in the Act on Prevention of Marine Pollution and Maritime Disaster (Law No. 136, 1970) amongst other issues. Safer and more suitable monitoring period and methods will be examined. Considering these points, a comprehensive system will need to be developed to cover separation, capture, transport, and storage in both economical and safe manner, with a suitable division of roles between the public and private sectors. This will be accompanied by active awareness campaign to seek further understanding among relevant parties such as local authorities and social acceptance of the CCS at large. The Government will continue to seek international collaboration on research and development, demonstration, standardization and further rulemakings.

(b) CCU / carbon recycling

Based on the Roadmap for Carbon Recycling Technologies [30], the Government will engage in the development of technology to reduce CO_2 capture costs and to convert the captured CO_2 into valuable carbon-derived materials and resources, such as chemicals, fuels and minerals, with the aim of creating a new social system backed by innovation. In order to pursue innovation with a fully global outlook, the Government will hold an international conference on carbon recycling, drawing participants from the industry, academia and government, and seeking collaboration in this context.

Carbon capture and utilization (CCU) offer can potentially contribute to decarbonization that meets economic sense in terms of alternatives to fossil-derived chemicals and fuels and concrete products utilizing CO_2 in the form of carbonate. However, CO_2 is a considerably stable substance, and large amount of energy inputs is required to convert CO_2 into another substances in almost all cases. . As such, objective and impartial life-cycle assessment (LCA) for the entire process is required for CO_2 reduction. A comprehensive LCA methodology for the CCU has not been contemplated globally, so research and development a viewpoint of LCA. In the case of l reactions using hydrogen for the purpose of CO_2 conversion into chemicals and fuels, a challenge also arises

[30] The Roadmap illustrates potential technologies that enable effective CO2 utilization together with technical problems, challenges for commercialization and the future targets.

in securing ample supply of affordable CO_2-free hydrogen besides, it is necessary to develop technologies for utilization of CO_2; efforts to lower the cost of hydrogen production are thus also required. While concrete products utilizing CO_2 in the form of carbonate have already been commercialized in Japan, they have yet to achieve sufficiently low costs to replace existing products. Further technological development is necessary to reduce their costs and explore their application. At this moment, the difference in price between CCU products and existing products remains extremely wide. Therefore, efforts will be required for wider use of CCU products, such as: lowering the procurement cost of hydrogen as a key substances; diffusion of environmental values with public-private collaboration; pursuit of application to high value added products, and; development of C1 chemistry for utilization of methane, which can serve as a bridge to future utilization of CO_2.

(c) Negative emissions technology

In addition to the CCS and CCU, negative emissions technology to recapture CO_2 already accumulated in the atmosphere in various ways has received much attention recently. Negative emissions technologies include: direct air capture (DAC), artificially separating and capturing CO_2 from the atmosphere directly ; afforestation; ocean fertilization to fixate carbon in phytoplanktons and useful aquatic plants; promoting downwelling and upwelling; enhanced weathering; bio-energy with carbon capture and storage (BECCS), and; carbon storage in cropland soil by using substances such as biochar. Researches on such negative emissions technologies had been long ongoing, but now that they are required in order to achieve the long-term goals set out in the Paris Agreement, the level of attention has increased greatly. However, life-cycle assessment on the effect of CO_2 reduction is still limited. Besides, DAC, amongst other methods, faces many challenges, including the necessity for significant energy input and cost reductions. Therefore, establishing basic technologies and various and objective examination will be required, also with a view to promoting effectiveness and social acceptance, as well as international collaboration.

○Target: Realizing energy and products utilizing CCU/carbon recycling at the level equivalent to existing energy and products in terms of cost and CO_2 reduction

○Examples of technologies relating to CCS, CCU and negative emissions

- **Separation and capture:** DAC; through chemical absorption; physical absorption; solid absorption; membrane separation; physical adsorption; closed integrated gasification combined cycle (IGCC),

and; super plants and microorganisms with greater CO_2 removal properties

- **Effective use:** EOR; methanation / conversion to fuel; artificial photosynthesis; conversion to raw material for chemicals; use of biomass, such as microalgae; carbonation / mineralization; building materials; super plants generating valuable substances; direct synthesis, such as those with microorganisms, of valuable compounds from exhaust gas without CO_2 separation, and; chemical synthesis using methane
- **Transportation and storage:** underground storage; survey on suitable sites and its monitoring, and; CO_2 transportation technology

c. Hydrogen

Hydrogen has potentials, beyond the use as a fuel for vehicles or power generation, for cross-sectoral innovation to contribute to large-scale CO_2 emission reductions in many fields, including in industrial processes, as a raw material for steel and chemical production processes or desulfurization in oil refining. Although the markets are not quite large yet, ENE-FARM, fuel cell vehicles, forklifts and buses have already been introduced to the society, while hydrogen power generation is in the demonstration stage. However, in order to achieve a hydrogen society including its use in industrial processes, the users require hydrogen to be priced at the level equal to or below natural gas per heat value, currently very far from the actual procurement cost of CO_2-free hydrogen. In addition to the cost issue, there is also an issue of ample supply. Water electrolysis has been globally touted as a possible method of hydrogen production for ultimate decarbonization, and a number of research and development as well as demonstration projects have already been carried out. However, the fluctuating nature of renewable energies such as solar and wind power has resulted in a relatively low ratio of capacity utilization, and the cost of electricity from renewable energy power sources is not yet sufficiently low enough. Therefore, the cost needs to be reduced further in order to achieve a hydrogen price satisfactory to the users. Another issue is securing the massive volume of electricity needed to generate hydrogen, at the level over several million to over several tens of millions of tons worth, required for the introduction of hydrogen power generation and the use of hydrogen in existing industrial processes to achieve decarbonization.

A fundamental issue in constructing a hydrogen society is the stable supply of large volume of CO_2-free hydrogen at an affordable price. While the production cost of electricity from renewable energy power sources remains high, seeking

out an alternative means of hydrogen production instead of water electrolysis, which does not generate CO_2, is a realistic option. Such means of hydrogen production may include: using fossil fuels with the CCS; using methane, including methane pyrolysis, independent from fossil fuels and the CCS; water pyrolysis using artificial photosynthesis and high temperature heat sources, and; using biomass. Constant efforts are needed to search out potential innovative technologies to further reduce the cost of hydrogen production. The purity and pressure specifications of hydrogen also needs to be set adequately according to the quality required by users, thereby pursuing lower costs. Efforts are also needed to reduce the high cost of hydrogen carriers required for overseas production as well as other purposes; these include the large energy inputs required for liquefaction, synthesis, dehydrogenation processing and transportation. In light of the situation, the potential of co-electrolysis technology, such as that synthesizing hydrocarbons from water (proton H inside water) and CO_2 using electricity from renewable energy power sources, without synthesis using hydrogen to produce a hydrogen carrier, followed by dehydrogenation. In any case, as these technologies are aimed at decarbonization, the best choice of technology needs to be made with the use of neutral and objective life-cycle cost assessment based on disclosed preconditions.

○ **Target: Realizing hydrogen cost equivalent to existing energy, including lowering manufacturing cost to one tenth**

○**Examples of technologies relating to hydrogen**

- **Production technologies:** Highly efficient water electrolysis; permeable membrane for high purity hydrogen; artificial photosynthesis; thermochemical hydrogen production using solar heat / industrial waste heat — IS process; hydrogen production from CO_2 free methane — pyrolysis, etc.; production of ethanol, ammonia, and hydrogen from exhaust gas; synthesis of hydrocarbon and ammonia directly from water without going through hydrogen
- **Transportation and storage technologies:** Liquefaction / storage / transport of liquefied hydrogen; highly efficient / long-lasting organic hydride dehydrogenation catalyst; ammonia production technology; methanol production technology; methanation technology; transportation of hydrogen by pipeline or mixing into existing gas pipelines; noncombustible alloy for hydrogen storage able to fill or release at low cost and low pressure; lowering the installation and running costs of hydrogen stations
- **Applied technologies:** Hydrogen power generation — mixed firing / single firing; CCU; hydrogen steelmaking; higher efficiency and lower

costs for fuel cell systems with expanded applications; direct ammonia combustion

d. Renewable energy

Since the Sunshine Project, significant amount of investment on research and development has already been made for the use of renewable energy, including solar, wind, and geothermal heat, with results much introduced to the society. However, the power generation cost of renewables in Japan is still high compared to thermal power generation and other sources, and the number of locations suited to renewable energy in Japan is limited. Renewable energy can contribute to decarbonization not only as a primary source of electrical power but also by reducing the use of fossil fuels in industrial fields through production of CO_2-free hydrogen and combination with electrification technologies.

(a) Cost reduction and overcoming locational constraints

In order to expand the introduction of renewable energy in the long term, its cost needs to be reduced to the level of the existing energy sources. At the same time, efforts will be made to avail locations previously unsuitable for a renewable energy site, such as: improvement in power generation efficiency and durability; making the weight lighter, and; forming it into bendable forms. In addition, technologies to contribute to significant increase in the volume of renewable energy that can be introduced at a cost equivalent to the existing energy sources will be sought. In the case of solar power, this will include technologies that allow the installation of solar panels on building walls, factory roofs, on top of water, and on vehicles and drones.

(b) Overcoming power grid constraints

Current power grids does not necessarily match the sites which have potential for renewable energy power sources. Together with reviews on the current system aimed at the consideration on next-generation networks, including grid upgrading, the development and introduction of transmission technologies which enable grid upgrading at a lower cost and in a shorter time will become important.

(c) Securing flexibility

In order to integrate fluctuating renewable energies such as solar and wind power in large volumes, flexible grid operation and appropriate flexibility sources need to be secured for stable power supply. Pumped-storage hydroelectricity and thermal power generation currently provide flexibility, but

decarbonization of flexibility sources will become important. In the future, storage of electricity from renewable energy that cannot be accepted in the grid will become important to make maximum use of acquired renewable energy. Research and development, as well as demonstration, of storage batteries for the grid, which appear promising large-scale energy storage technology, have been conducted, but as with other decarbonizing technologies, the primary problem for large-scale use in the society is the cost. The batteries also take up significant areas of space, and lithium-ion storage batteries currently use flammable electrolyte, which require safety design and constraints on the site of location. These are the background to their limited usage, despite the promising prospect to contribute to expansion of renewable energy. Large-scale storage energy technologies available at a low cost, equivalent to the pumped-storage power system needs to be realized in the future. There is much expectation on the decline in the cost of lithium-ion batteries to go along with increasing demand for electrified vehicles, the use of all-solid-state and the development of redox-flow storage batteries using low-priced materials. For automobile batteries, the standardization of technologies to assess battery deterioration and ways to evaluate their residual value for proper appraisal to allow secondary use of these batteries after the original purpose is required. It is also important to pursue various modalities of energy storage, not limited to electricity, provided that they are available in large scale and economically. Heat storage, previously unattended due to its low level of efficiency, and a storage energy system using hydrogen might make it a candidate. It may be worth noting here that using heat and hydrogen without returning them to electricity where possible will avoid the loss resulting from energy conversion.

Thermal power is becoming increasingly more important in terms of flexibility in response to renewable energy. Accordingly, it is important for new and existing thermal power stations to aim for shortened time for power adjustment and increased efficiency in partial load operation with improvement in operation and rehabilitation. (This may also apply to hydrogen power generation in the future.)

In addition, in order to achieve a decarbonized society, adjustment on the demand-side capacity is also important, not only on the supply and the grid. IoT technology is much used in the energy management already in place, such as the virtual power plant (VPP) and demand response (DR), while the AI and block chain technology also offer promising avenues to explore. As large-scale introduction of renewable energy will lead to a large-scale surplus of electricity, the management of energy storage system and the demand creation DR as a response on the part of the industries, as well as enhancement of such potentials will become important. In pursuit of the potentials of demand-side

capacity adjustment, close scrutiny into the industries, the manufacturing processes and potentials to respond to the demand creation and lowering the cost for controllable distributed energy resources, such as fixed storage batteries, are important, alongside the management of hydrogen and heat as a means to store and utilize electricity.

○**Target: Achieving renewable energy costs equivalent to existing energy sources;**
Establishing technology contributing to large-scale expansion of capacity of renewable energy;
Using demand response (DR) to the level comparable to the USA

○**Examples of technologies relating to renewable energy**

- **Renewable energy:** Third-generation solar cells — tandem (multi-function), perovskite, III-V family, etc.; fourth-generation solar cells — quantum dot, etc.; floating offshore wind power; ocean energy sources; supercritical geothermal heat, and; space solar power
- **Storage energy and systems measures:** Storage batteries for power systems — NAS, redox-flow, etc.; storage batteries for automotive and personal use — lithium-ion, all-solid-state, etc.; automotive battery deterioration assessment technology; hydrogen storage; high efficiency thermal storage; compressed air; multi-terminal offshore power transmission systems
- **Decentralization and digital controls:** Frequency controls and inertial force measures; output control of thermal power generation / (hydrogen); AI, IoT; P2P, VPP and DR using block chain technology — demand creation / limitation; innovative sensors; vehicle control technology — smart charging, V2X; sector coupling — exchange of energy among electricity, heat, mobile unit, hydrogen; power electronics

e. Nuclear energy

Regarding nuclear energy, which is an option for decarbonization at the stage of practical use stage, it is required to proactively make efforts to resolve technical challenges, while improving light-water reactor technology and responding to domestic and international environmental changes in the uses of nuclear energy. In doing so, the perspective of promoting innovation of nuclear related technology, taking into account growing and various social demands such as hydrogen production, heat utilization, ,and coexistence with renewable energy, in addition to further enhancing safety, reliability and efficiency, is important. In proceeding

with these activities, Japan will ensure strategic flexibility, including competition of various technologies and selections by domestic and international markets, taking into account the activities in the United States and Europe which are advancing innovative nuclear reactors including small modular reactors and molten-salt reactors.

On nuclear fusion energy, in parallel with steady implementation of the ITER project, which uses the tokamak and the Broader Approach Activities, Japan will promote the research on helical and other types based on unique Japanese ideas, aims at establishing scientific and technological feasibility.

○Target:

- **Pursuing reactors with excellence in safety, economic efficiency, and flexibility;**
- **Technology development for solving backend problems**

○Examples of technologies relating to nuclear energy

- **Nuclear energy:** fast reactor; small modular reactor; high-temperature gas-cooled reactors; molten-salt reactors; nuclide transformation technology using accelerators, etc.
- **Nuclear fusion:** experimental reactor; tokamak superconducting magnets; helical fusion reactor, etc.

II. Innovation in Economic and Social Systems

Together with innovation to create technologies, “innovation in economic and social systems”, in which technologies are put to wide use, is indispensable to achieve decarbonization of the society. In particular, in order to make the maximum use of private sector abilities and attract finance and investment, it is imperative for the Government to provide a “consistent climate change policy towards an ambitious vision” and “preparing environment for investment.” Technological innovation starts to reduce GHG emissions only after it has come to be used throughout the society. Policies to encourage corporate efforts and promote the creation of self-sufficient business models are required for the outcome of the innovation to be used throughout the society. At the same time, while performance and efficiency are important aspects, they will remain untapped unless chosen by the user. Accordingly, the Government will pursue measures to achieve innovation in economic and social systems, including a spur to the user’s choice of innovation for decarbonization.

III. Lifestyle Innovation

“Lifestyle innovation,” shifting the way of life of each citizen towards sustainability, provides a major impact directly and indirectly on climate change through consumer behaviors and the use of fuels, energy, and resources. The shift from consuming goods to utility and price-driven to quality-driven, as well as the expansion in “ethical consumption,”[31] is part of an overall economic shift “from quantity to quality”; a shift from mass production and mass consumption to small lot, high added value production and consumption, fully aligned with the move towards the decarbonization of society. These changes are creating new demand, leading to innovation in new goods and services.

The Government intends to take measures to urge changes in the life-style leading to decarbonization, such as the sharing economy, “visualize” the GHG reduction effects accompanying such changes, and promote businesses conforming with this trend. The Government will further engage in dialogue and

[31] Consumer behavior to care the people, society, and environment, including regional revitalization and employment. “Caring for the Environment” includes Eco Mark goods, recycled products, sustainable forestry management and certified fishery product, “Caring for the Society” Fair Trade goods and goods with donation, “Caring for the People” support for the disabled. Local production for local consumption and purchasing goods of the disaster-affected region are also considered to fall into this category.

analyses on the potential for accelerating the shift to a decarbonized society through future lifestyle changes.

Section 2: Promotion of Green Finance

1. Current Status

(1) International Trends

The creation of innovation in technological, economic, and social systems is important to realize the society aimed at the Paris Agreement. In this context, it is necessary that private sector investment focus on corporations which address climate change issues and/or take on innovations. The role of finance has thus become more important.

Following the call from the United Nations, the “Principles for Responsible Investment” was formulated in 2006 and the concept of “environmental, social and governance (ESG) investment” was presented. Since the global financial crisis of 2008, the potential impact of non-financial information, together with financial information, on the corporate value has drawn much attention. This has led to a gradual rise in the ESG investment, primarily from the United States and Europe. In 2015, the Paris Agreement and the SDGs by the United Nations were both adopted. As the creation of innovation is important to realize both of them, it is hoped that ESG investing will play a role in the longer term increase of corporate values.

In fact, the ESG investment increased by approximately 2,000 trillion yen in 2018 compared to 2012, marking a major change in financial flows worldwide. The growth of the market for the “E (environmental)” investment has been conspicuous, due to the extreme weather events of recent years. In the direct financial market, for instance, the divestment from stranded assets and active corporate engagement have been noticeable, and it is becoming a standard, especially in European financial markets, to include climate change risks in investment and lending decisions. The value of green bonds -- a type of bond whose proceeds are invested in projects that generate environmental benefits -- has also risen, reaching 50 times the value in 2012 as of 2018.

In line with such trends, there have been increasing demands for disclosure of climate-related financial information. On the instruction of the G20 Finance Ministers and Central Bank Governors, the Financial Stability Board in December 2015 set up the private sector-led “Task Force on Climate-related Financial Disclosures (TCFD).” The task force released its final report (the “TCFD Recommendations”) in June 2017. The TCFD Recommendations set out a framework for voluntary disclosure by the financial and non-financial sectors of information on climate-related risks and opportunities.

(2) Trends in Japan

Japanese ESG investment market is small compared to the world overall, but it expanded from USD 0.5 trillion in 2016 to USD 2.1 trillion in 2018, marking a substantial increase by 4.2 times. As such trends continue, active initiatives by institutional investors have been witnessed; for example, the Government Pension Investment Fund, the world's largest asset owner, for the purpose of maximizing the longer term investment returns, added descriptions on the ESG in its Investment Principles, and encourages the asset managers to consider ESG factors with active engagements and the adoption of ESG indices.

The Government has made initiatives for the expansion of the green bonds market and taken policies to support the issuance of the green bonds, such as the formulation of Green Bond Guidelines and the establishment of the Green Bond Issuance Promotion Platform. With these initiatives in the public and private sectors, Japanese green bonds market has grown; the issuance of green bonds has risen by approximately seven times over two years from 2016 to 2018, and both issuers and the uses of proceeds have diversified. The Japanese financial institutions have provided largest amount of finance in the world to projects relating to renewable energy, and, accordingly, there are expectations for their engagement in the climate change efforts as the funder domestically and internationally.

In the light of these trends, the Government has taken the following policies, in particular with regard to climate change, to support the ESG investment.

The “High Level Meeting on ESG Finance” considered the issues of the leadership and role of the financial sector in a decarbonized society and the transition to a sustainable society, and came up with its recommendations for Japan to become a major presence in ESG finance in July 2018.

Furthermore, the Government published the “Report on Ideas for Use of Environmental Information in Evaluating the Corporate Value” by the Working Group on Environmental Information and Corporate Value. This report describes the basic ideas for investors to note and specific examples of the use of environmental information, and the Government intends to attain wider utilization of ESG investment by using environmental information for the assessment of corporate values with this Report.

Corporate governance reform is also being promoted through constructive dialogue between institutional investors and companies, in order to achieve sustainable growth and increase corporate value in the longer term. Specifically, the Corporate Governance Code clearly states that the listed companies should take appropriate measures to address sustainability issues. The Stewardship Code provides the example of risks and opportunities arising from social and

environmental matters in a guidance for institutional investors to monitor investee companies.

For the disclosure of climate-related financial information, the Government also formulated the world's first “Guidance for Climate-related Financial Disclosures (TCFD Guidance)” in December 2018, in order to facilitate the dialogues between business operators and investors at a managerial level and to effectively disclose the initiatives and strong points of the companies in each sector. This TCFD Guidance may also be viewed as a specific attempt under the “Guidance for Integrated Corporate Disclosure and Company-Investor Dialogue for Collaborative Value Creation” (the Ministry of Economy, Trade and Industry (METI), May 2017), which sets a common narrative between the companies and investors; it thus encourages the formation of corporate value creation stories in terms of action on climate change. In addition, the “SDG Management / ESG Investment Study Group” has considered integrating SDGs into the management as well as the solutions that the business can offer to the social challenges including climate change from a long-term perspective on enhancing corporate values. Furthermore, the Government is working to disseminate the efforts of the Japanese public and private sectors such as holding TCFD symposiums in and outside Japan and raise the awareness on the TCFD. At the same time, the Government encourages the endorsement of the TCFD by companies, as a means to promote ESG investment with active corporate initiatives. Furthermore, the Government formulated the “Practical Guide for Scenario Analysis in line with TCFD Recommendations” (the Ministry of the Environment, March 2019) to support companies analyze their own climate-related risks and opportunities within the TCFD framework and practically reflect the results in their business strategies.

In order to facilitate the dialogue between investors and companies, a database to enable the comparison of information disclosed by each company will be required. The Government has thus developed the world’s first platform to encourage disclosing environmental information to reflect the global trends, and established the ESG Dialogue Platform with direct dialogue functions.

The international environmental initiatives working on the disclosure and assessment of information on climate change measures by global companies, such as the CDP, RE100, and SBT are becoming more influential, and the Japanese companies need to respond to such initiatives. However, the lack of sufficient prepared and available information to make an argument in the international context, such as the methods to calculate GHG emissions or procurement of renewable energy in Japan, has been a challenge. The Government has therefore provided technical support to the companies who are engaged in these international environment initiatives and aim at ambitious

efforts and also formulated the “Guidance for Encouraging Japanese Companies to Address International Initiatives on Climate Change.”

2. Directions of Policy Measures

(1) Basic Directions of Policy Measures

Initiatives and innovations by companies to contribute to climate change measures need to be appropriately “visualized” in order to realize a virtuous cycle of environment and growth. Outstanding initiatives and technologies for decarbonization of a company will not connect with investment unless they are “visualized” in such a way that can be properly assessed by investors or financial institutions.

In order to realize the virtuous cycle of environment and growth, a mechanism for an international flow of funds is important to support investors and financial institutions assess the risks and opportunities over the long term and actively take on the decarbonizing innovation. The Government will urge companies and financial institutions to take positive stances and improving the environment for mainstreaming ESG finance.

(2) Mobilizing finance through Disclosure including the TCFD and Dialogue

The Government seeks to utilize the TCFD, the global climate-related financial disclosure framework, to establish the virtuous cycle of environment and growth by “visualizing” individual company’s climate-related technologies and initiatives as opportunities. The TCFD is an international initiative discussed within the G20 and elsewhere. It is increasingly being incorporated into the global corporate assessment framework as well as the systems of various countries and regions, giving it a central position as the information disclosure framework relating to climate change.

In order to make the “visualization” more detailed and effective, while maintaining its credibility, the accumulation of best practices of disclosure is important. Accordingly, the Government encourages the companies to support the TCFD. The Japanese industries have taken positive stances toward the climate change challenges, as evidenced by the fact that Japan has the largest number of TCFD supporters among non-financial sectors, and have various technologies essential for solution. Achieving these initiatives requires contributions from the industries as well as the financial sector; it is important for Japan, with its strong industries, to play a central role in leading the world into a virtuous cycle of environment and growth. In this regard, Japan will lead the global

rule-making for information disclosure relating to climate change, and change the global financial flow.

a. Promoting effective information disclosure by companies (expanding on the TCFD Guidance / Scenario Analysis Guide)

To help Japanese companies more effectively disclose their information, the Government needs to facilitate the understanding of the TCFD and clarify key points for various types of industries and sizes of companies. Accordingly, The Government is promoting the TCFD Guidance, for example, by broadening the range of industries covered, and facilitating the use of the Guidance by small and medium-sized companies. As for the scenario analysis to conform with the TCFD, the Government will further expand the “Practical Guide for Scenario Analysis in line with TCFD Recommendations” with more best practices to facilitate companies appropriately analyze and assess the opportunities and risks, and formulate a resilient business strategy appealing to the investors as a result.

b. Facilitating assessment of disclosed information by financial sectors (Guidance on Green Investment)

The modality of assessment and use of disclosed information related to climate change currently vary by investor. The disclosure of climate change-related information and examples of corporate assessment based on such disclosed information have increased, but for further expansion of green investment, it is necessary to connect appropriate assessment of the disclosed information with investment and lending.

A guidance for financial sectors will be formulated to provide the investors and ratings, evaluation and other organizations with the key points in assessing a company’s value using its disclosed climate change-related information. This will promote greater information disclosure, while also stimulating a flow of finance taking sufficient consideration of climate change risks and opportunities.

c. Dialogue between the industries and the financial sector (TCFD Consortium)

The TCFD Consortium is formed, which will serve as a venue for the TCFD supporters among Japanese companies and financial institutions, who will make the world’s largest community of TCFD supporters. Through proactive dialogues among companies and financial institutions, various issues pertaining to the disclosure of climate change-related information and the future direction for attracting investment and achieving a virtuous cycle of environment and growth

will be discussed. The dialogue in this consortium will expand the range of industries covered and allow for the formulation or revision of guidance, which may be applied globally, leading efforts for disclosure worldwide.

d. International collaboration on information disclosure (TCFD Summit)

Japan aspires to become a model country for the TCFD with the largest number of supporters and opens up this frontier with discussions at the TCFD Consortium on the specifics of climate change-related information disclosure and discussions to encourage investment in innovation. In order to share such knowledge and best practices, the TCFD Summit will be held in fall 2019 as an international gathering of leading companies, investors, and organizations involved with the TCFD. The summit will serve as an opportunity to spark discussions among relevant parties, leading to disclosure and its sophistication worldwide.

e. Response to international climate change initiatives (CDP, RE100, etc.)

The Government will provide assistance to the participation of Japanese companies and their target-setting, disclosure and argument in the international climate change initiatives, such as the CDP and RE100, so that the Japanese companies aware of trends in climate change, such as the use of renewable energy, and actively engaged in such efforts will receive proper appraisal, and promote climate change actions and expansion of renewable energy investment.

(3) Promoting Initiatives to Expand ESG Finance

a. Initiatives to expand ESG finance

For direct finance, the Government will promote the issuance of green bonds and support the expansion of the domestic green bond market with the efforts of both public and private sectors. At the same time, the Government will aim to establish the reputation of Japanese capital market as “green” by expanding the trend of ESG-consciousness in other financial instruments, real estates, and further on. Institutional investors and other actors involved in direct finance will be encouraged to conduct self-assessments of the current status of their ESG investment and voluntarily disclose such information.

Initiatives to give consideration to ESG factors will also be promoted for indirect finance, which has an overwhelming presence in Japan. In particular, local financial institutions that underpin the sustainability of the locality are encouraged to coordinate with local authorities, while actively seeking out challenges related

to ESG issues with potential business prospects, making use of their abundant financial expertise to participate in the formation of new businesses.

b. Development of a dialogue platform on environmental information and corporate value assessment

In order to achieve a virtuous cycle of environment and growth, it is important to expand ESG finance by encouraging effective dialogue among companies, investors and other parties. Therefore, the Government will develop an ESG Dialogue Platform, with the aim of starting full-scale operation by FY 2021, encouraging effective dialogue on environmental information relating to climate change, resource circulations, issues concerning natural capital as well as corporate value assessment.

c. Maintaining and creating momentum on ESG finance among investors and financial institutions

In these ways, greater ESG finance literacy among those including investors and financial institutions will be enhanced, leading to improved effectiveness of ESG finance as well as growth in the quantity and improvement in the quality. By setting up an ESG Finance High-Level Panel with commitment from the top management of investors and financial institutions, and reviewing initiatives relating to ESG finance, momentum on ESG finance among financial institutions and other organizations will be maintained and created. Japan will thus aim to become a major presence in ESG finance.

Companies are expected to actively participate in such discussions and initiatives, to form strategic business models enabling efforts to address climate change and raise the corporate value at the same time, and to send out such messages and engaged in dialogue with investors in particular. The investors, on the other hand, needs to proactively use the information disclosed relating to climate change and engage in dialogue, thus assessing companies, and making investment decisions with appropriate consideration to climate change risks and opportunities. The Government will support such initiatives, including with the activities of the TCFD Consortium.

(4) Promotion of Investment on research and development and Support of Startups (recapitulation)

Superior technologies on energy and environment owned by the start-ups are

a source of innovation. The Government will provide knowledge-based support (NEDO Pitches, etc.) for companies selected by public organizations for their excellence, making such companies “visible” to the market, and design incentives to expand private sector investment.

(5) Supporting Formation of Decarbonization Projects with Investment

Projects for decarbonization have to secure the private finance in the first place, but the Government will facilitate investment in the project with insufficient financial backing.

Section 3: Business-led promotion of International Application, and International Cooperation

1. Current Status

It is important that the disruptive innovation created in Japan be offered for international application, thereby driving global decarbonization.

(1) Promoting International Application of Competitive Technologies and Products with high environmental performance

Japanese environmental technologies and products of excellence have contributed to competitiveness and offered both well-being and solution of global environmental problems to the world. Japan has to continue creating new business with the advanced technological capacities and promote international application of environmental technologies and products of excellence, thereby leading the world in global reduction of emissions. To this end, it is important that goods and services are developed at a competitive price by reducing costs, made more competitive and offered to the market overseas. At the same time, the sales volume needs to grow to improve the prospects of business and make it sustainable.

The global energy supply-demand structure is undergoing major changes, with increased demand for energy primarily due to the rise of the emerging countries, as well as the shale revolution and the substantial decline in the costs of renewable energy. The entry into force of the Paris Agreement in particular has driven the momentum for decarbonization by countries around the world in order to achieve its long-term goals.

(2) Developing Initiatives by Diverse Actors Including the Private Sector

The activities of various actors, such as local authorities, companies, financial institutions and research institutions to achieve the long-term goals stipulated in the Paris Agreement have intensified worldwide. The Government needs to enhance decarbonization measures in qualitative and quantitative terms including by collaborating with these actors, providing financial support and capacity building, and preparing grounds for the expansion of market related to decarbonization.

Efforts have been made in the world for companies to estimate GHG emissions in the entire supply-chain and reduce them. Such efforts will not only concern the countries where the companies are registered, but also other countries where

affiliated companies or factories are located. Efforts to improve transparency and reduce GHG emissions under the international initiatives will help the international standings, and in the long term, manifest the resilience of the company in responding to the economic and social transition to a decarbonized society.

(3) Policy and Institutional Support as a Basis for Greenhouse Gas Emission Reductions

Policy and institutional support expands the opportunities associated with the reduction of GHG emissions, and provide partner countries with wider application of decarbonizing technologies. It will also serve as a basis for the fruits of co-innovation by various actors to be widely shared in social and economic systems, as explained in detail later.

In many developing countries, basic information on climate change measures, including the actual situation regarding their GHG emissions, is not available, which makes detailed planning of the actions to take and accurate assessment of the effects on measures challenging. In order to ensure the effectiveness of the Paris Agreement for the achievement of its long-term goals, the enhanced transparency of such information as basic information, systems[32] and investment will be essential. To this end, it is important to send out a message that enhanced transparency will be accompanied by incentives: the promotion of projects and investment of the private sector.

In the quest for a decarbonized society, co-benefits, rather than substitutions, will often rise among several SDGs. It is desirable that the co-benefits between climate change measures and other SDGs are shown to the society as a model case.

(4) Investment in Climate Change Measures by Private Finance, Including Use of Public Funds

Japan has provided much support for the international application of low-carbon and decarbonizing technologies of excellence with various public financial resources. For example, as in the Expanded Partnership for Quality Infrastructure announced in 2016, the Government set a target to supply approximately 200 billion dollars of financial resources for five years to support the Japanese companies' engagement in the vast demands for infrastructure, and enhance the

[32] For example, systems pertaining to the inventory of and estimating, reporting and publishing of GHG.

assistance modalities of Japan International Cooperation Agency (JICA), Japan Bank of International Cooperation (JBIC), Nippon Export and Investment Insurance (NEXI), and Japan Oil, Gas and Metals National Corporation (JOGMEC).

Furthermore, new modalities such as the provision of risk money and guarantee are desirable.

Official Development Assistance (ODA) plays a role as a catalyst for mobilizing private sector ESG finance aimed at addressing climate change and environment, in addition to the conventional modalities. It is also desirable that the ODA supports the pioneering of social and institutional reforms for sustainable development with decarbonization efforts and expanding them (such as institutional support, human resource development and project formulation).

The Green Climate Fund (GCF), the financial mechanism under the United Nations Framework Convention on Climate Change (UNFCCC) emphasizes a paradigm shift in the locality over technology transfer in approving projects. In addition, movement to support climate change measures in financial sectors are also spreading, as seen in ESG investment and green bonds. The issuing of green samurai bonds by the governments of developing countries may well contribute to effective collaboration with private fund. The potential of climate change measures is particularly vast in developing countries where demands for infrastructure are expanding. Bearing in mind that enhanced resilience by introducing sustainable and resilient infrastructure will improve the investment environment for the private sector, it is also important, in the context of international cooperation, for the private financial flow towards addressing climate change issues in developing countries to activate.

2. Directions of Policy Measures

(1) Basic Directions of Policy Measures

Japan aims at a large-scale reduction of emissions of its own, and endeavor to lead global decarbonization. Based on the established confidence and supported by overseas establishments, Japan will expand cooperative partnership with other countries, create new business with Japanese advanced technologies and promote international application of the products and goods with high environmental performance, thereby leading global efforts and contributing to global reduction of emissions.

To this end, the Government will facilitate business-led international application with further improvement of environment such as creating markets, human resource development, and institutional development. Instead of simply exporting

innovation -- introducing Japanese decarbonizing technology and institution to the partner country and promote their usage -- collaboration with the partner country will be sought for “co-innovation” benefiting both countries: to adapt Japanese decarbonizing technology suitable to the partner country and supporting necessary changes in the economic and social systems and life-styles. In such a way, contribution to changes in the society and system towards decarbonization will be sought worldwide. In turn, Japanese advanced decarbonizing technologies and industries will be further sophisticated, and, with partnership and fair and healthy competition, be more active in the global decarbonizing market, offering high quality infrastructure, products and services.

It has been widely recognized that the initiatives by private companies and the use of private funds greatly contribute to building a decarbonized society, not least at the Climate Change Summit. In addition to strengthening partnerships with various entities and institutional support, the public finance will be used as a valuable leverage to private investment, such as by providing finance to reduce risks. By raising awareness of institutional investors on environmental finance, such as ESG investment, and stimulating the appetite of investors on environmental projects including green bonds, the Government will facilitate investment and lending on climate change measures in Japan and abroad, including developing countries.

The Government will establish the “Circulating and Ecological Economy” as a model to achieve the SDGs and decarbonization in the locality and disseminate the notion to the world as a role model of Japanese origin, offer Japanese expertise for Asian and other countries in building such an economy of their own. By establishing the social model which can be shared with the world and providing a recipe for achieving the goals of the Paris Agreement, the growth and contribution to the international community will be achieved in parallel, to the benefit of a decarbonized society.

Efforts need to made to expand the financial base for climate change, not just in terms of the ODA and Other Official Flows (OOF), and to increasingly take into account the perspectives of climate change in all cases, in view of the long-term goals stipulated in the Paris Agreement.

(2) Promoting International Application of Decarbonizing Technologies together with Policy and Institutional Support and Rule-Making

a. Policy and institutional development and further application to other countries

In order to make environmental technologies and products of excellence contribute to a decarbonization society in the whole world, the Government will

formulate projects to offer advanced technologies together with policy and institutional development. For example, with the Joint Crediting Mechanism (JCM) amongst other means, the Government can support the introduction of Japanese decarbonizing technologies in a partner country together with policy and institutional development for the use of such technologies, thereby offering an opportunity to significantly reduce GHG emissions by widely applying such technologies. By applying this method to another partner country, further business-led application and reduction of GHG emissions in global terms will be achieved. The Government will build up such best practices and develop a model for success to prepare more significant changes in the economic and social systems of partner countries.

In order to achieve wider application of decarbonizing efforts in many countries and regions, the Government will facilitate the business-led international application based on public-private collaboration, for example with public-private workshops to share best practices on: global comparison and assessment of energy efficiency, introducing energy efficiency labels and building systems such as international standardization.

As the weight of energy consumption in Asia increases, international cooperation on climate change measures and energy policies, together with specific collaborations, will become more important than ever. Japan will support Asia, especially decarbonization and energy transition in ASEAN, by leading tailor-made institutional development according to the diversities of each country and the level of development. Relevant ministries will collaborate with private companies to support cooperation on international application, improve business environment through public and private sector initiatives in ASEAN and promote a virtuous cycle of environment and growth in each country.

In order to encourage accountable actions and initiatives by the partner country, the Government will provide cooperation on necessary institutions and capacity building to enable sustainable efforts of various entities with the sense of ownership.

To enable international application of local companies, the Government will facilitate the accumulation of expertise and the sophistication of technology in that specific region. Subsequent proactive international application of its technology will contribute to developing that region with expanded employment as well as achieving a decarbonized society.

b. Leading international rule-making

The Government will lead international rule-making, including the formulation of international standards for the wider usage of technologies and products for decarbonization worldwide.

In order to speed up energy efficiency on a global scale, the Government will make efforts, such as preparing data for the “visualization” of energy consumption efficiency by industry and by country and region, as well as working towards international standards on the assessment on the energy consumption by the steel sector, the energy efficiency capacities of building materials and general estimates on GHG emissions. The GHG emission reductions and removals achieved with international contribution will be handled based on an agreement with the partner country and under international rules including the Paris Agreement, ensuring environmental integrity and preventing double counting. The Government will take the initiative in international rule-making based on the experiences in leading the establishment of the JCM, to create an appropriate framework for using market-based mechanisms.

As a major shipping and shipbuilding country, Japan will seek to contribute to the GHG reduction targets of the international shipping as agreed globally at the IMO, and to this end, contribute to decarbonizing international shipping by developing energy efficiency technologies and formulating an international framework at the IMO. By taking a leading role in discussions for reduction of CO_2 emissions in ICAO, Japan will also contribute to reducing emissions from international aviation.

c. Promoting International application of low-GWP and non-fluorocarbon refrigerant technologies and products

The Government will proceed with the development and introduction of low-GWP and non-fluorocarbon refrigerants and equipment using such refrigerants, and facilitate international application of Japanese refrigerating and air conditioning technologies. Regarding the reduction of fluorinated gas emissions, the Government will provide assistance to developing countries based on Japanese expertise to prevent leaks in their use and emissions upon equipment disposal, thereby reducing fluorinated gas emissions.

d. Promoting International application of climate change measures in agriculture, forestry and fisheries

GHG emissions from agriculture, forestry and other land use sectors make up

a fourth of all emissions from anthropogenic sources globally, and there are vast potentials for reducing emissions, especially in developing countries. Working with international organizations, and with the JCM and other mechanisms, the Government will apply Japanese renowned decarbonizing technologies in the agriculture, forestry and fisheries sectors, such as farm soil carbon fixation technologies, measures addressing deforestation and forest degradation and technologies to promote afforestation and reforestation in other countries, thereby contributing to reduction of GHG emissions worldwide.

(3) Strengthening Development and Investment of Energy Infrastructure Contributes to Reduction of CO_2 Emissions

In order to address two major global challenges of improving the energy access in the world and achieving a decarbonized society, it is indispensable that the innovation required for decarbonization of fossil fuels, such as the CCS, CCU and carbon recycling, is achieved. Japan will contribute to the world by exercising leadership in the international collaboration to develop and apply technologies to that end and share expertise.

At the same time, the Government will present all available options to help reduce CO_2 emissions according to the needs of the partner country, and proactively work on the wider application of the fruits of innovation, such as renewable energy and hydrogen, so that the world will reduce its dependency on fossil fuels to achieve a decarbonized society.

Bearing these in mind, the Government will promote the development and investment of energy infrastructure abroad in order to contribute to the global reduction of CO_2 emissions consistent with the long-term goals stipulated in the Paris Agreement. Especially in the light of growing demands on renewable energy worldwide, the Government will facilitate the use of renewable energy according to the circumstances of the partner country. On geothermal power generation, Japanese technologies have much competitiveness, and the Government will particularly take a wide range of measures to facilitate international application, including surveys on potentials, development, operation and preparation such as capacity building in Africa, Asia and other regions. The Government will also seek international application of offshore wind power generation, waste power generation, cogeneration systems and smart cities. The Government will also facilitate international application of such technologies as grid and energy storage to support the expansion of renewable energy, considering the needs in the partner country. During the transition to a decarbonized society, the Government will support the shift to cleaner use of gas by supporting the institutions and infrastructure to introduce LNG worldwide,

consistent with the long-term goals stipulated in the Paris Agreement.

(4) Development and Investment of Urban and Transportation Infrastructure Contributes to Reduction of CO_2 Emissions

The Government will facilitate the international application of high quality infrastructure using the private finance, and promote the application of environmental infrastructure abroad including in developing countries where the demand is strong. This will include establishing decarbonization models, such as smart cities, in Japan and promoting international application of such infrastructure as a “package”.

The proactive collaboration of local authorities and municipal entities in various sectors provides a very effective approach for establishing a global decarbonized society. The Government will broaden the opportunities for dialogue, such as meetings, among various actors, encourage municipalities to be actively involved in collaboration with other cities, and create more opportunities for these actors to be proactively engaged in finding solutions to urban challenges.

The Government will also actively facilitate international application of aviation infrastructure to enable efficient operation to reduce CO_2 emissions.

(5) Effective Use of Public Finance and Greater Mobilization of Private Finance

The Government will make efforts to expand financial resources for climate change, not limited to ODA or OOF.

Japan announced the “Actions for Cool Earth (ACE) 2.0” as a commitment for drastic global reduction of emissions with assistance to developing countries and innovation prior to COP 21 in 2015, and has been implementing it. Japan will continue to provide climate change finance as stipulated in the Paris Agreement, and it will be necessary to further utilize all public finance to this end. The OOF will be primarily used for Japanese companies seeking opportunities abroad, and ODA such as Private Sector Investment Finance will be used for international cooperation to support developing countries; the synergy between the two modalities to mobilize private finance and create impact will be sought. Furthermore, in order to support the Japanese companies with technologies of excellence useful for decarbonization in the world, in both developing and developed countries, the Government will support providing public finance on projects using advanced technologies and new ventures, thereby promoting innovation and investment by Japanese companies.

The Government will actively engage in the effective and efficient operation of the GCF and the Green Environment Facility (GEF) for improved access of funds

for developing countries, as well as for fostering understanding on financing mechanism and project cycles and networking with accredited agencies, with a view to the participation of the Japanese and partner companies leading to co-innovation.

Cooperation with the public and private financial institutions in the partner country and capacity building for financing in the climate-related sector are also important. The Government will support collaboration between the local authorities, private companies and financial institutions of Japan and the partner country to facilitate the use of private finance in the partner country, including by setting venues for dialogue and together with such institutions as the World Bank and the Asian Development Bank.

The cost of advanced decarbonizing technologies are often difficult to cover for developing countries. Therefore, the Government will take measures, including the use of the JCM, to alleviate the fiscal burden on the developing country for wide usage of decarbonizing technologies.

The Government will mobilize these public finance modalities as a leverage to encourage private investment, including by providing public finance to reduce risks and utilizing green samurai bonds.

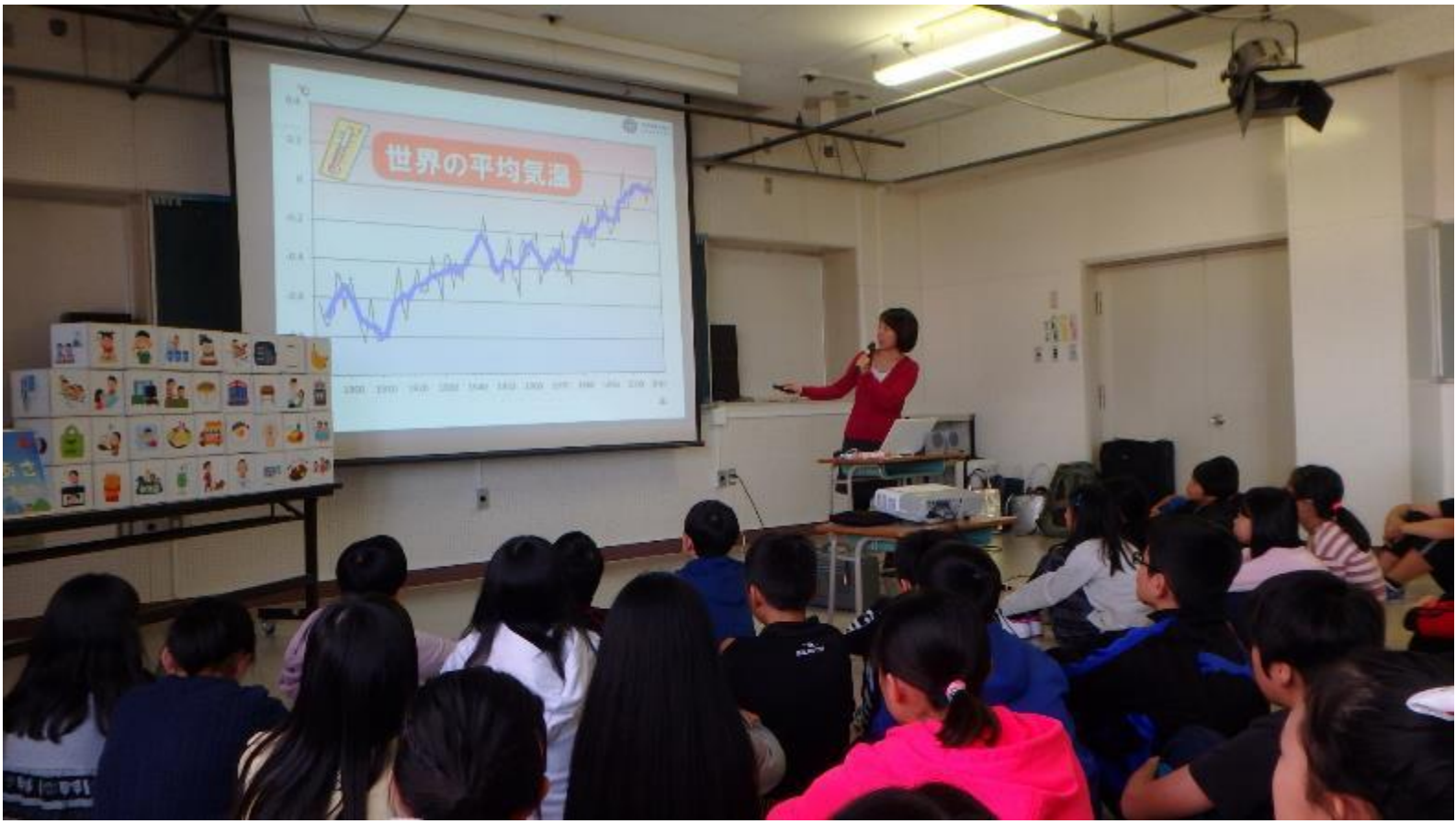
(6) Building Basis for Decarbonized Societies on a Global Scale

The Government will promote capacity building and institutional improvement in a partner country by utilizing Japanese expertise and collaborating with relevant organizations, such as: assistance for formulating the Nationally Determined Contribution and mitigation plan; institution building, and; improvement and strengthening of existing institutions. These measures will reduce the risk for private investment, provide incentives to private companies and enhance the flow of private funds, thereby activating the market for decarbonizing technologies.

The Government will facilitate co-innovation under enhanced transparency, in view of the growth in international initiatives to estimate and control the reduction of the emission in the entire supply chain. The Government will also aim for enhanced transparency in the entire supply chain of public corporate activities to foster decarbonizing technologies and industries.

Chapter 4

Direction of Other Cross-Sectoral Policy Measures



Chapter 4: Direction of Other Cross-sectoral Policy Measures

(1) Human Resource Development

a. Education

The Government will further promote the Education for Sustainable Development (ESD) to help achieve SDGs, including climate change. Through the activities of UNESCO schools, which are designated as the ESD hub, and other schools, the Government facilitates raising awareness and interests among pupils, students and teachers. At places outside schools, such as families, local communities and workplaces, voluntary efforts will be encouraged and best practices actively shared, including by introducing awards. Collaboration with various stakeholders in the local community working on climate change will also be sought.

The Government will facilitate human resource development for a sustainable community, towards achieving the Circulating and Ecological Economy and based on the notion of the ESD, together with various stakeholders. The Government will thus promote the development of human resources to cultivate partnerships and further communication with other localities.

b. Human Resource Development for Innovation

In order to create sustained innovations for the virtuous cycle of environment and growth, it is important that the Government develops and maintain human resources in a wide range of fields, starting with science and technology that relate to environment and energy. In order to continue developing human resources for the future, the Government needs to be continuously engaged in human resource development from a long-term perspective. As the issue of decarbonized society is of a global nature, the entire international community needs to make efforts together. In this context, it is important that Japan, renowned for high academic and technological standards, develop human resources to lead the world decarbonization.

Accordingly, human resource development for comprehensive research and development from basic research to practical application in the fields of environment and energy will be conducted, including preparing necessary environment such as on-the-job training, aimed at educating young and capable researchers.

In business management, the Government will facilitate companies incorporate perspectives to appropriately address environmental issues and create new

corporate values. In this context, the Government will facilitate efforts of companies to develop human resources in and out of the company to be engaged in management emphasizing environment and environmental protection and lead a “green” socio-economic system -- environmental human resources.

(2) Enhancement of an Integrated Approach in Building a Resilient Society to Adapt to Climate Change

In responding to climate change, mitigation and adaptation are complementary measures to each other. The Government will steadily promote climate change measures based on two laws and two plans respectively.

In particular, the promotion of measures that bring about positive effects on both mitigation and adaptation will help reduce the GHG emissions while simultaneously improving societal resilience. These measures will also bring many benefits as well, such as developing a sound local community and improving people’s health. For example, the introduction of self-sustained and distributed energy including renewable energy is a mitigation measures, and, at the same time, helps revitalize the local economy and secures energy in the event of disaster, thus beneficial for adaptation. Developing and disseminating technology to streamline and conserve water use and increasing awareness on water conservation will also contribute to reducing GHG emissions by reducing the energy required for water supply and sewage system treatment. In addition green infrastructure and ecosystem-based approaches including the one based on forest (EbA and Eco-DRR) will have various advantageous effects, such as: adaptation to climate change such as disaster risk reduction; mitigation of climate change in terms of carbon sink; generation of various social, economic and cultural co-benefits in local communities, and; contribution to conservation of biodiversity and its sustainable use.

The type and scale of climate change effects significantly vary by climate, geography, socio-economic conditions, and other regional characteristics. The fields requiring urgent measures also differ by region. In light of the situation, the Government has utilized a knowledge platform on climate change (A-PLAT), to strengthen and improve knowledge by linking the data of various ministries, agencies and research institutions and will provide information such as climate risk in a practical format to be utilized by various entities.

In addition, the Government will enhance the awareness of business operators on adaptation and encourage taking measures by preparing and providing the best practices of business operators in and out of Japan -- “visualizing” --, on “climate risk management” -- finding climate risks associated with business activities and taking measures -- and “adaptation business” -- providing

technologies, products and services on adaptation.

(3) Just Transition

In moving toward a decarbonized society, the Paris Agreement takes into account the imperatives of a “just transition of the workforce”. The Just Transition Declaration was adopted at COP24, underlining the growing international recognition of the importance of just transition. It is important that a just transition is made with decent work and improvement in productivity. Since many companies in Japan are rooted in localities, a comprehensive consideration on transitioning local economies and companies will be required as well. While there may be challenges with these transitions, there will also be opportunities in terms of restructuring in the industry.

Against this backdrop, the Government, local authorities and companies will work together to provide vocational training to the workforce, support for diversification and shifts in business operations, inviting new business and support for placement of the labor force, in order to achieve the transition of the workforce to a decarbonized society smoothly and without delay.

(4) Government’s Own Efforts to Lead the Society

The Government will lead the way in carrying out initiatives to create a decarbonized society on its own administration and undertakings, while working for the comprehensive introduction to the entire society. The Government will contribute to make available the information of the budget on environmental protection, including climate change.

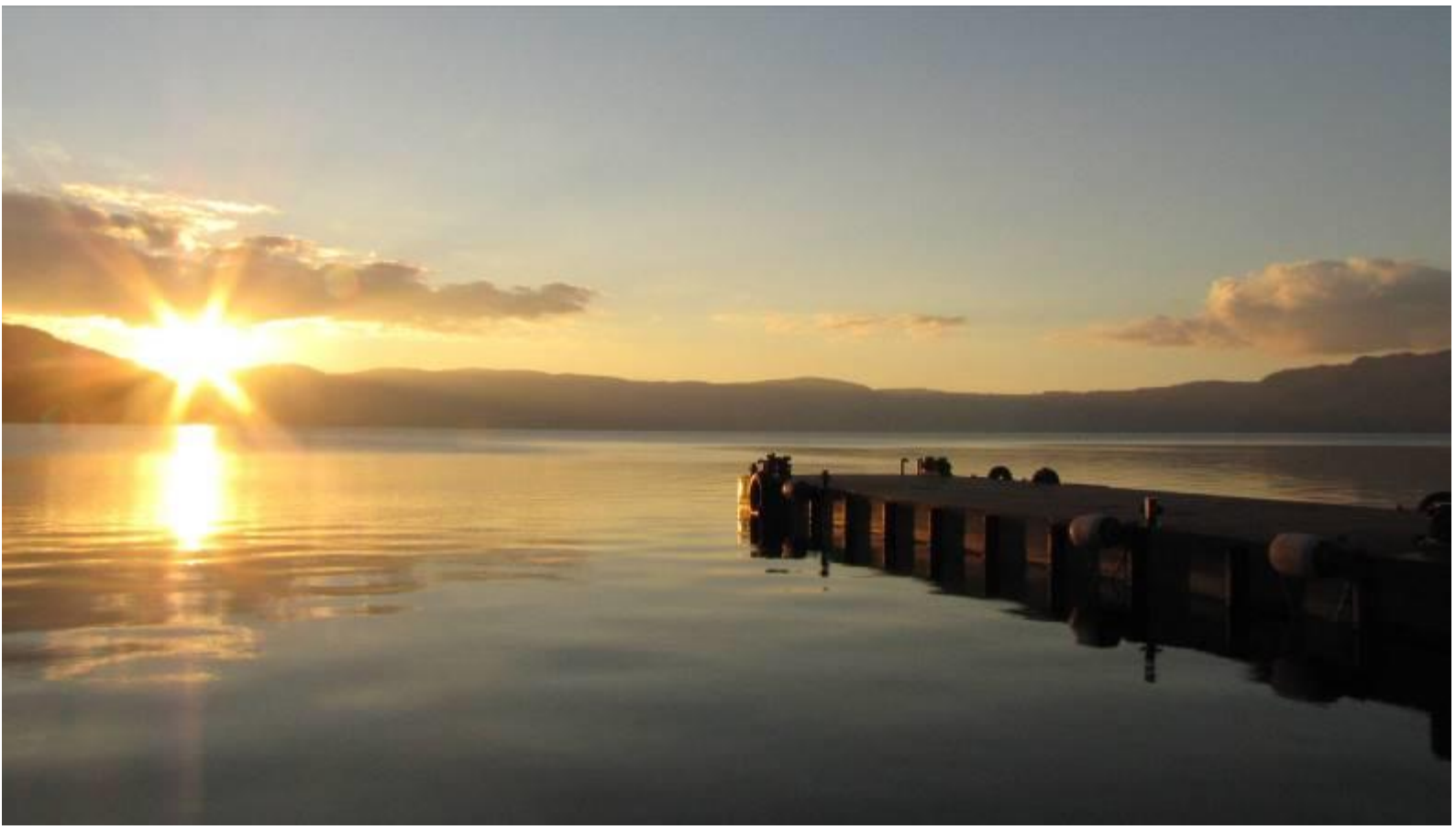
(5) Carbon Pricing

Discussions on carbon pricing took place at the G7 Ise-Shima Summit in 2016 and the G7 Charlevoix Summit in 2018. Some countries and regions, including some European countries and States in the US have already introduced carbon pricing schemes, and China introduced the Emission Trading Scheme (ETS) on a national scale. On the other hand, the marginal cost of CO_2 reduction is high in Japan, as are energy costs. From the perspective of energy security, there is the fact that Japan imports the majority of its energy resources from abroad. Carbon pricing includes not only the pricing at the market, but also taxation, which has already been introduced to some degree. However, the effects, assessment, and challenges vary by system. Professional and technical discussions considering the perspectives of international trends, conditions in Japan and

international competitiveness are required.

Chapter 5

Review and Implementation of Long-term Strategy



Chapter 5: Review and Implementation of Long Term Strategy

In relation to this Strategy, the Government will carry out analyses, taking future situational changes into account, based on the best available scientific knowledge, on issues such as the constraints on land, climate, resources and social systems, adverse economic effects and opportunities for growth caused by climate change. Furthermore, the Government will widely disseminate the information that has been found, and promote further initiatives by pursuing collaboration with the stakeholders and dialogue that include younger generations, who will uphold the society over the long term.

Reflecting on the vision established in this strategy and taking into account the Plan for Global Warming Countermeasures and the Strategic Energy Plan, the Government will revisit the policy measures referred to in this Strategy flexibility about every 6 years with reference to situations, and review this Strategy as may be required.