Provisional Translation

Strategic Energy Plan

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Introduction

In response to the March 2011 Great East Japan Earthquake and accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi Nuclear Power Station, in April 2014 the Government of Japan established the fourth Strategic Energy Plan for 2030 which stated the policies of reducing nuclear power dependency, reducing fossil resources dependency, and expanding renewable energy.

Four years after the establishment of the fourth Strategic Energy Plan, the time has come to not only revise the plans for 2030 but also for Japan to conceptualize its energy choices once again, including responses focused on 2050 in response to the Paris Agreement coming into force, ultra-long-term responses in preparation for the depletion of fossil resources in the longer term, responses to changing energy environments, etc. For that reason, the present revision of the Strategic Energy Plan is comprised of realization of the long-term energy supply and demand outlook in 2030 (July 2015 Ministry of Economy, Trade and Industry decision; hereinafter referred to as the "energy mix") and the design of scenarios focused on 2050.

There are points that must be taken into account at all times when conceiving energy choices.

Firstly, there has consistently been no change to the position that the starting point is to take measures keeping the experience, regrets, and lessons learned of the TEPCO's Fukushima Daiichi Nuclear Power Station accident uppermost in mind.

We will do our utmost to achieve the reconstruction and recovery of Fukushima while reflecting on and responding to the pain felt by the people affected by the accident at TEPCO's Fukushima Daiichi Nuclear Power Station. GOJ and nuclear operators must continue to reflect on the fact that they fell into the trap of the so-called "myth of safety", resulting in the failure to adequately deal with the severe accident and prevent a disaster like this. Around seven years after the disaster, approximately 24,000 people still remain subject to the evacuation order. It is essential to proceed with such measures as compensating for the damage done by the nuclear accident, implementing decontamination work, constructing an interim storage facility for radioactive waste, decommissioning damaged reactors, disposing of contaminated water and controlling damage from groundless rumors. There is also a pile of other challenges related to nuclear power generation, including what to do with spent fuels and final disposal of radioactive materials. In order to address these challenges, GOJ should play a more proactive role in implementing preventive and multi-layered measures in order for the fundamental settlement of the contaminated water issue and decommissioning and the other issues related to nuclear power generation by bringing together domestic and international

wisdom.

Japan, which has experienced the accident at TEPCO's Fukushima Daiichi Nuclear Power Station, is giving the top priority to safety regarding nuclear power when realizing the 2030 energy mix and making its energy choices for 2050 and is reducing its dependency on nuclear power as much as possible as it aims to expand renewable energy.

Secondly, a consistent idea regarding energy choices since the war has been energy independence. The energy independence policy of reducing the enormous energy costs and changing the structure dependent on overseas energy is an unchanging requirement. The global momentum toward decarbonization seen in the Paris Agreement coming into force overlaps with the present energy choices.

The measures for these issues lead to answers to the question of how to secure energy after fossil resources are depleted one day. Japan, a country with advanced energy technologies, must play a leading role in the development of decarbonized energy.

Energy technologies themselves are rare resources for securing safety, realizing energy security and decarbonization, and strengthening competitiveness. Japan will boldly challenge itself to resolve these issues by pursuing the potential of all technological options and working on the development of those technologies through public-private cooperation.

Premised on the above two points, the perspectives when realizing the 2030 energy mix and considering the design of scenarios focused on 2050 are as follows.

Energy environments change moment by moment, and since the establishment of the previous plan a groundswell leading to major changes, for example a huge fall in the prices of renewable energy globally, has been seen but at the present stage no perfect energy sources exist.

The current situation is that for renewable energy with fluctuating output such as solar power and wind power, etc. adjustments using demand control, pumping, thermal power, etc. are necessary, and complete decarbonization is difficult using these methods alone. They become more useful when combined with electricity storage and hydrogen, but there are the issues of the increase compared to overseas of the power generation cost and the power grid constraints, etc. Nuclear power has only partially gained the trust of society, and in the context of the spread and liberalization of renewable energy the development of nuclear power is a task for the future. With fossil resources decarbonization is possible using hydrogen conversion, but this is also still being developed. There are no essential changes to the technology trends at the 2030 stage which were anticipated at the time of the establishment of the plan four years ago. Japan will start by focusing all of its efforts on the steady realization of the 2030 energy mix.

On the other hand, if we look ahead to the prospects for 2050, there is the possibility of non-continuous technological innovation. Competition over the development of not only renewable energy but also all decarbonization technologies such as electricity storage and hydrogen, nuclear power, distributed energy systems, etc. is intensifying. Competition among nations and among companies with the aim of obtaining the initiative in energy technologies is accelerating. Japan is not blessed with fossil resources. It is a country for which obtaining the initiative in energy technologies is more necessary than anything else. Japan will maintain all options regarding decarbonization technologies, work their development through public-private cooperation, and lead the challenge to achieve decarbonization. It will challenge itself to achieve energy transitions and decarbonization. This is the basis of the energy choices for 2050.

Based on the above, the present Strategic Energy Plan, which is the fifth plan, further strengthens measures for the steady realization of the 2030 energy mix and sets out the challenge to achieve energy transitions and decarbonization in 2050 as the new energy choices. We expect that these policies and the approach taken to them will bear fruit as the behavior of the nation, industries, finance, and individual from all walks of life and will lead to the implementation of Japan’s vision of the future of energy.

Chapter 1 Structural Issues, Changes in Circumstances, and Policy Timeframe

Section 1. Structural issues faced by Japan

1. Vulnerability due to high dependency on overseas energy resources

Japan has controlled energy consumption through various energy-saving efforts since the first oil shock in 1973 while improving the people's lives and industrial activity as well as shifting the industrial structure to the service industry. As a result, final energy consumption in 2012 was only 1.3 times higher compared to 1973.

Japan depends on imports for almost all of its energy resources. Therefore, Japan has a fundamental vulnerability: it would be difficult for the country to secure the resources autonomously if an energy supply problem should occur abroad.

Since energy saving alone is not enough to resolve this vulnerability, Japan has made constant efforts to secure domestic energy resources while diversifying risks by promoting the utilization of alternatives to oil, its core energy source.As a result, Japan's energy self-sufficiency (including nuclear power) in 2010 before the Great East Japan Earthquake improved to about 20% but after the Great East Japan Earthquake the situation worsened due to the closure of the nuclear power plants, etc., and energy self-sufficiency was no more than about 8% in 2016. The fundamental vulnerability of the energy supply structure in Japan still remains.

2. Mid- to long-term changes in the energy demand structure (population decline, etc.)

The Japanese population is on a downtrend. Population-related factors like this would reduce energy demand. Thanks to the Japanese industry's efforts, such as improving automobile fuel efficiency and raising the energy saving standards for home electrical appliances, as well as the decreasing energy consumption rate in the manufacturing industry, Japan is making steady progress in its energy saving initiative.

Moreover, the demand structure is being significantly altered by the expansion of the application of energy sources such as the introduction of a new generation of automobiles that derive power from electricity or hydrogen as well as cogeneration systems, which use gas efficiently.

The rapid aging of society will also bring about changes to future energy demand. Moreover, there is an increasing possibility of major transformations to the demand structure due to digitalization such as AI, the IoT and VPP, etc. and the use of those technologies.

Such changes in Japan's energy demand structure due to the population decrease and

technological innovation are expected to continue, and the challenge ahead is how to cope with the changes.

3. Instability of resource prices (increased energy demand in emerging countries, etc.)

As for global trends, the main source of energy demand is shifting from developed to developing countries. Global energy demand is expected to greatly increase, however much of the demand increase is attributable to growth in non-OECD ("Organization for Economic Co-operation and Development") countries.

Countries where energy demand is expanding, including China and India, are making active efforts to promote resource development and procurement through their state-run companies. As a result, fierce competition for resources involving companies in emerging countries is occurring around the world. In particular, the proactive and strategic moves with respect to the expanded energy demand and acquisition of resources by China and the increasing introduction of electric vehicles (EVs), etc. could have a major impact on not only global resources and their price trends but also the mid- to long-term energy security of Japan.

On the other hand, major structural changes are also occurring on the supply side, including increased supply of shale gas and oil by the U.S. In 2015 U.S. became number one in country crude oil production volume, and it also jumped to number one for natural gas production volume. The shale revolution is also having an impact on the prices of crude oil and natural gas; for example, crude oil prices temporarily dropped below 30 dollars a barrel in 2016, the lowest level since 2003. Subsequently, crude oil prices recovered due to the impact of agreements to cut production by the Organization of the Petroleum Exporting Countries (OPEC) and regional conflicts, etc. but these structural changes on the supply side sometimes encourage wild fluctuations in crude oil prices.

As above due to the changing economic circumstances in addition to the escalation of competition for natural resources and regional conflicts, changes in the demand trend and change in the supply structure are resulting in a long-term uptrend of resource prices and a situation where wild fluctuations in resource prices are more liable to occur than before. The International Energy Agency (IEA) has presented the possibility that crude oil prices will be fluctuating in the range of 60 dollars to 140 dollars in 2040.We are likely to continue to see the current situation of the crude oil price changing significantly depending on the political and social situations in the Middle East region and the economic conditions in Europe, the U.S. and China.

4. Increasing global greenhouse gas emissions

Strong energy demand in developing countries has completely changed the state of greenhouse gas emissions. Global energy-derived carbon dioxide (CO_2) emissions have increased overall and emissions by emerging countries are showing particularly strong growth. The world's total greenhouse gas emissions have decreased from around 70% in 1990 to around 40% in 2010. Thus, the proportion of emissions by developing countries is now larger than that of emissions by developed countries.

Global emissions of energy-derived CO_2 are expected to increase further, according to the IEA. Specifically, in the policy scenarios taking into account the NDC(nationally determined contribution) of each country based on the Paris Agreement, an increase from approximately 32 billion tons in 2016 to approximately 36 billion tons in 2040 is anticipated. The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) found that global warming is an indisputable fact and that in order to curb climate change, it will be necessary to make fundamental and continuous efforts to reduce greenhouse gas emissions. In this context, we should note the adoption of the "2030 Agenda for Sustainable Development" at the United Nations and the coming into force of the Paris Agreement. This agenda sets out sustainable development goals (SDGs) related to energy, economic growth and employment, climate change, etc. Furthermore, the agreement aims to achieve a balance between anthropogenic emissions of greenhouse gases and the amount of greenhouse gases eliminated through sinks globally in the second half of the current century, and globally the momentum toward decarbonization is growing. (This plan indicates that "in order to achieve a balance between anthropogenic emissions of greenhouse gases and amount of greenhouse gases eliminated through sinks globally in the second half of the current century, carbon emissions must be reduced by reducing dependency on the use of fossil fuels, etc.") In order to achieve the SDGs and fundamentally resolve global warming problems, it is an urgent task to drastically reduce global greenhouse gas emissions, not to mention reducing domestic emissions.

Section 2 Changes in energy environments

1. Start of inter-technology competition for decarbonization

(1) Growing expectations for renewable energy

In the last few years the prices of renewable energy have fallen substantially overseas against the background of the introduction of many feed-in-tariff system (FIT), etc. Many EVs have also been introduced through policy support by major countries, and as a result the prices of in-car storage batteries have begun to fall.

Taking these opportunities, attempts to create decarbonizing energy systems combining renewable energy, electricity storage, digital control technologies, etc. are accelerating and involving a wide range of industries. Some of the large-scale electric power companies and gas companies have also started the development of distributed energy systems centered on renewable energy. Even on the demand side, some global companies are aiming to cover 100% of their electric power consumption with renewable energy. These kinds of moves by companies are increasing globally, and the expectation is emerging that it will be possible to realize economic growth while aiming for decarbonization through energy transitions.

On the other hand, it has become clear at the same time that a variety of issues arise with the introduction of large amounts of renewable energy. For example, the current situation is that for renewable energy with fluctuating output such as solar power and wind power, etc. adjustments using thermal power, pumping, etc. are necessary, and decarbonization cannot be realized using these methods alone. Due to the problem of intermittency due to the weather condition, trust in the supply is low and as dependency on renewable energy increases it becomes difficult to achieve the stability of quality (maintenance of frequency) for preventing power cuts due to natural fluctuations. Furthermore, it is necessary to further improve the power generation efficiency to reduce the installation area and it is necessary to redesign the entire transmission and distribution network through investment to upgrade the grid network in order to ensure different power generation locations from thermal power and nuclear power. Furthermore, development of compact electricity storage systems, etc. is important for utilizing renewable energy as a distributed energy system.

In this way, expectations of renewable energy are higher than they have ever been before, but electric power systems depending on renewable energy alone face many issues at the current stage for self-reliance and decarbonization, and it is predicted that technological innovation competition will intensify going forward power in the areas of improvement of generation efficiency, escaping from dependence on thermal power, pumping, etc., the

development of electricity storage systems, and the establishment of distributed network systems, etc.

(2) Innovation in renewable energy leads to innovation in other energy sources

Falls in the prices of renewable energy and gas induce technological innovation for other fossil energy and nuclear power and moves to oppose or co-exist with renewable energy are also emerging.

As one example of this, attempts to decarbonize fossil fuels have begun, including a Japan-Australia initiative to gasify lignite to manufacture hydrogen, and cheaply capture and store the CO_2 (CCS) that is generated in that process to convert it to a decarbonized energy source.

Nuclear power is not an exception. In the U.S. there is a movement attempting to realize 80 years of operation by thoroughly implementing safe operation and management of large nuclear reactors, and in addition development of small nuclear reactors has started. It is a challenge based on new concepts that aim to shorten the investment period, increase suitability for investment, and explore the possibilities for co-existence with renewable energy, and in the United Kingdom, Canada, etc. as well similar attempts are occurring under the leadership of the private sector. In this way attempts at innovation meeting social needs are starting worldwide, for both large and small reactors.

Although the “possibilities” are growing, at the current time perfect energy technologies that are economic and decarbonized and can satisfy fluctuating energy demand alone have not been realized. Competition among technologies has just started, and the outcome of that competition is still unclear.

2. Geopolitical risks increased by technology changes

(1) Increase in geopolitical risks

Changes in technologies have an impact on the geopolitical environment surrounding energy. There is the view that if a transition from an energy structure dependent on oil primarily located in the Middle East to an energy structure of renewable energy and gas providers with a smaller regional skew than oil can be realized through the shale revolution in the U.S. and the fall in the prices of renewable energy, then the countries of the world will not under the influence of particular countries, bringing about the democratization of energy.

On the other hand, according to the IEA, even if the scenario based on the SDGs, a sustainable development scenario, is achieved at the 2040 stage, the ratio of fossil fuels in the primary energy supply is forecast to be 53% in developed countries and 63% in

emerging countries. On the other hand, renewable energy will account for no more than 32% in developed countries and 29% in emerging countries. If we take into account this outlook, we can conclude that in reality the energy structure under which global energy environments greatly influence geopolitical risks due to oil will continue.

Furthermore, as is shown by the fact that China's rapid shift to gas caused LNG prices in Asia to double in an instant, we cannot ignore the fact that the rising energy demand of emerging countries such as China, India, and countries in Southeast Asia has the effect of increasing the risk of fluctuation in the prices of fossil resources price. Moreover, the rising volatility of the prices of fossil resources means increasing uncertainty in the national finances of the oil producing countries, and there is a possibility that the instability arising from the economic structures of the oil producing countries will increase geopolitical risks.

If we take into account the above, we can conclude that there is a high likelihood that the geopolitical risks surrounding energy will not be alleviated but rather will increase, at least transitionally.

(2) Diversification of risks with regard to energy (emergence of geo-economical risks, etc.)

The other point that must be noted is that the emerging superpowers of China and India are increasing their influence on both the demand and supply side of energy, and through that the so-called "geo-economical risk" that they will exercise their political power could emerge.

In particular, China's rise is marked in technology sectors that support decarbonization such as the electricity storage that underpins solar panels and EVs, digitalization technologies, and nuclear power. Supply of solar panels in Japan by Japanese companies has fallen substantially in the last few years and Japan is now dependent on China. In the context of this change in the situation, the pattern that "the leading energy technology countries = Japan, the U.S., and Europe" is not a given anymore. It is a situation in which we must reaffirm the importance of the concept of "technology self-sufficiency" (the amount of energy supply which is covered by our own country's technologies with respect to domestic energy consumption) under which our own country secures the core technologies in the energy supply chain and leads the world in innovation regarding those technologies. Furthermore, as digitalization and the introduction of the IoT, etc. progress, there is a high likelihood that energy environments will become unstable transitionally. For example, we must be aware of responses to new risks, such as the risk of a cyber-attack on energy-related equipment such as power generation facilities and the grid

network, etc.

3. Intensified competition between nations and firms

The long-term low-emissions development strategies presented by major countries are all ambitious with respect to the level of the greenhouse gas emissions reduction targets, but they present overall visions and policy directions; no country has clarified the specific achievement methods. On the other hand, all of the countries face issues specific to them and the governments of each country have clarified their “intention to reform” to decarbonization, and that is generating global momentum toward decarbonization.

Major energy companies in Europe and the U.S. are also competing over measures for decarbonization. They are closely assessing the core businesses in their business portfolio while pursuing the possibilities of new technologies in parallel. Their strategies differ for each company and are diverse, but at a time when there is both a sense of crisis and a sense of expectation with respect to the groundswell toward energy transitions and decarbonization there is largely agreement on the point that positive exploration with respect to reformation is continuing.

Note that in the financial capital markets efforts to carefully assess the impact of the groundswell toward energy transitions and decarbonization on the sustainability of companies, industry, and society are intensifying. In parallel with the expansion of ESG investment placing importance on the Environment, Society, and Governance, there is a trend of examples of engagement (encouraging improvement by lobbying investment destination companies through constructive dialogue) and examples of divestment (withdrawing funds from fossil fuels, in particular coal thermal power generation-related assets), etc. leading to a reduction in the use of fossil fuels with large greenhouse gas emissions such as coal, etc. If we take the long-term view, there is the possibility that it is precisely business management setting out an “energy transitions and decarbonization scenario with a set time frame” in which long-term corporate value will be found and attention will be attracted in financial capital markets.

Section 3 Achievement of an optimal energy mix by 2030 and its relation with the 2050 scenario

The 2030 energy mix is a forecast that comprehensively takes into account existing infrastructure, technologies, and human resources and is presented with sufficient probability. This forecast is consistent with the reduction target submitted to the United Nations Framework Convention on Climate Change Secretariat as Japan's NDC under the Paris Agreement (reduce greenhouse gases by 26.0% compared to the FY2013 level by FY2030 (25.4% down compared to the FY2005 level)), provides a certain degree of predictability with respect to the medium-term investment behavior of the private sector, and is an important guideline providing a solid foundation for that behavior.

When we confirmed the progress toward this energy mix it was as follows, and we can reach the evaluation that steady progress is being made, but the level is not adequate and the situation is that we are only partway to the goal.

Taking into account the above, and based on the principle of 3E+S, Japan will strongly adhere to its previous Basic Policies of thorough energy saving, maximum introduction of renewable energy, streamlining of thermal power generation, and reduction of dependency on nuclear power as much as possible, while aiming for steady realization of the 2030 energy mix by identifying and strengthening implementation of measures, etc. for each energy source.

On the other hand, regarding the long-term outlook for 2050, a forecast with a high level of probability is difficult because it involves the potential and uncertainty of technological innovation, etc. and the lack of transparency regarding changes in conditions. For this reason, it is appropriate to take an approach using multiple-track scenarios under which ambitious targets are set but priorities are always decided based on the latest information.

(1) Energy saving

Final energy consumption in FY2013 was about 360 million kl crude oil equivalent, and due to thorough energy saving measures a reduction of about 50 million kl compared to before the measures is expected in FY2030. This is equivalent to a reduction of about 2.8 million kl per year. The reduced amount as of FY2016 is about 8.8 million kl, and the current situation is that it is being reduced at the pace of about 2.2 million kl per year. Note that the breakdown of the final energy consumption as of FY2016 (about 340 million kl) is about 90 million kl for electric power, about 80 million kl for transportation, and about 180 million kl for heat.

(2) Zero-emission power source ratio

The zero-emission ratio in FY2013 was about 12%, including renewable energy of 11% and nuclear power of 1%, and this is expected to reach about 44% in FY2030 through the promotion of the introduction of renewable energy and the restarting of nuclear power plants that are recognized by the Nuclear Regulation Authority to conform with regulatory requirements which are at the most stringent level in the world. This is equivalent to a rise of about two percentage points per year. In FY2016 it reached about 16% so the current situation is that it is rising roughly two percentage points per year.

(3) Energy-derived CO_2 emissions

Energy-derived CO_2 emissions in FY2013 were 1.24 billion tons, and they are expected to be about 930 million tons in FY2030. This is equivalent to a reduction of about 20 million tons per year. In FY2016 they were about 1.13 billion tons, so the current situation is that they are reducing at the pace of about 40 million tons per year.

(4) Electricity costs

In FY2013 electricity costs, the sum of the fuel costs of electric power and the purchase costs of the FIT system, etc., were 9.7 trillion yen, and they are expected to be lowered to 9.2-9.5 trillion yen in FY2030. The current situation is that there is an increase in purchase costs due to the FIT system while on the other hand resource prices are falling, and in FY2016 electricity costs were 6.2 trillion yen overall.

(5) Energy self-sufficiency

Energy self-sufficiency in FY2013 had fallen greatly after the Great East Japan Earthquake to 6% but it is expected to reach 24% in FY2030 through the promotion of the introduction of renewable energy and the restarting of nuclear power plants that are recognized by the Nuclear Regulation Authority to conform with regulatory requirements which are at the most stringent level in the world. This is equivalent to a rise of about one percentage point per year. In FY2016 it was about 8%.

Chapter 2 Basic Policies and Measures towards 2030

Section 1 Basic Policies

1. Confirmation of the basic viewpoint of the energy policy (3E + S)

(1) Basic Viewpoint of the Energy Policy (3E + S)

Energy is the foundation that supports all human activities.
Japan cannot keep developing without establishing an energy supply-demand structure that realizes a stable energy supply system which imposes a light burden on society.
However, as mentioned in Chapter 1, Japan's energy supply-demand structure is vulnerable. In particular, carrying out a bold reform of the energy supply-demand structure is inevitable in order to overcome challenges Japan has faced since the Great East Japan Earthquake and the TEPCO's Fukushima nuclear accident.

When promoting the energy policy, it is important to look at the entire supply chain of energy from production and procurement to distribution and consumption in order to tackle mid- to long-term issues after clarifying basic viewpoints.

The point of the energy policy is to first and foremost ensure stable supply ("Energy Security"), and realize low cost energy supply by enhancing its efficiency ("Economic Efficiency") on the premise of "Safety." It is also important to make maximum efforts to pursue environment suitability ("Environment").

Under this principle of 3E+S, GOJ will steadily advance energy policy and the responses based on it with the aim of steady realization of the 2030 energy mix.

(2) Importance of the Global

Viewpoint Changes in the circumstances surrounding energy supply we are facing now affects not only Japan domestically but also many other countries as a new global trend. In the field of energy, challenges that cannot be solved by any one country alone are increasing.

For example, in terms of resource procurement, consuming countries and companies can work together to improve their terms of trade through negotiations with resource-supplying countries while competing with each other. In this way, they can enhance the rationality of the terms of resource trading while entangled in a web of competitive and cooperative relationships.

Also, regarding safe and peaceful use of nuclear power, for example, global warming countermeasures and securing of a stable energy supply system, must be addressed from the global viewpoint, because it is impossible to achieve the original objectives without cooperation among relevant countries.

GOJ must establish energy policies that precisely reflects the global developments described above. Moreover, the international trend is for developments to further

accelerate and become liquid, including geopolitical and geo-economical perspectives, so there is an even greater requirement to respond quickly and appropriately to this.

The global viewpoint is also increasingly necessary for the energy related industries.

In light of Japan's energy supply structure that depends heavily on overseas resources and increasingly weakening domestic energy demand, it is more important than ever for Japan to proactively promote internationalization, pursue collaboration and cooperation between companies both domestically and overseas, strengthen overseas business operations and take advantage of foreign demand in order to enable the energy industry to reinforce the management base and achieve further development while helping to stabilize Japan's energy supply.

(3) Importance of the viewpoint of economic growth

Energy supports the basis of industrial activities. In particular, stability of energy supply and energy cost greatly affect business strategies, including where to locate business operations, as well as business activities.

As mentioned in the "Basic Viewpoint," achieving stable supply of energy and reducing the environmental load while realizing low cost energy supply by enhancing economic efficiency is a precondition for keeping existing business operations in Japan and attaining further economic growth.

The "Japan Revitalization Strategy (Cabinet decision on June 2013)" strongly calls for promoting the establishment of an energy supply-demand structure in which constraints on electric power and energy are overcome and cost is reduced at the same time by carrying out reforms of the energy sector in order to make Japan a friendly place for business activities through enhancement of the country's competitiveness as a business location.

In addition, the reform of the energy supply-demand structure will encourage new business entry in various ways, and may lead to the arrival of companies which supply energy more comprehensively and effectively and create a new market integrated with non-energy markets.

Furthermore, such reform structuring will provide an opportunity for Japan's energy industry to strengthen its competitiveness and boost its presence in the global market. It is expected to contribute to improving the trade balance through exports by energy-related companies of energy-related equipment and services with high value added.

In addition, effectively utilizing the energy resources present in the regions to build an independent and distributed energy system leads to the economic revitalization of the regions and their greater resilience including disaster management, etc.

Therefore, the contribution to economic growth should be considered as an important viewpoint when developing energy policies. When doing so, the viewpoints of utilization of the outstanding energy technologies possessed by Japanese companies and the creation

of domestic and overseas markets and expansion of overseas contributions using those technologies are also important.

2. Building of a "multilayered and diversified flexible energy supply-demand structure" and policy direction

For Japan to create an environment where social and economic activities are conducted in a stable manner despite the limited availability of energy resources, it is necessary to establish an energy supply-demand structure which makes it possible to secure a stable supply-demand balance continuously. To that end, it is necessary to ensure stability and efficiency so as to enable flexible responses to changes in energy supply volumes and prices in normal times. At the same time, it is also necessary to make it possible to use other energy sources as backups in a smooth and appropriate manner if supply of a specific energy source is disrupted in times of crisis.

We aim at to create such a "multilayered and diversified flexible energy supply-demand structure."

Japan will implement policy measures based on the following objectives in order to establish such an energy supply-demand structure.

(1) Creating a supply structure where various energy sources make up a multilayered supply system

As each energy source has its advantages and disadvantages in terms of supply chain, there is no all-purpose energy source that can support a stable and effective energy supply-demand structure on its own.

To create a supply-demand structure that ensures stable supply even in times of crisis, it is necessary to establish a multilayered supply structure which has a combination of energy sources so that the strengths of individual energy sources can be maximized to appropriately offset each other's weaknesses.

(2) Promotion of a resilient energy supply structure

Establishing a multilayered energy supply system which is sufficiently resilient to function properly not only in normal times but also in times of crisis so as to ensure stable supply of energy is one of the top priorities for truly ensuring a stable supply of energy.

By looking at the whole energy supply chain, including supply of secondary energy such as electric power, we should continue to carefully identify problems in order to minimize defects of the supply system and realize quick recovery of supply and should quickly take necessary measures.

(3) Participation of diverse entities in the energy supply structure through structural reforms

Breaking down the sectoral barriers of the energy market through the reform of the electric power and gas systems is expected to promote mutual entry of existing energy suppliers into each other's sector, the entry of new suppliers from non-energy industries into the energy market, and free participation of local governments, non-profit organizations and others that conduct regional energy supply-demand management service in the energy supply structure.

Allowing diverse entities to provide various energy sources will increase competition in the energy market and will promote the efficiency of the energy industries. Currently, electric power and gas system reform is proceeding, but through this process it is necessary to promote the development of the mid- to long-term business environment, including encouragement of competition by diverse entities, transformation into efficient markets, market reforms taking into account public nature, and a response to the underinvestment problem, etc., and to carry out global development and innovation using AI and the IoT, etc.

This is also expected to contribute to local revitalization by creating a new local industry, for example.

(4) Creating an energy supply-demand structure led by the demand side through providing various options for end users

We can make the energy supply-demand structure flexible by providing various options for end users and by allowing them to participate in the supply structure through a distributed energy system, for example.

If end users can select an energy source from among various options, the demand trend will have effects on the shares of energy source types in the supply structure and the scale of supply. Consequently, a more efficient supply structure is expected to be created.

If the supply structure changes flexibly according to changes in the demand trend, it will increase the stability of the multi-layered supply structure. Furthermore, the further expansion of demand side-led distributed energy systems is expected due to the popularization of local production for local consumption-type renewable energy and the popularization of cogeneration, technological innovation in storage batteries, etc., the utilization of AI and the IoT, etc.

(5) Improving self-sufficiency by developing and introducing indigenous energies, etc. to minimize the impact of changes in overseas circumstances

Since Japan depends heavily on overseas energy resources, the country always faces the risk of supply instability against the background of the limits of its negotiating power in resource procurement and the effects of changes in the situations of resource-supplying countries and sea lanes. Ensuring energy security continues to be a significant challenge for Japan.

To overcome such challenges and enhance response capability against changes of international situation, it is important to develop a policy framework that enables the improvement of self-sufficiency by continuing mid- to long-term efforts to strategically utilize renewable energy, nuclear power as quasi-domestic energy, and resources laying in Japan's EEZ, including methane hydrate and other offshore resources, as a domestically-produced energy. Furthermore, in this context, it is effective for example to set targets, etc. as necessary for the independent development ratio in oil, natural gas and coal (the proportion of import volume and domestic production volume accounted for by the volume of trades and domestic production volume pertaining to the interests of Japanese companies), including obtaining interests in overseas resources.

(6) Contribution to global warming countermeasures for reducing domestic and overseas greenhouse gas emissions

Japan has taken the initiative to proactively solve global warming problems by improving energy efficiency before other countries. Since Japan has accumulated technologies and know-how for saving energy and expanding use and applications of energy sources with lower environmental load, it is well-positioned to make significant contributions to resolving global warming problems using its outstanding technology.

Therefore, of course it is important for Japan to continue to promote domestic global warming countermeasures in accordance with the Plan for Global Warming Countermeasures (May 13, 2016 Cabinet Decision) and it is also important for Japan to contribute to the reduction of global greenhouse gas emissions. For example, utilizing the outstanding energy technologies of Japan to expand the overseas contribution, including utilization of the Joint Crediting Mechanism (JCM) and low-carbon infrastructure exports, etc. is effective, so these kinds of measures should be actively developed.

3. Position of each energy source in the primary energy structure and its policy direction

To establish a stable energy supply-demand structure in Japan, it is important to identify the characteristics of the respective supply chains of individual energy sources, clarify the energy sources' position in the supply-demand structure and indicate policy directions so that their strengths can be exercised to complement each other's weakness.

Particularly, in terms of electricity supply, it is important to utilize each energy resource based on its character as electricity power source in order to realize energy supply structure where stable supply, low cost and environmental acceptability can be achieved in a proper balance; each energy source is positioned as an electricity power source as below.

1) Geothermal energy, ordinary hydropower (run of river type), nuclear energy and coal as "base-load power source", which can be operated stably and by low cost regardless of day and night.
2) Natural Gas and so on as "intermediate power source", which can be produced by low cost next to base-load power source, whose power output can respond quickly and flexibly to the situation of electricity demand.
3) Oil and pumped-storage hydropower as "peaking power source", whose power output.

Based on this arrangement, in order to respond to the challenges of Japan's energy supply-demand structure we define the position of and policy direction for each energy source in the "multilayered and diversified flexible energy supply-demand structure" as follows:

(1) Renewable energy

(i) Position

Renewable energy has various challenges in terms of stable supply and cost at this moment, but it is a promising, multi-characteristic and important energy source which can contribute to energy security as it can be domestically produced free of greenhouse gas emissions, is low-carbon, and is utilized with a focus on reducing the environmental load over the long term.

(ii) Policy direction

GOJ has been accelerating the introduction of renewable energy as far as possible since 2013 and will continue actively promoting it. Therefore, GOJ steadily proceeds with the enhancement of power grids, rationalization of regulation, research and development for cost reduction, etc. GOJ utilizes the policy coordination of the Ministerial Council on Renewable Energy, Hydrogen and Related Issues to continue promoting cooperation among related ministries and advance the implementation of further measures. In this way, GOJ is advancing on early measures for laying the foundation for steady conversion of renewable energy into a major power source, as well as for realization of the power source

composition ratios in the 2030 energy mix.

Besides, it is necessary to proceed with technology development in a way to keep a good balance between economic efficiency and other factors while taking into consideration the different characteristics of various energy sources, with a view to creating new energy-related industries and jobs, including creation of new technologies such as the world's most advanced floating offshore wind power systems and large-scale storage batteries.

1) Solar

Solar power can be developed on a large scale, and in addition it can be used as a distributed power source generated in an area adjacent to end users, including individuals, for personal consumption and local production for local consumption and as an emergency power source.

However, the power generation cost of solar power is high, and there are supply problems such as the fact that power output is unstable. Therefore, further technological innovation is necessary.

In the mid- to long-term, cost reduction is expected to promote the introduction of solar power based on its position as an energy source which is utilized as a large power source anticipating the sale of electricity to the market, complements peak demand in daytime hours in the distributed energy system, and contributes to the implementation of energy management involving the participation of consumers.

2) Wind

Wind power is an energy source which has a potential to be capable of securing economic efficiency, since the power generation cost is close to that of thermal power generation when developed on a large scale.

However, while there is sufficient load following capacity to adapt to changes in supply volume in a service area where demand is large, that is not necessary the case in areas suited to wind power, such as Hokkaido and the northern part of Tohoku. Therefore, it is necessary to develop transmission lines, to secure sufficient load following capacity through broad-area operation of power grids and to utilize storage batteries. GOJ needs to promote the utilization of wind power while taking economic efficiency into consideration.

3) Geothermal energy

Geothermal energy is a stable power source at low power generation cost that can play a role of a base-load power source, since Japan has the world's third largest amount of geothermal energy resources.

Various ways to use it, such as a use of hot water produced after power generation, is also expected.

On the other hand, since the development of geothermal power generation requires long time and cost, it is necessary to promote sustainable development from the mid- to long-term point of view by reducing investment risk, establishing transmission lines and pursuing development harmonious with local communities to facilitate smooth introduction.

4) Hydropower

As hydropower plays a role of excellent energy source of stable supply except for drought-related problems, it will keep an important role in the energy supply structure.

Ordinary hydropower (run-of river type), whose operation cost is low, serves as a base-load power source, while the pumped storage type of hydropower, whose output can be easily adjusted, is used as a peaking power source.

Regarding 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.

Small and medium-scale hydropower, for which there are still undeveloped regions, is expected to be used as an energy source that forms the foundation of a regional distributed energy supply-demand structure in light of challenges related to the business environment, such as the high-cost structure.

5) Woody Biomass and so on (including biofuels)

Biomass power generation, including woody biomass using unutilized materials, can be used as a stable power source which may also contribute to local revitalization. Particularly, regarding woody biomass power generation and heat utilization, it plays the role of a regionally-distributed and local production for local consumption-type energy source as well as keeping up Japan’s precious forest and revitalizing the forestry industry.

On the other hand, given the diverse biomass materials, including wood and wastes, and diverse ways of usage as well as cost and other problems, it is desirable to increase introduction of biomass energy by pursuing scale merit and adopting mixed combustion at existing thermal power plants while taking into consideration the coordination of competition for resources between various ways of usage and stable supply of materials as well as its position in the distributed energy system.

As for biofuels, which are mostly imported, GOJ continues the introduction of such fuels while taking into consideration international situation and the technology development trend concerning next-generation biofuels.

(2) Nuclear power

(i) Position

Nuclear power's energy output per amount of fuel is overwhelmingly large and it can continue producing power for several years only with domestic fuel stockpile. Nuclear power is an important base-load power source as a low carbon and quasi-domestic energy source, contributing to the stability of the energy supply-demand structure in the long term, on the major premise of ensuring of its safety, because of the perspectives; 1) superiority in stability of energy supply and efficiency, 2) low and stable operational cost, and 3) free from GHG emissions during operation.

(ii) Policy Direction

On the premise that safety comes before everything else and that every possible effort is made to resolve the people's concerns, judgment as to whether nuclear power plants meet the new regulatory requirements will be left to the Nuclear Regulation Authority (NRA) and in case that the NRA confirms the conformity of nuclear power plants with the new regulatory requirements ,which are of the most stringent level in the world, GOJ will follow NRA's judgment and will proceed with the restart of the nuclear power plants. In that case, GOJ will make best efforts to obtain the understanding and cooperation of the host municipalities and other relevant parties. Dependency on nuclear power generation will be lowered to the extent possible by energy saving and introducing renewable energy as well as improving the efficiency of thermal power generation, etc. Under this policy, GOJ will steadily advance the necessary responses with the aim of realizing the power source composition ratio in the energy mix for 2030 formulated by carefully examining the volume of electricity to be secured by nuclear power generation, taking Japan's energy constraints into consideration, from the viewpoint of stable energy supply, cost reduction, global warming countermeasures and maintaining the technologies and human resources necessary to secure safety.

GOJ takes thorough measures to minimize the risk of the accidents considering the experience of and lessons of the TEPCO's Fukushima nuclear accident. In addition to that, in case the accident occurs, GOJ copes with it responsibly based on the related legislation. In addition, accumulation of spent fuels resulting from the generation of nuclear energy is a global problem to be solved. As a responsibility of the current generation, it is essential to steadily make efforts to deal with the problems of spent fuels while making use of an international human network in order to avoid passing the problem on to future generations.

Moreover, Japan will take necessary measures and promote relating R&D to ensure nuclear non-proliferation and strengthen nuclear security in light of international developments, including the holding of the Nuclear Security Summit and the adoption of the revised Convention on the Physical Protection of Nuclear Material.

(3) Coal

(i) Position

Though coal has a problem — it emits a large amount of greenhouse gas — it is currently evaluated as a fuel for an important base-load power supply because it involves the lowest geopolitical risk and has the lowest price per unit of heat energy among fossil fuels, but it is expected that the need to adjust power output appropriately will grow as a consequence of the expansion of the introduction of renewable energy. Going forward, GOJ will promote conversion to high efficiency and next-generation coal thermal power generation and utilize this energy source while focusing on reducing the environmental load in the long term, for example by making efforts to shift to the cleaner use of gas and fadeout inefficient coal use.

(ii) Policy Direction

In addition to speeding up the metabolism through the introduction of available leading-edge technology, GOJ further promotes the development of technologies to largely improve power generation efficiency and drastically reduce greenhouse gas emissions per unit of generated power, etc. (IGCC, CCUS, etc.).

In order to lead global decarburization taking into account the Paris Agreement, GOJ proposes to the partner country all options that contribute to CO_2 emissions reduction, including renewable energy and hydrogen, etc., based on the needs of the partner country, to actively promote “low-carbon infrastructure exports.” In this process, in the case that there is a request from a partner country for Japan’s high efficiency coal thermal power generation then only for those countries that are forced to choose coal as an energy source from the perspectives of energy security and economic viability GOJ supports the introduction of power generation equipment that is in principle at or above ultra-supercritical pressure (USC), the global state-of-the-art, taking into account OECD rules and in a form that is consistent with the energy policy and climate change measures of the partner country.

(4) Natural Gas

(i) Position

Natural gas accounts for more than 40% or more of power sources and has high efficiency as a heat source, so its use is increasing. Though Japan does not import natural gas through pipelines, the gas involves relatively low geopolitical risk compared to oil and emits the least amount of greenhouse gases among fossil fuels. Therefore, natural gas plays the central role as an intermediate power source. Natural gas may also become a part of the foundation of a hydrogen society.

In the future, fuel prices will be determined through competitive pricing due to the shale revolution, and a shift to natural gas is expected to proceed in various sectors. Therefore,

natural gas is an important energy source whose role is expected to expand while focusing on reducing the environmental load in the long term.

(ii) Policy Direction

For the moment, Japan is procuring LNG at a high price compared to international standards. Therefore, it is important to promote cost reduction by diversifying the supply sources, etc. while avoiding overly depending on it as a power source.

From the viewpoint of global warming countermeasures, it is also important to encourage a steady shift to natural gas in the industrial field, etc. by diversifying the way of utilization, including the use of the gas for local-level distribution of power sources through cogeneration systems, etc. as well as its use as a hydrogen source, and to promote the advanced usage of natural gas, such as combined cycle thermal power generation using metabolism. At the same time, it is essential to make system improvements, such as increasing the resilience of the supply system in emergencies.

(5) Oil

(i) Position

Though domestic oil demand is on a downward trend, oil still accounts for about 40% of Japan's primary energy sources. Its advantage lies in its wide applicability as fuel in the transportation, consumer, power supply sectors and also as a material for chemical and other products.

Especially, the transportation sector relies heavily on oil. Oil is also important as a material for the manufacturing industries. Compared with the amount of oil used for such applications, the amount of oil used as a power source is not large. Still, oil plays a certain role as a peaking and adjustable power source. Among fossil fuels, oil has the highest geopolitical risk related to procurement; it will continue to be used as an important energy source because it can serve as an alternative when other energy sources have been lost, given its high portability, well-developed nationwide supply network, and abundant stockpiles.

(ii) Policy Direction

It is essential to promote diversification of supply sources, cooperation with oil producing countries, enhancement of crisis management, including stockpiling, effective utilization of crude oil, diversification of fuels for transportation, utilization of oil thermal power as load following power source, etc.

In addition, since oil will be an energy source of "last resort" in the event of a disaster, it is necessary to further strengthen the resilience of oil supply networks and to enhance the management foundation of the oil industry in order to maintain the nationwide supply networks in normal times while the decline of domestic demand and the enhancement of

supply throughout the entire Asian region are concurrently occurring.

(6) LP Gas

(i) Position

The supply structure of LP gas was vulnerable due to the high dependency on the Middle East as a supply source; however, since the purchase of inexpensive shale-associated LP gas from North America has been started, the geopolitical risk of LP gas is decreasing as a trend.

As LP gas emits a relatively small amount of greenhouse gases compared with other fossil fuels, it can be used as an intermediate power source for generating power. LP gas also offers an advantage in terms of portability and storage easiness due to well-developed systems of supply to end users and stockpiling. Therefore, LP gas is a clean and distributed energy source that supports the people's lives and industrial activities in normal times and which is also useful in emergency situations.

(ii) Policy Direction

Since LP gas will be an energy source of "last resort" in the event of a disaster, GOJ promotes to make supply system more resilient such as proceeding with stockpiling and enhancing facilities of core filling stations. Also, GOJ promotes diversification in its usage by curbing cost through conducting surveys on retail prices and providing information about them to enhance transparency and through improvement of the supply structure of business operators, and LP gas is required to play a more important role in the transportation sector, as a fuel for LP gas-powered vehicles, for example.

4. Principles of the secondary energy structure

To make a new energy supply-demand structure more stable and effective, it is necessary to conduct a detailed study on not only the primary energy structure but also the secondary energy structure, whereby end users consume energy. In particular, in order to maximize energy conservation, it is necessary to thoroughly consider how to efficiently convert energy into electricity and heat and how to make full use of it without any waste and to make efforts to put the ideas into practice.

Since technological innovation has proceeded, now is the time to advance comprehensive initiatives for a "hydrogen society," which uses hydrogen as an energy.

While establishing a multi-layered supply structure so that the strengths of individual energy sources can be exercised to complement each other's weaknesses, we will consider what the secondary energy structure should be like if maximum efficiency is to be achieved.

(1) Electricity which plays the central role in the secondary energy structure

Electricity can be produced by converting various energy sources, and offers high convenience of use. Therefore, the electrification rate is expected to rising in the future, too, and electricity will continue to play the central role in the secondary energy structure.

Unlike European countries such as Germany and France where power grids are interconnected, Japan is not able to interchange power supply with another country when supply has become unstable. Japan's situation is also different from that of the U.S., where power transmission and distribution networks have been established across multiple states over a huge area. Therefore, it is essential that power sources and grids are established and secured nationwide in a well-balanced manner so as to ensure that the power supply system can be used efficiently over a broad area. As for power supply, it is important for Japan to secure inexpensive and stable base-load power sources; intermediate power sources whose output can be adjusted flexibly according to the demand trend; and peaking power sources with an appropriate balance and to use them in combination with distributed power sources such as renewable energy, etc.

Regarding the power source mix, it is important to secure inexpensive and stable base-load power sources at a level equivalent to international standards, to maintain reserve capacity and load following capacity required for stable supply and to pursue environmental suitability while avoiding overly depending on a specific power source or fuel source. In this way, Japan should continue to focus on securing a well-balanced power source mix.

Meanwhile, electricity demand in Japan has changed after the TEPCO's Fukushima nuclear accident. We should continue to improve the efficiency of the supply structure by leveling the power load through efforts to reduce peak loads, such as electricity saving and peak-cut of air-conditioning energy while taking into consideration changes in the demand trend.

In the future, the power source mix may change due to the reform of power systems. In that case, large-scale capital investment may be required. That is because of the need for investment not only for constructing new power generation facilities, including renewable energy facilities, but also for constructing power transmission and distribution networks that can adapt to the different power generation time zones and power output characteristics of various energy sources as well as for taking measures to enhance the stability of power grids, including the installation of load following power sources and storage batteries.

Following the shutdown of nuclear power plants after the TEPCO's Fukushima nuclear accident, the share of nuclear power in the power source mix fell steeply from around 30%, while the dependency on overseas fossil fuels rose above 80%. As a result, the dependency on overseas fossil fuels in terms of the power supply structure is now higher than the level at the time of the first oil crisis (which was 76%, and the ratio later improved to just over 60% because of the replacement of oil with alternative fuels and the utilization of nuclear

power). Against the background of this cost expansion resulting from the increase in fossil fuels procurement, Japan’s electricity prices continue to be high for both households and industry when compared to international levels, and concerns are growing that Japan’s international competitiveness with respect to energy costs will deteriorate further. In light of the fact that the greatest factor behind the rise in electricity prices after the Great East Japan Earthquake is a steep rise in the cost of fossil fuels for power generation, it is extremely important for the public and private sectors to work together to reduce the cost of procuring fossil fuels.

In the future, additional costs necessary for developing transmission networks and enhancing their stability and cumulative surcharges resulting from the FIT system may be added to electricity prices. While the cost of the power generation business itself may be curbed through competition, it is necessary to endeavor to curb the burden of electricity prices including other factors as well, to ensure the international competitiveness, etc. of the industry.

Therefore, as for what the power source mix should be like, it is important to pursue a well-balanced structure in order to prevent possible additional costs from imposing a heavy burden on the people's lives and economic activities.

In addition, from the perspective of enhancing the resilience of power supply on the assumption of a major disaster, it is necessary to promote distributed energy sources at the local level in combination with the development of natural gas infrastructure.

(2) Heat utilization: Promotion of utilization of cogeneration and heat generated from renewable energy, etc.

In Japan, final energy consumption is made mostly for non-power applications, mainly usage of heat. Therefore, in order to enhance the utilization efficiency of energy, it is important to utilize heat more efficiently, and it is necessary to strengthen measures for that purpose.

The way of utilizing heat may vary depending on the lifestyle of individuals and families as well as the presence of local heat sources. Therefore, it is important to make efforts to enable flexible usage that suits the lifestyle and local circumstances.

Cogeneration, which generates a combination of heat and electricity, is one way of utilizing energy most efficiently by concurrently using heat and power. Usually, a cogeneration system has an excess generation capacity, so it is expected to serve as a backup to make up for a shortage of power supply in times of emergency.

The introduction of cogeneration is increasing in the context of the rise in electricity prices and the progress of measures for energy saving after the Great East Japan Earthquake. From the perspective of switching to a low-carbon approach, it is necessary to further expand the introduction of cogeneration by promoting regional utilization in addition to separate utilization by individual buildings, factories, houses, etc.

Using renewable energy heat such as solar heat, underground heat, snow ice heat, hot spring heat, seawater heat, river heat and sewage heat more effectively is also expected to be effective in improving efficiency of the energy supply-demand structure.

Such heat sources have not been adequately utilized until now. That is not only because of the high cost of installing equipment for using heat sources. There are also other significant factors, such as that business profitability is low because the demand does not always match the supply for reasons such as a lack of sufficient local demand for heat compared with the capacity of the local supply equipment and that suppliers of such heat energy sources have not adequately grown because of low public awareness. It is important to promote ways of using heat sources that take advantage of the characteristics of the regions where the sources are located.

(3) Hydrogen: The realization of the “hydrogen society”

As for future secondary energy, hydrogen is expected to play the central role, as well as electricity and heat.

Hydrogen, though it is necessary to secure safety in handling it, it has many superior characteristics such as excellent utility and energy efficiency, and emits no greenhouse gas and is expected to be useful in times of emergency.

In order to introduce hydrogen as an energy source, development and research and demonstration projects concerning various element technologies have been implemented by many entities; however, there are still many challenges to overcome in terms of technology, cost, system and infrastructure in order to establish the “hydrogen society”, where we utilize hydrogen for daily life and industrial activities. Therefore, based on the Basic Hydrogen Strategy (determined by the Ministerial Council on Renewable Energy, Hydrogen and Related Issues) established in December 2017 and other policies, GOJ promotes the arrangement of systems and infrastructure strategically to ensure that hydrogen becomes the trump card for mid- to long-term energy security and global warming countermeasures utilizing the technologies of Japan, and promotes diverse technology development and lower costs in order to implement highly feasible technologies in society.

Section 2 Policy measures towards 2030

1. Promotion of securing of resources

As Japan's dependency on fossil fuels continues to be high, it is important, while taking future changes into consideration, to secure resources in accordance with the global energy supply-demand structure which has increasingly become unstable. GOJ has been aiming to realize the optimal portfolio of resources, and to secure resources in a stable and economical manner by (i) diversifying major resources and (ii) reducing the procurement risk of each resource through the diversification of supply sources, securement of interests in upstream projects and enhancement of relationships with supplying countries.

On the other hand, as a consequence of the rise of emerging countries, etc. the bargaining power of Japan has declined and the destabilization of international supply and demand has become more marked, and in this context in addition to the previous measures the ideas of (iii) forming a highly flexible and transparent international resources market and (iv) capturing the strong demand of Asia while securing energy security on the Asia scale by participating in its energy value chain are important.

Japan has been actively engaged in resource diplomacy as represented by the Prime Minister's visits to the U.S., Russia, Saudi Arabia, the UAE and Qatar, among other countries. The achievements include the acquisition of export approvals for a U.S. LNG project involving Japanese companies and the acquisition of interests in an independently-developed oil field in the UAE. Japan will continue to execute a comprehensive policy to secure a stable supply of resources.

(1) Promotion of independent development of fossil fuels and establishment of a robust industrial system

In Japan, which depends on imports from overseas for virtually all of its resources, in order to achieve stable and inexpensive procurement of resources it is extremely important to not only procure them from the international market but also to promote so-called independent development whereby Japanese companies deliver the produced items by securing resource interests overseas and directly participating in operations.

Since experiencing the oil crises in the 1970s, Japan has promoted an independent development policy for oil and other fossil fuels. Recently, this policy has steadily produced results, including securement of interests in a mining area on land (2015) and a mining area at sea (2018) in the Emirate of Abu Dhabi, UAE, participation in shale oil and gas development in North America, commencement of production in an LNG project in Australia, etc.

In recent years the degree of technological difficulty in resources development has become more sophisticated and complex, and in addition competition between state oil companies from countries with a marked increase in demand for fossil fuels such as China,

India, etc. and Japanese resources development companies has been intensifying more and more. However, the scale of production and financial base of Japanese resources development companies are smaller than those of the major Western resources companies and the state oil companies in the emerging countries, so the strengthening of their international competitiveness is an urgent issue. On the other hand, regarding the energy mix, fossil fuels are expected to account for approximately 80% of the primary energy supply even in 2030, so in Japan, a country with few energy resources, securing a stable supply of oil, natural gas and coal will continue to be an important issue.

Taking into account this situation, it is necessary to continue to make efforts to secure interests in upstream projects to ensure a stable supply of oil, natural gas and coal, and to establish a resilient industrial structure so that Japan does not lose out in the competition with foreign countries. For this reason, GOJ is aiming to raise the oil and natural gas independent development ratio (27% in FY2016) to 40% in 2030, and to maintain the coal independent development ratio (61% in FY2016) at 60% in 2030.

Furthermore, folstering upstream development companies possessing international competitiveness is an urgent task in order to win the competition to capture resources which will intensify more and more going forward due to the rise of emerging countries such as China, India, etc. Specifically, GOJ will continue to aim to create “core companies” possessing a certain degree of production scale, an appropriate and resilient financial base and blue-chip assets able to withstand fluctuations in resource prices, and a good ability to open up demand, and will consider the future vision of upstream industries and the path for reaching that vision. In order to realize these goals, the functions of the Japan Oil, Gas and Metals National Corporation (JOGMEC) for supporting corporate buyouts, etc. were enhanced under a November 2016 law change, and based on the principle of private initiatives it is working on making assets and companies more resilient through the risk money supply, supporting the acquisition of innovative resources development technologies that apply AI, the IoT, etc., and supporting upstream and mid to downstream deployment utilizing policy finance, etc.

(2) Reinforcement of the foundation of the resources procurement environment through multifaceted development of resource diplomacy, etc.

To date Japan has actively developed resource diplomacy as represented by the Prime Minister with countries possessing resources, and this has produced results such as Japan securing interests in an independently-developed oil field in the UAE, the acquisition of export approvals for a U.S. LNG project in which Japanese companies are involved, etc. In order to secure a stable supply of resources, it continues to be important to make comprehensive diplomatic efforts to develop comprehensive and mutually beneficial bilateral relations with countries that supply Japan with resources, instead of merely forming relations based on resource trade. The countries include Saudi Arabia and the

UAE in the case of oil; Australia and Qatar in the case of natural gas; Australia and Indonesia in the case of coal; Chile, Peru, Australia, Canada and South Africa in the case of metal resources, and the U.S., Saudi Arabia, etc. in the case of LP gas. Japan will invigorate diverse economic transactions and human exchanges at various levels of society. On the other hand, the international conditions surrounding resources have changed with dizzying speed in recent years, so it is necessary to develop the resource diplomacy of Japan in a more comprehensive, multifaceted and strategic manner.

In traditional countries rich in resources, for example in the Middle East, which is a major supply region for oil and natural gas, national finances have been tight as a result of the stagnation in crude oil prices from 2014 onwards; therefore moves to secure revenue by selling not only crude oil itself but also oil products with higher added value to Asia, where demand is expected to increase rapidly going forward, and moves to build an economic structure that is not dependent on the energy industry are being prominently seen. Furthermore, on the consuming countries side, due to the growing global environmental awareness based on the Paris Agreement, switching to low-carbon energy has become an issue, and in that context the establishment of a highly flexible and transparent international market for the procurement of LNG, the fuel for power generation with the lowest carbon emissions, is required. Going forward, in order to continue to secure a stable supply of fossil fuels in Japan, where a decline in resources demand is expected, it is important to understand the needs of both these countries rich in resources and the consuming countries, while globally contributing to the energy security of Asia, which will be a particular growth engine going forward, thereby realizing a stable supply of fossil fuels for Japan.

Therefore, as part of the effort to build such comprehensive and mutually beneficial bilateral relations with both resources supplying countries and resources consuming countries, ministerial-level resource diplomacy, including strategic use of summit diplomacy, will be actively pursued in order to create an environment where resource transactions are conducted in a stable manner through bilateral relations based on strong relationships of trust.

Specifically, with respect to resources supplying countries, (i) Japan will go beyond the upstream sectors to create business opportunities in middle and downstream sectors such as oil refining, petro chemistry, LNG liquefaction, etc. and cooperate in opening up demand in third countries such as Asia, etc., and in addition (ii) contribute to making the industry more multifaceted and low-carbon by introducing new technologies such as hydrogen, the IoT, etc. With respect to resources consuming countries, (1) Japan will provide assistance for infrastructure development and human resources development in order to meet the demand for resources which will grow rapidly in Asia in particular, and (2) implement cooperation, etc. among consuming countries in order to foster international rules and practices utilizing multilateral frameworks.

To improve the stability of sea lanes, bolstering relations with countries and regions involved in the sea lanes are important. Japan will reinforce measures to ensure safe and secure navigation of commercial ships by promoting various cooperation with the maritime safety organization of each country, by supporting preparation and improvement of infrastructure, such as harbors, and ship operation control systems, by strengthening rescue and recovery support systems to respond to disasters in coastal areas, as well as by deepening the U.S.-Japan cooperation in the field of security, including maritime security, based on the Regional Cooperation Agreement in Combating Piracy and Armed Robbery against Ships in Asia (Recap) and the "cooperation mechanism" concerning safe navigation through the Strait of Malacca and Singapore Straits.

Note that recent years Japan must not forget its relations with the new resources supplying countries that have a growing presence. Securing a supply from the U.S., which is having a large impact on the international supply structure of fossil fuels due to the shale revolution, Russia which has abundant resources potential and is geographically adjacent, Africa which is expected to be the "final frontier" of LNG and metal resources, etc. contributes to the diversification of the supply sources of Japan and further strengthens Japan's energy security, so Japan will advance cooperation in the energy sector and non-energy sector with these new resources supplying countries.

(3) Improvement, etc. of resources procurement conditions through the establishment of a highly flexible and transparent international trading market

The terms of resource procurement are basically determined between private companies at the individual contract level. For its part, GOJ needs to improve the environment that enables discussions on diversification of terms and conditions of transactions, such as the pricing mechanisms and destination clauses. They also need to support strategic efforts to procure stable and competitive resources, including strengthening the bargaining power through the strategic use of new joint procurement schemes.

To date the natural gas market has been divided into three markets: The European market and North American market which have each developed gas fields and pipeline networks within their region and in neighboring countries, and the Asian market centered on LNG conveyance and long-term contracts. An international trade market enabling fair and flexible arbitrage transactions was not sufficiently established.

In this context, on the demand side, rapidly growing China and India and other Asian countries are expected to rapidly drive LNG demand going forward, and a certain degree of demand expansion is expected in Europe, the Middle East, and Central and South America as well. On the supply side, the global market environment is in a period of transformation. For example, the U.S. and Australia are strengthening their presence as LNG supplying countries.

Currently, Japan, the world's largest LNG importer, is fostering an environment

oriented toward more flexible LNG procurement. For example, Japan has begun the complete liberalization of the electric power and gas markets. Establishment of a highly flexible and transparent LNG trading market is a good opportunity led by Japan.

Aiming to build a highly flexible and transparent international LNG market, based on the "Strategy for LNG Market Development" announced in May 2016 Japan is continuing to tackle (i) improvement of the liquidity of the LNG trade, (ii) establishment of an LNG price discovery mechanism reflecting supply and demand, and (iii) open and sufficient infrastructure development.

Specifically, Japan is improving the liquidity of the market by introducing more flexibility into commercial practices that hinder the liquidity of trade, in particular destination restraints, and the revitalization of the LNG trade through the encouragement of the participation of new players, and is providing assistance for funding and human resources development, etc. to open up the latent demand in Asia, in order to encourage the launching of upstream development and liquefaction projects, and promote the participation of Japanese companies in the LNG supply chain Asia-wide, including in Japan.

Furthermore, Japan will further advance the opening up of new demand for LNG bunkering, etc., improvement of the reliability of price evaluations by price reporting agencies, revitalization of the futures trade, transmission of information such as prices, etc. to encourage optimal trading, and improvement of access to infrastructure such as LNG receiving terminals, etc.

Furthermore, public-private collaboration including other countries will be important for realization of a highly flexible and transparent international LNG market. Therefore, communications between energy producers and consuming nations will be facilitated and collaboration between consuming nations will be strengthened by providing many opportunities for international dialogue, such as the LNG Producer-Consumer Conference, international conferences such as the G7, G20, APEC, EAS, etc., and in addition workshops, etc. based on the Memorandum of Cooperation with the EU concluded in 2017.

One specific initiative was when the Minister of Economy, Trade and Industry announced at the LNG Producer-Consumer Conference 2017 (October 2017) a ten billion dollar-level financing initiative from the public and private sectors in Japan for upstream, midstream and downstream LNG projects, and human resources development assistance for 500 people over five years in order to boost demand for LNG in Asia. Private sector companies and the related institutions will collaborate to steadily advance the measures based on these initiatives going forward, and they will build a highly flexible and transparent international LNG market while forming collaborative relationships with new countries and regions.

In the coal market, in recent years Japan's relative position as an importing country in the global coal market has declined due to the increase in the import volumes of China

and India, progress in the oligopolization of upstream interests by the major coal companies, etc. In order to continue securing economically rational and stable procurement of coal going forward, Japan will address the issues including the expansion of short-term and spot trading, ensuring the flexibility of coal procurement, and the expansion of bargaining power in collaboration with private sector companies and related institutions so that the price formation reflects supply and demand trends appropriately.

(4) Promotion of the development of energy and mineral resources in Japan's oceans, etc.

The presence of marine-derived energy and mineral resources has been confirmed inside the maritime jurisdiction of Japan, the sixth largest in the world. If Japan proceeds with the development of these domestic resources then the supply of stable energy and mineral resources that are not affected by geopolitical risks will be possible, so the promotion of domestic resources development continues to be important from the perspective of energy security. In addition, relevant ministries and agencies and private companies are expected to cooperate in marine development to promote related industries. For this reason, Japan will develop the business environment so that appropriate development business operators with willingness and ability, regardless of whether they are in Japan or overseas, can work on private sector-led resources development. For example, Japan will advance the metabolism of mining rights holders. Regarding the development of domestic resources, the implementation of environmental impact assessment will be ensured.

In May 2018, the Basic Plan on Ocean Policy (May 15, 2018 Cabinet Decision) was reviewed based on the Basic Act on Ocean Policy, and new government goals concerning the development of marine energy and mineral resources were set.

Going forward, taking into account the Basic Plan on Ocean Policy, GOJ will revise the Plan for the Development of Marine Energy and Mineral Resources and clarify the development plans for marine energy and mineral resources.

(i) Methane hydrate

The presence of significant reserves of methane hydrate is expected in the seas surrounding Japan so it is an important energy resource contributing to the stable supply of energy to Japan. Therefore, during the period from 2023 to 2027 Japan will carry out technology development with the aim of projects for commercialization led by private sector companies being commenced.

Regarding the sand layer type of methane hydrate, reserves of which have been confirmed mainly in the Pacific, in March 2013 an experiment to produce gas with "a decompression method" was conducted in an offshore area for the first time in the world, using "Chikyu", a deep-sea drilling vessel owned by the Japan Agency for Marine-Earth

Science and Technology, and from April to June 2017 a second experiment was conducted. Continuing on from this, after appropriately evaluating the research outcomes to date, efforts will be made to establish production technologies for the realization of long-term stable production, ascertain the reserve amount for guaranteeing economic viability, and develop a production system using multiple wells focused on commercialization, etc.

As for the surface layer type of methane hydrate, reserves of which have been confirmed mainly in the Sea of Japan, the necessary wide-area distribution survey was conducted for three years from FY2013 to assess the reserve amount. Currently, survey research into recovery and production technologies is being commenced, and opportunities are being given to a wide range of technical possibilities, while in the case that a promising technique is discovered the research target is narrowed down and further technology development for commercialization is promoted.

(ii) Oil and natural gas

Geophysical exploration covering about 6,000 square kilometers per year was conducted annually until FY2018 in areas of the seas surrounding Japan where little exploration activity has so far been conducted. From FY2019 onwards government-led explorations using a three-dimensional geophysical survey ship (approximately 50,000 square kilometers over ten years) will continue to be flexibly conducted. Obtained results, such as geological data, will be passed on to private businesses to promote exploration activities offshore Japan. When doing this, in order to realize more efficient and effective exploration and improve competitiveness in the market, the building of structures including the introduction of world-class equipment and technologies through the upgrading of the three-dimensional geophysical survey ship will be advanced. Furthermore, consideration of increasing prospecting opportunities for promising structures and of the best approach to utilization of hydrocarbon resources rooted in the regions will be carried out.

(iii) Mineral Resources

Sea-floor polymetallic sulphides are present in the comparatively near sea and shallow seafloor so development is expected to be promising. In the efforts from FY2013 to FY2017, a total of six deposits were discovered in the seas off Okinawa, and in FY2017 the pilot test of excavating and ore lifting for continuously collecting and lifting sea-floor polymetallic sulphides together with seawater from a sea floor at a depth of approximately 1,600m to the surface, a world first, was conducted. Following on from these results, the reserve amount will be assessed, production technologies will be developed, environmental impact assessment techniques will be upgraded, economic viability will be evaluated and the best approach to legal systems will be considered, so that projects aiming for commercialization with the participation of private sector companies will be

commenced with a focus on international condition and in accordance with the Basic Plan on Ocean Policy.

Regarding cobalt-rich crusts containing several types of important rare metal such as cobalt and nickel, etc. which are present in the seas around Minamitorishima Island and for which demand is expected to grow against a background of increased use of electric vehicles and electrification, JOGMEC concluded an exploration operations contract with the International Seabed Authority (ISA) in January 2014, and obtained the exclusive exploration right for the cobalt-rich crusts located on the high seas southeast of Minamitorishima Island. Going forward, the mining areas that are promising for exploration will be identified by 2023 in accordance with the regulation on exploration set by the ISA, and the fundamental technologies developed in development of sea-floor polymetallic sulphides will also be utilized to consider production technologies for excavation, ore-lifting, etc.

It will be continued with regard to polymetallic nodules in the exploration area off Hawaii that is owned by Japan. The presence of rare earth yttrium rich mud has been confirmed in the seas surrounding Minamitorishima Island, so from 2013 to 2015 the Agency for Natural Resources and Energy conducted a presence status survey and surveys of the related technologies sectors to consider the future resources potential of the rare earth yttrium rich mud, and in 2016 it compiled the Report on the Resources Potential of Rare Earth yttrium Deposits. Going forward, keeping in mind future development and production, firstly in the “Innovative Deep Sea Resources Survey Technologies” in the Cross-ministerial Strategic Innovation Promotion Program (SIP) under a promotion structure involving each ministry and agency, surveys and analyses of the amount present will be carried out, and measures will be taken as a part of the development and demonstration of marine resources survey technologies, production technologies, etc. at a depth of 2,000m or more that can be widely utilized for marine mineral resources.

(5) Securing a stable supply of mineral resources

Due to the electrification of automobiles in Japan and overseas and the popularization of renewable energy and new energy equipment, an increase in demand for a variety of minerals is expected while on the other hand companies from China and other emerging countries are more actively entering countries rich in resources. In this context it is necessary for Japan to further enhance its assistance measures related to securing a stable supply of the necessary mineral resources. After considering the risk money supply function of JOGMEC and the best approach to assistance for development and corporate acquisitions, the necessary measures will be taken, and measures taken to strengthen resource diplomacy with Africa, where cobalt, etc. are primarily located, and every effort will be made to more strongly secure a stable supply of mineral resources.

To secure stable supply of metallic mineral, it is important to not only diversify supply

sources but also steadily collect metals from used products and aggressively promote to develop new technologies for recycling metals. Regarding metallic minerals ore, whose presence is concentrated in regions with high country risk, efforts to develop substitute metals and to reduce use of metals in products will be made. Regarding the metal resources vital to Japanese industries, by combining these efforts and upstream development, the self-sufficiency ratio regarding mineral resources (base metals) will be raised to more than 80% in 2030 (from 50% in FY2016) so that stable supply is secured even when the resource prices surge or when the supply-demand situation tightens. In addition, to cope with short-term supply interruptions of metallic minerals, GOJ will steadily stockpile necessary rare metals while closely monitoring the price trends and the domestic supply and demand trends of various rare metals and will improve the national stockpiling system so that reserves can be flexibly released in response to the needs of receiving companies in case of an emergency such as supply disruption.

2. Realization of a thorough energy efficient society

Due to the combined efforts of the public and private sectors Japan's energy consumption efficiency has improved 40% since the oil crises in the 1970s and is at the highest level in the world. The Act on the Rational Use of Energy (The Energy Saving Act), which was established in 1979 in response to the oil crises, obligates business operators that use a lot of energy in industry, operation and transportation to report the state of their energy efficiency measures and improvement of energy consumption efficiency every year to the government, and builds a framework that encourages such business operators to take measures for energy saving. Also, in the commercial and residential sectors, the act encourages manufacturers of equipment, etc. to improve their energy consumption efficiency using Top-Runner programs for energy consuming equipment. Realization of a more rational energy supply-demand structure and the reduction of emissions of greenhouse gases will be advanced by implementing these measures based on the Energy Saving Act and effective support measures for each sector in an integrated manner.

Also, in 2013 the Energy Saving Act was amended, and from April 2014 GOJ started taking measures that take into account in the evaluation of energy saving the efforts contributing to the equalization of electricity demand on the demand side to deal with peak demand of electricity, and it is estimated that equalization of electricity demand is making progress through the efforts of the business operators.

Furthermore, with the advance of technological innovations such as next-generation power electronics devices which is anticipated to make power consumption even more efficiently, more efficient energy use and the applications of energy sources will continue expanding. Besides, due to structural reforms such as the electricity system reform, a diverse set of options regarding the usage of energy, including the management of the demand amount as well as the supply amount, will become available for consumers as a result of the entry of various entities into the energy market.

In a market that offers a variety of options, consumers can make choice freely based on their own rational judgment. Through this process, changes in the supply structure and the energy source mix will occur.

It is necessary to reinforce measures to accelerate the creation of such a new energy supply-demand structure. As a result of the efforts to date, the measures by individual business operators using energy have made substantial progress. Furthermore, the energy consumption performance has improved due to the pursuit of optimal design for each individual piece of equipment. Going forward, for further energy saving, in addition to the measures to date, it is necessary to utilize AI and the IoT, big data, etc. to promote measures for new energy saving that can be realized through mutual collaboration among multiple business operators and types of equipment.

Furthermore, when proceeding with energy saving, further utilization of data related to

the state of energy use is important. Through utilization of the IoT and EMS, building of infrastructure enabling the low cost and open acquisition and use of a full range of data in each sector will be advanced and an environment enabling a variety of energy saving services will be developed. When doing so, the related data held by the government will also be opened up as much as possible.

(1) Enhancing energy efficiency in each sector

(i) Enhancing energy efficiency in the business and household sectors

In the residential and commercial sectors, improvement of energy efficiencies for buildings and houses are expected to be the most effective way of conserving energy. Using high performance construction materials for openings and walls which heat dissipates is especially effective, but this has so far been excluded from the Top Runner Program, which sets the standard for energy consumption efficiency of machines and instruments in Japan. The Top Runner Program was introduced by the amendment to the Energy Saving Act in 1998. It designates commodities such as appliances and cars; it indicates numerical criteria based on the most excellent commodities in energy consumption efficiency at that time and requires manufacturers or importers to make their commodities clear the criteria by a target year. Until now, efforts for energy saving in the commercial and residential sectors have progressed under the Top Runner Program. For example, as of FY2016 the efficiency of air conditioners improved 28% compared to FY2001, of TV sets improved 71% since FY2001, and of household electric refrigerators improved 252% since FY2001.

In order to promote such measures of energy efficiency in the sector of buildings and houses like as the above, GOJ added products that contribute to improvement of the energy consumption efficiencies of houses, buildings and other equipment into the scope of the Top Runner Program, and for that purpose the Energy Saving Act was revised in 2013. As a result, construction materials were added to the scope of the program, and the insulation standards for insulation materials, windows, and sashes were specified.

Other than those, energy consuming equipment such as commercial electric refrigerators and freezers, multi-function devices, printers, electric water heaters (heat pump water heaters) and LED lamps were newly added. We aim to achieve a penetration rate of 100% on a flow basis by 2020 and on a stock basis by 2030.For that purpose, currently separate targets have been set for fluorescent and LED lighting, but shared targets for energy consumption efficiency will be set.

Regarding energy consuming equipment such as home appliances, etc., large energy savings have been achieved to date by improving the performance of components and the control system, but recently the introduction of new technologies such as AI and the IoT, the utilization of big data, and cooperation between devices, etc. has been advanced with the aim of further improving efficiency. In the Top-Runner program appropriate system

design is being considered so that these kinds of measures can be promoted in addition to conventional technologies.

Furthermore, GOJ will promote energy efficient measures such as renovation and rebuilding of existing buildings and houses with high energy efficiency performances and the enhancement and dissemination of the evaluation and labeling schemes concerning comprehensive environmental performance, including energy efficiency performance. In addition, GOJ will encourage high heat insulation performances for new buildings and houses and the introduction of energy efficient equipment into them and promote the dissemination of certified low-carbon buildings, which have better energy efficiency performances' has supported around 28,000 projects (cumulative total as of the end of FY2017) across the nation as measures to achieve net zero energy by introducing energy efficient technologies such as high performance thermal insulation/air sealing, high-efficiency air conditioners, heat exchangers, LEDs with motion detectors and so on in public buildings, houses, office buildings and hospitals.

With a view to creating a standard for energy saving performance for buildings in the future, GOJ aims to achieve ZEB (net zero energy buildings) on average with regard to newly constructed buildings, by 2020 for non-residential buildings and by 2030 for newly constructed public buildings nationwide. With regard to houses, GOJ aims to achieve ZEH (net zero energy houses) for more than half of the ordered stand-alone houses newly constructed by home-makers, etc. by 2020 and for standard newly constructed houses by 2020 and for all newly constructed houses on average by 2030. Note that when doing this GOJ takes care to coordinate with the measures pertaining to promotion of the introduction of the renewable energy essential for ZEB and ZEH and utilizes the Top-Runner Program for building materials while taking popularization promotion measures for reductions in the prices of high-performance building materials.

While improving the environment for improvements of energy efficiency performances for buildings and houses such as the above, GOJ has decided to phase in the obligation for newly constructed houses and buildings to meet the energy efficiency standard by 2020, with due consideration given to the need for and degree of the regulation, etc. In response to this, the obligation to meet the standard has started to be phased in for large-scale non-residential buildings based on the Act for the Improvement of the Energy Saving Performance of Buildings established in 2015.

In addition, GOJ continues to expand the market for low-carbon products, services, and lifestyles and to disseminate lifestyles that lead to improvements of the quality of life and energy saving at the same time, by rolling out national campaigns and developing energy saving guidelines using information transmissions (nudges) that utilize big data analyses, etc. to encourage behavioral changes.

(ii) Promotion of diverse energy efficiency measures in the transportation sector

In the transportation sector, automobiles consume most of the energy, so it is important to improve the energy efficiency of automobiles transportation. Regarding automobiles, large improvements in fuel economy have been achieved to date under the fuel economy standards based on the Top-Runner program but in order to achieve further energy saving GOJ is establishing the next passenger vehicle fuel economy standards and, with the aim of increasing the ratio of next-generation vehicles to all new vehicles to 50%-70% by 2030, taking into account major environmental changes such as the electrification and automation of automobiles, shifting automobiles to the service industry, etc., GOJ is stipulating strategies for the development of the world's most advanced institutional environment and social infrastructure and drastic strengthening of the development of fundamental technologies, in particular next-generation batteries, and the public and private sectors will work together to advance these strategies and take other measures regarding automobiles themselves. Furthermore, GOJ is promoting comprehensive measures, including steps to improve traffic flow such as the development of loop routes and other trunk road networks and introduction of the Intelligent Transportation Systems (ITS), which will contribute to energy saving.

In addition, technology development and demonstration projects for advanced energy saving measures and enhancement of the efficiency of distribution operations will be launched in the transportation sector, including maritime transportation, which consumes the second largest amount of energy after automobiles, and effective energy saving measures will be disseminated, including the establishment of an evaluation system for the energy saving measures of coastal shipping business operators.

Moreover, in order to streamline energy consumption pertaining to freight transportation, GOJ is encouraging consignees to also make every possible effort, in addition to the consignors and freight carriers that were already required to take measures under the Energy Saving Act. Furthermore, by promoting cooperation among these players, it is strengthening initiatives such as consolidation of distribution bases and joint distribution and transportation, etc. In addition, in order to response to the increase in small-volume transportation and redeliveries resulting from the expansion of the Internet mail-order sales market, GOJ is revising the approach to regulation of consignors in the Energy Saving Act, to further encourage the strengthening of measures and cooperation among players involved in distribution such as Internet mail-order sales, etc.

Furthermore, not only conserving energy consumed by vehicles and ships, but also energy used at facilities such as railway stations, harbors and airports will be reduced by introducing energy efficient equipment and increasing the use of LEDs for lighting.

(iii) Acceleration of energy efficiency in the industrial sector and others

Since the oil crises in the 1970s, enterprises in the industrial sector have improved their energy consumption efficiency by 40%, thereby achieving a high level of energy saving.

For example, a house-building company achieved energy saving by 34% in FY2012 compared to FY2005, as a result of a variety of efforts in a model factory, such as developing new fabricating methods and optimization of inverter control in productive facilities, and application of the achievements to other factories.

On the other hand, in recent years the improvement has stagnated, so for further progress of energy saving mainly in the industrial sector, which has already achieved a high level of energy saving as described above, it is necessary to strengthen the upgrading or replacement of existing facilities to or with those with a high energy saving effect.

When doing so, it is necessary to encourage energy saving through both regulations under the Energy Saving Act and assistance measures such as subsidies, etc. but taking into account the fact that measures by individual companies have made significant progress, going forward promoting collaboration among multiple business operators will be important. However, the Energy Saving Act sets out the principle that individual companies should conduct the evaluation of the energy use status, etc. reported by specified business operators, etc. every fiscal year, so in the case that multiple business operators collaborate to take energy saving measures there are cases when individual companies are looked at in which there are business operators for which energy use increases in spite of the fact that overall there is energy saving. Going forward, GOJ will take assistance measures while also advancing the development of a system to ensure that an appropriate evaluation of energy saving through collaboration between business operators under the Energy Saving Act can be conducted when promoting energy saving through collaboration. Furthermore, GOJ will revise the system so that in the case that energy management is carried out in an integrated manner by group companies, etc. which have capital relationships the handling can be conducted in an integrated manner in spite of the fact that the Energy Saving Act stipulates individual companies. Note that these system developments will be carried out in the same way for the transportation sector.

Regarding assistance measures, an environment for companies to make the best possible efforts for energy saving shall be created by taking various measures, such as providing assistance for investment in energy saving equipment and facilities or assistance for energy saving investment utilizing lease techniques for small and medium-sized enterprises, etc. Furthermore, in order to assist the energy saving measures of small and medium-sized enterprises, etc. which do not necessarily possess enough energy saving know-how, GOJ will continue to advance the development of a structure which can provide integrated support from the diagnosis that there is room for energy saving to the formulation, execution and review of the measures.

The Energy Saving Act set the non-binding target of a 1% improvement per year in the energy consumption efficiency. In addition to this, GOJ has advanced the introduction of the Industry Top-Runner Program (benchmark program) which sets targets for the energy consumption per unit of GDP, etc. in each industry. This program has already been

introduced in 12 industries and 16 sectors but GOJ is continuing to expand the industries in which it is introduced with the aim of covering 70% of industrial and business sectors by energy consumption. Furthermore, regarding the business operator class division evaluation system, which divides business operators into classes based on reports from the specified business operators and takes measures based on the class of the business operator, GOJ is considering more nuanced responses such as strengthening the response to business operators who have not made adequate improvements and dividing up the classes into smaller segments, etc.

The development of innovative energy saving technologies is important for realizing drastic energy saving which is not merely an extension of previous energy saving in each sector and in particular in the industrial sector. GOJ encourages development of innovative technologies that can realize significant energy saving across industries. In addition, in order to encourage smart use of energy, GOJ facilitates introduction of energy management systems, such as FEMS, etc. Furthermore, it encourages the utilization of the ISO50001 standard for energy management procedures.

(2) Leveraging demand response that promotes efficient energy supply

Previously, during the peak hours, power supply was secured by using load following power sources. However, it is possible to ensure the supply-demand balance by having consumers, rather than suppliers, control the amount of power needed. As a step to establish a demand response system that controls the amount of demand according to that of supply, the electricity price may be varied significantly according to the time of the day so as to encourage consumers to change their power consumption patterns. However, this system has not fully taken hold in the general consumer market, even though the industry is making active use of it and is taking such steps as shifting operations to night-time hours.

Therefore, by the early 2020s, smart meters will be introduced into all households and businesses. At the same time, through the full retail competition under the electricity system reform, electricity will be priced in a more effective and diverse way, making it possible to control electricity demand during peak hours to a significant degree.

Moreover, as the second step of demand response, the method of quantitatively managing the control of the amount of electricity demand is being considered. This method has been in place in the form of a contract on the regulation of supply and demand between electric power companies and large users. To make this method take hold widely in society as in Europe and the U.S., it is necessary for relevant parties, including electric power companies to share the recognition of its efficacy, value, etc. For this reason, GOJ has established a system under which consumers control demand according to requests from retailers and transmission and distribution operators and receive rewards from them in exchange through the mediation of an operator to manage energy use information (aggregator), who handles trading of Negawatts (credits for the amount of electricity

saved) on behalf of multiple consumers, and GOJ is working to smoothly disseminate and expand use of this system. In addition, GOJ will develop an environment in which a demand response is utilized. Demand response means that the amount of demand is increased by shifting demand, etc. Specifically, based on the full range of systems and the development of the market, GOJ amends the guidelines, etc. specifying the methods for evaluating amount of the demand controlled and the matters that are necessary for trading of the demand response, etc.

Moreover, if trading of Negawatts resulting from reduction of power consumption is made easier, it will become possible for consumers to more effectively control their own electricity demand. Therefore, by steadily carrying out the electricity system reform, an environment will be created to make it easier to introduce a new type of business model (an energy resource aggregation business) that utilizes demand response and virtual power plants, and to keep the amount of power generated at a rational level by managing demand, ensuring stable supply.

Furthermore, technological innovation in recent years, namely AI and the IoT, have the potential to contribute to the building of new distributed electric power systems based on demand response, etc. and also to improve the sophistication of supply and demand forecasts and optimize power plant operation. GOJ will advance the implementation of these kinds of new technologies in the energy sector.

These measures and utilization for electric vehicles and other businesses require the use of consumer information, including data concerning the amount of electricity used. For this reason, special consideration must be given to protecting personal information in using consumer information.

Moreover, although there is innovation in information technologies for realizing this kind of demand response, etc., on the other hand cyber-attacks are diversifying and becoming more sophisticated, so they are becoming a major threat to the stable supply of electric power. For this reason, GOJ will improve cybersecurity in the electric power sector by strengthening information sharing and analyses in the industry as a whole and strengthening international collaboration by both the public and private sectors.

3. Efforts for the utilization of renewable energy as the major power source

The situation surrounding renewable energy is undergoing major transformations. Globally, the power generation cost is rapidly falling, it has become a power source that has cost competitiveness compared to other power sources, and the amount of renewable energy introduced is rapidly increasing. In Japan too, since the introduction of the FIT system in July 2012 the introduction of renewable energy has progressed rapidly but on the other hand the power generation cost remains high compared to the international level, which is bringing about an increase in the public burden. In the energy mix, the total purchase costs in the FIT system in the case that the FY2030 level of introduction of renewable energy (22% to 24%) is achieved are expected to be about 3.7 to 4 trillion yen, but it is anticipated that the total purchase costs in FY2018 will reach about 3.1 trillion yen already, so inhibition of public burden in the effort to convert renewable energy into a major power source has become an urgent issue. Furthermore, as the introduction of renewable energy continues to expand, power grid constraints under conventional power grid operation emerge, and the cost of accepting renewable energy on electric power grids, including securing the load following capacity for adjusting the power output fluctuations of renewable energy, is also growing. Moreover, in addition to local concerns regarding coexistence with the region and the disposal of the equipment after the power generation business ends, a concern has also come to light with respect to long-term, stable power generation, namely whether future reinvestment, particularly in small scale power sources, will be delayed.

For this reason, GOJ is steadily advancing consideration of the best approach to systems for encouraging the appropriate operation and self-reliance of the FIT system, the overcoming of power grid constraints, the securing of load following capacity, rebalancing of regulations, research and development into lowering costs, etc., and measures to take at the time of disposal and for reinvestment. GOJ will continue to utilize the Ministerial Council on Renewable Energy, Hydrogen and Related Issues for the policy coordination by the government, and to promote cooperation among the related ministries.

GOJ will aim for cost reduction to a level that is competitive compared to other power sources and for self-reliance from the FIT system and will continue to actively promote measures for the smooth, large-volume introduction of renewable energy so that it becomes sustainable as a long-term, stable, major power source that can play a role in Japan’s energy supply.

(1) Measures to make solar power and wind power, which are expected to get cheaper rapidly, into major power sources

Taking into account the fact that introduction of solar power and wind power at low cost is expanding globally, Japan expects that going forward these power sources will

reach a cost level that is just as competitive as other power sources as further cost reductions are achieved through technological innovation, etc., and that these power sources will mature as long-term, stable power source as they are combined with storage batteries, etc. While taking into account these kinds of issues, GOJ will advance measures aimed at utilizing residential-use and small-scale solar power for personal consumption and as a distributed power source that carries out local production for local consumption of energy, and at utilizing other kinds of solar power as a large power source predicated on sale of electricity to the market, which has particularly high cost competitiveness.

(i) Solar power

In order to utilize solar power as a large power source in the future, it is necessary to aim to realize mid- to long-term price targets in the FIT system (aiming for the level of the power generation cost in solar power generation for business operations to become 7 yen/kWh in 2030, etc.) and to achieve further cost reductions. In order to reduce power generation costs, GOJ will promote innovative research and development and carry out appropriate operation of the FIT system, including utilization of auction that encourages cost reductions through competition and the lowering of procurement prices using the Top Runner method for mid- to long-term price targets, etc. At the same time, GOJ will work on effective utilization of potential, for example utilization of ruined farmland that is difficult to reuse and coexists with the region.

Furthermore, regarding utilization as a distributed power source for personal consumption and local production for local consumption of energy, the popularization of small-scale solar power is proceeding in the regions, including the utilization of idle land and roofs of schools and factories, and GOJ continues to support such measures. In particular, regarding residential-use solar power, the public and private sectors will work together to thoroughly publicize and inform people about the fact that from 2019 onwards, when the acquisition period of the FIT system ends, the option of selling excess electric power through bilateral contracts, etc. for personal consumption and to retail electricity business operators, etc. at the end of the acquisition period and afterwards will be gradually introduced in order to foster a market environment for independence from the FIT system. Furthermore, GOJ will advance price reductions for the independent popularization of storage batteries that contribute to personal consumption.

Moreover, in order to make solar power a long-term, stable power source, GOJ will work for coexistence with the regions while considering the problem of the disposal of solar panels which will arise on a large scale in the future, including the development of legal systems, take steps to ensure that the proper disposal and processing of used panels is implemented reliably, and secure and encourage reinvestment in the appropriate maintenance of small-scale solar power generation for business operations.

(ii) Wind power

When introducing wind power generation equipment, coordination with the local people, environmental assessments, and complying with the full range of regulations and constraints for the site are necessary, and even under the FIT system introduction takes a long time compared to introduction of solar power generation equipment for which there is little need for these steps. Furthermore, there is the problem that as the introduction of renewable energy continues to expand, the capacity of the current grid network is used, leaving little room for connection. Moreover, at a time when the power generation cost is falling substantially overseas, the power generation cost in Japan remains high, so it is necessary to work toward large cost reductions including the equipment cost, work cost, power grid connection cost, etc., with the aim of realizing the mid- to long-term price targets in the FIT system (aiming for the level of the power generation cost in wind power generation excluding floating offshore wind power generation to become 8 to 9 yen/kWh in 2030, etc.).

In order to utilize wind power as a large power source in the future, GOJ will work for coexistence with the regions while considering the necessary measures taking into account issues such as making environmental assessments faster, revising the scale requirements, and narrowing down the reference items, so that the introduction of wind power generation equipment can be realized in a shorter period and smoothly, and continuing to advance measures such as rationalization of the safety regulations under the Electricity Business Act, etc. as necessary.

Furthermore, in order to achieve large cost reductions GOJ will tackle the development of technologies to lower cost and the promotion of competition and efficiency improvement utilizing the FIT system, etc.

Regarding onshore wind power, in order to utilize appropriate places for wind power such as Hokkaido or Tohoku area at a maximum, GOJ will aim for utilization of onshore wind power that achieves harmony and coexistence with agricultural and forestry land and will take measures for further rationalization of regulations and systems as necessary.

Regarding offshore wind power, globally, cost reductions and the expansion of introduction of offshore wind power are proceeding rapidly. Further introduction of offshore wind power is indispensable for Japan where appropriate places in which onshore wind power can be introduced are limited. In Europe, cost reductions have been proceeding rapidly over the last few years due to the development of rules for ocean use and the introduction of a bidding system. GOJ will refer to Europe’s measures regarding offshore wind power generation while taking measures to promote the introduction of offshore wind power generation that combines the development of rules for ocean use that achieve coexistence with the regions with power grid constraints, measures for base ports, making the related procedures faster, and price bidding. Furthermore, GOJ will provide demonstrations and development support for lowering the cost of fixed offshore wind

power, and for floating offshore wind power it will carry out evaluations of safety, reliability, and economic viability through the development and demonstration of technologies.

(2) Measures to make geothermal and hydropower and biomass, which are achieving harmony with the regions and steadily becoming independent, into major power sources

There is a possibility that geothermal power generation using the underground steam and hot water present in the regions, medium/small hydropower generation using small rivers and agricultural water, biomass power generation using wood and other locally available materials, and renewable energy heat such as solar and geothermal heat, etc. may play an important role as balanced distributed energy systems that offer advantages in terms of cost if measures to reduce costs are taken. Moreover, they are energy sources that are deeply rooted in local communities. Therefore, it is expected that each local community, including regional governments and regional companies and residents to take the initiative in proceeding with the introduction of such energy sources.

In addition, the establishment of distributed energy systems using renewable energy creates new local industries and may lead to regional vitalization. They also help to secure a certain amount of energy supply in regions even when it has become difficult to ensure supply from a large power source in case of emergency.

Therefore, GOJ will aim for coexistence of these power sources with the regions by multifacetedly promoting them in conjunction with the agriculture and forestry industry, etc. while gradually realizing self-reliance by advancing measures for cost reduction. It is expected that these power sources will become a presence that plays a role as a long-term, stable power source.

GOJ will provide assistance to make it easy for individuals and small-scale business operators to participate in these power sources so that the building distributed energy systems combining small-scale renewable energy sources is accelerated. Furthermore, GOJ will actively utilize the Act on Promoting Generation of Electricity from Renewable Energy Sources Harmonized with Sound Development of Agriculture, Forestry and Fisheries (Agriculture, Forestry and Fisheries Villages Renewable Energy Act), etc. and push ahead with the introduction of renewable energy that contributes to the revitalization of the regions.

Moreover, in order to flexibly approve the supply of power, including power stored in storage batteries that has become superfluous within distributed energy systems, to power grids, more flexibility will be allowed with regard to the operation of reverse power flow. Technological innovations required to ensure the stability of power grids will be promoted.

(i) Geothermal power

There are issues with the development of geothermal power generation including that it takes time and money, power grid constraints are emerging as a consequence of the fact that the promising regions for geothermal resources are primarily located in only some regions and, just as with wind power generation, there is a need for coordination with the local people, environmental assessments, and complying with the full range of regulations and constraints for the site, etc. It is necessary to overcome these issues in order to utilize the value of geothermal power generation as a base-load power source and advance its utilization as a competitive, self-reliant power source in the mid- to long-term, centered on the sale of electricity to the market.

Therefore, GOJ will promote the understanding of local communities, reduce investment risks, develop technology that contributes to improving drilling success rate and drilling efficiency, advance measures to make environmental assessments faster, and take measures for the further rationalization of regulations and systems, including the safety regulations under the Electricity Business Act as necessary so that the introduction of geothermal power generation equipment can be realized in a shorter period, at a low cost, and smoothly.

Moreover, with geothermal power generation multi-stage usage of the energy, such as hot water usage after power generation, is expected. For example, geothermal power plants play a role in stabilizing regional energy supply by supplying electricity in a stable manner and providing warm water generated from steam for use by neighboring hotels, agricultural greenhouses, etc. Considering such merits, based on the mid- to long-term perspective, GOJ studies measures such as arrangements for site location and system development for appropriately managing geothermal resources, in order to continue promoting sustainable development in coexistence with the regions.

Furthermore, given that Japanese companies have captured approximately 70% of the global market share of geothermal power generation equipment, GOJ will consider the best approach to assistance measures for the promotion of the global expansion of geothermal power generation from the perspective of global expansion of decarbonization technologies.

(ii) Hydropower

Hydropower generation is important as a clean power source able to maintain a stable power output, but it entails high development risks and development of new sites is difficult. In addition, there is the issue of power grid constraints, etc. It is necessary to overcome these issues in order to gradually reduce costs and realize self-reliance while also achieving coexistence with local communities that is tailored to the flood control objectives, etc. of the local communities.

Therefore, GOJ will work to reduce the development risks by providing assistance for site surveys of the discharge rate, etc. and promoting of local understanding, etc. In

addition to the development of undeveloped sites, GOJ will promote measures to increase the amount of power generated by existing dams by upgrading the operations of the dams utilizing IT technologies, etc. Furthermore, while aiming for efficiency improvements and harmonization with flood control functions through introduction of the latest equipment for hydropower generation equipment that has reached the time when it needs to be replaced, GOJ will aim for the expansion of active introduction of hydropower while reducing costs through the effective utilization of existing dams, etc.

Moreover, due to the 2013 amendment of the River Act it has become simpler and easier to apply for river rights with regard to power generation using agricultural water that has already been permitted, and therefore GOJ will continue to take proactive steps to expand the introduction of such power generation while also ensuring coexistence with the regions.

(iii) Woody biomass, etc.

Biomass power generation faces issues such as the reduction of the power generation cost, the majority of which is accounted for by fuel costs, stable procurement of the fuel, and ensuring sustainability, etc. It is expected that these issues will be overcome, and the aim will be multifaceted promotion of this energy source in conjunction with the agriculture and forestry industries, etc. in the regions.

Therefore, in terms of the usage of woody biomass power generation and heat based on stable and efficient supply of unused materials with big potential, GOJ positively promotes forest/timber policies and measures through the Agriculture, Forestry and Fisheries Villages Renewable Energy Act for the effective use of forest resources and revitalization of the forestry industry, which also contributes to the cyclical economy, and GOJ also promotes the introduction of renewable energy harmonious with the sound development of the agricultural, forestry and fisheries industries. Moreover, measures will be taken to promote the use of biomass, such as domestic animal waste, sewage sludge and food waste, etc. and the introduction of crop plants for biofuel in deserted arable lands.

Cost efficient introduction through a bidding system based on the FIT system and predicated on stable and sustainable fuel procurement will be encouraged for power generation for which cost reductions through competition are expected, primarily large-scale biomass power generation.

(iv) Renewable Energy-drived Heat

It is important to promote the use of renewable energy-derived heat, which is important regional energy, together with renewable energy-derived electricity, the use of biomass heat generated from sewage sludge and waste wood, biomass fuels that can partially replace oil products used as fuel for transportation and the recovery of heat in the process of waste processing, in accordance with the energy source’s economic efficiency and the characteristics of the region. Support will be provided for the introduction of heat supply

facilities that use renewable energy-derived heat, including solar heat, geothermal heat, snow ice heat, hot spring heat, seawater heat, river heat and sewage heat. At the same time support will be given to measures region-wide provision of heat among multiple consumer groups, aiming to expand the introduction of renewable energy-derived heat.

(3) Feed-in-tariff system

Since the start of the FIT system in July 2012, the installed capacity of renewable energy power generation, excluding large-scale hydropower, had grown by 2.7 times by the end of March 2017, indicating steady progress in the introduction of renewable energy. The objective of the feed-in-tariff program is to accelerate investments in renewable energy by providing predictability regarding the recovery of investments. For this reason, it is important to continue operating the program in a stable and appropriate manner so as to reduce risks involved in the program and enable businesses to concentrate on competition. Also, it is meaningful to consider systems taking vitalization of regions into account including small-scaled efforts.

On the other hand, from the standpoint of the cost burden on the people, appropriate consideration must always be made; for example, in accordance with the legal provisions, utilization of a bidding system, setting of mid- to long-term price targets that also take into account international price trends, and examination of said targets and the setting of procurement prices taking into account cost reduction achievements, and in addition revision of certification standards and the methods of confirming them, and prevention of non-operational projects by setting deadlines for commencement of operations, etc. Moreover, the systems for promoting the use of renewable energy sources, such as the FIT system, must be comprehensively studied in light of such issues as a cost burden increase, overcoming the constraints of power grids, linking to markets developed as a consequence of wholesale electricity trading market and electricity system reforms in reference to the situations in other countries, and on the axis of developing policy combinations which can optimally balance both promotion of maximum use of renewable energy and mitigating public burden, in accordance with the revision of the Strategic Energy Plan based on the law. Necessary steps will be taken based on the results of the study and drastic revisions will be carried out until the end of FY2020.

(4) Overcoming power grid constraints and securing load following capacity

To date Japan’s power grids have mainly been built in a form that connects large power sources to the demand areas, and they do not necessarily match the sites that have potential for renewable energy power sources, so the power grid constraints are becoming apparent as a result of the expansion of the introduction of renewable energy. Therefore, going forward, eliminating these power grid constraints is important when advancing efforts to convert renewable energy into a major power source.

In order to achieve both maximum introduction of renewable energy and inhibition of public burden, it is effective to firstly utilize the existing power grids to the maximum extent, so GOJ will refer to examples in Europe while realizing the early implementation of the “Japanese version of Connect & Manage.”

In addition, if we look to 2030 and beyond, it is expected that some further power grid upgrading will become necessary. In addition to structural issues such as the decline in demand resulting from population decline and aging measures, etc., in order to switch to a next-generation transmission and distribution network taking into account the introduction of a lot of renewable energy, the expansion of distributed energy and other environmental changes, GOJ will reduce the costs related to power grid upgrading, etc. as much as possible through network cost reform, and advance the development of an environment that secures predictability so that the necessary investments are made, etc.

Furthermore, it is forecast that the load following capacity that is necessary will grow as a result of the increase in the amount of natural fluctuating power sources (solar power and wind power) being introduced. For the time being, this load following capacity will be steadily secured through flexible utilization of thermal power generation, utilization of the adjustment functions of the renewable energy itself, and revitalization of interchange between areas utilizing interconnection lines, etc. Furthermore, GOJ will advance decarbonization of the load following capacity by utilizing Virtual Power Plants (VPPs) and Vehicle-to-Grid (V2G) technology that controls the reverse power flow from storage batteries in EVs, stationary-type of storage batteries and, in the long term, hydrogen, the next-generation load following capacity.

(i) Maximum utilization of existing power grids

With systems in Japan to date, when newly connecting power sources to the power grid, the power sources were accepted on a first-come-first-served basis within the range of the spare capacity of the power grid, and in the case that the spare capacity ran out the power grid was upgraded and then the power source was additionally accepted. On the other hand, in Europe there are some countries that have introduced the system of maximum utilization of the capacity of the existing power grid and allowing the connection under certain conditions. It takes a lot of money and time to upgrade a power grid, so it is important to firstly implement maximum utilization of the existing power grid. Therefore, GOJ will implement and realize early the “Japanese version of Connect & Manage” which flexibly utilizes the spare capacity of the power grid. Specifically, in addition to the rationalization of estimated power flow, a method that more precisely estimates the future flow of electricity based on past performance to compute the spare capacity, GOJ will accelerate discussions about utilization of a power transmission framework for use at times of emergency that uses an instant shutdown device when there is an accident, measures involving “connection to the power grid under certain constraint conditions”

such as control at a time of power grid congestion, etc., and also about the best approach to information disclosure and release pertaining to power grid information, etc., and then GOJ will take the necessary measures based on the results of those discussions.

(ii) Handling the upgrading of power grids using network cost reform, etc.

In order to switch to a next-generation transmission and distribution network that takes into account the introduction of a lot of renewable energy and other environmental changes, it is necessary to work to inhibit public burden while developing an environment that secures predictability so that the necessary investments are made for power grid upgrading, etc. When carrying out network cost reform, GOJ will adopt the basic policies of greatly reducing the power generation cost pertaining to renewable energy and securing the source funds for next-generation network investment and reducing the costs overall by thoroughly reducing the existing network costs.

From the perspective of inhibition of public, it is necessary to thoroughly reduce the costs of the existing network, etc. in order to reduce to the maximum extent the network costs, which are rising as a result of the expanded introduction of renewable energy. Specifically, GOJ will promote thorough cost reductions through reform of the procurement of general electricity transmission and distribution utilities, including promotion of the standardization of specifications, etc. and disclosure of information to the national government about procurement, and the submission of independent roadmaps and confirmation of the status of measures by general electricity transmission and distribution utilities for cost reduction, etc. When doing this, the GOJ will assume these measures and consider a wheeling charge system that encourages constant efficiency improvement. Furthermore, regarding the best approach to the cost burden for promoting next-generation investment, GOJ will at the same time advance development of the environment, including systems to promote investment for the future, etc., and this development will include consideration of a wheeling charge system that is likely to create incentives for investment and consideration of fiscal assistance, etc. Moreover, GOJ will secure incentives and options for power generation equipment installers to carry out business expansion with awareness of the network cost. Specifically, in addition to the partial specified burden method in power grid upgrades that have already been introduced, GOJ will introduce basic charges on the power generation side, etc. and introduce mechanisms for efficient utilization of the power grid, including revision of the upper limit of the general burden.

(iii) Measures for securing load following capacity and its decarbonization

At a time when the introduction of natural fluctuating power sources (solar power and wind power) is expanding, it is important to adjust the power output fluctuation to match the supply and demand balance, and then efficiently and effectively secure the load

following capacity. Therefore, for the time being it is essential to secure the load following capacity through thermal power generation and flexible utilization of pumping, etc., so GOJ will develop a supply and demand adjustment market, etc. for efficiently procuring load following capacity, and will also consider the best approach to the burden. In addition, in order to further utilize functions for adjusting renewable energy itself, such as wind power generation, etc., GOJ will identify the adjustment functions that should be installed, such as newly interconnected wind power generation, etc. and stipulate their specific level. Moreover, GOJ will proceed with consideration of measures for revitalizing cross-regional operation utilizing interconnection lines. Through these measures, etc. GOJ will steadily secure the load following capacity for the time being. Furthermore, it is important to utilize next-generation load following capacity and advance the decarbonization of the load following capacity. Next-generation load following capacity includes V2G technologies that reverse the power flow of and control electricity stored in VPPs and EVs that utilize distributed energy resources installed on the consumer side, such as stationary storage batteries and cogeneration, EVs, etc., storage batteries used for power grid stabilization, and furthermore Power-to-Gas (P2G) technologies that store and use electric power as hydrogen over the long term. Regarding VPP and V2G, GOJ will aim for business development in the supply and demand adjustment market, etc. which it plans to develop by about 2020, and will advance arrangement of the necessary technological requirements and technology demonstrations, etc. in parallel. Regarding storage batteries, GOJ will advance measures to lower costs and also technology development, etc. in order to promote their introduction. Furthermore, P2G technologies are predicated on the reduction of the procurement cost of renewable energy which becomes the hydrogen production cost so GOJ will advance measures for implementation of P2G technologies together with the development of hydrogen businesses.

(5) Establishing Fukushima as a center of the renewable energy industry

In Fukushima, a demonstration research project regarding large floating offshore wind power generation is ongoing with a view to the world's first full-fledged commercialization. In addition, the Fukushima Renewable Energy Research Institute was opened at the National Institute of Advanced Industrial Science and Technology in April 2014, and it is conducting research activities concerning technologies related to appropriate use and evaluation of geothermal power generation and renewable energy. Furthermore, based on the Fukushima Plan for a New Energy Society, efforts are being made to enhance transmission and interconnection lines for the further expansion of the introduction of renewable energy.

Through these efforts, Japan aims to establish Fukushima as a center of the renewable energy industry.

4. Re-establishment of the nuclear energy policy

(1) Starting point of the nuclear energy policy – Sincere reflection on the TEPCO's Fukushima nuclear accident

Regarding TEPCO's Fukushima Daiichi Nuclear Power Station accident, the government and nuclear operators must continue their efforts to make sure not to let such accident happen again, not forgetting even for a moment that their falling into the so-called "myth of safety" invited the disastrous situation, sincerely reflecting on that fact, and also learning lessons from the various experiences with what happened at the Onagawa and Tokai Daini and other nuclear power plants, which fortunately did not lead to any serious accident.

The Japanese, in cooperation with TEPCO and many other parties involved, has been making its utmost efforts toward the restoration and reconstruction of Fukushima, lifted the evacuation order for almost all areas except the difficult-to-return zones, and decided on the policy of taking fuel debris out of the reactor. On the other hand, however, even after a lapse of some seven years after the accident, about 24,000 people still remain subject to the evacuation order, leaving Japan only half way through its efforts toward restoration from the accident.

Furthermore, there still exist concerns among the Japanese people over nuclear power generation and distrust of and resentment at the government and nuclear operators that promoted the nuclear power policy. Social confidence in nuclear power has yet to be fully obtained.

The Japanese government must take such a situation seriously and squarely, and continue its maximum efforts toward obtaining social confidence in nuclear power.

(2) Efforts toward restoration and reconstruction of Fukushima

Efforts toward restoration and reconstruction of Fukushima should be placed at the starting point in order to rebuild the energy policy. As its top priority, the Japanese government must do its utmost to achieve the restoration and reconstruction of Fukushima through implementing the measures for decommissioning and contaminated water, ensuring compensation for the nuclear accident damage, creating new industries and employment, supporting reconstruction of businesses and livelihood, controlling damage caused by groundless rumors about the accident, and working for decontamination and construction of an interim storage facility.

In order to further accelerate the restoration and reconstruction of Fukushima from the above perspective, the government formulated the Basic Policy for Accelerating Fukushima's Reconstruction from the Nuclear Disaster (the Cabinet Decision of December 2016; hereinafter referred to as the "Basic Policy") to add and expand necessary measures for that objective, and clarified the division of roles between the national government and TEPCO once again.

Since the decommissioning and countermeasures against contaminated water in the wake of a serious nuclear accident, like TEPCO's Fukushima Daiichi Nuclear Power Station accident, are difficult tasks, unprecedented even in the world, the government needs to take the initiative, instead of leaving them to nuclear operators, in addressing them with an unwavering resolve to undertake each measure safely and steadily for the surefire implementation of the decommissioning by calling upon a great amount of expertise and wisdom at home and overseas.

To that end, in order to steadily implement the decommissioning of the TEPCO reactors that caused the accidents that is expected to require a massive amount of funds over an extended period in accordance with the Basic Policy, the Act on the Nuclear Damage Compensation and Decommissioning Facilitation Corporation was revised in 2017 to put in place a system that requires accident-responsible nuclear operators to accumulate funds necessary for the decommissioning with the Nuclear Damage Compensation and Decommissioning Facilitation Corporation. Also in 2017, the "Mid- and Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1–4" (Mid- and Long-Term Roadmap) was revised for the fourth time. In view of a better understanding of the conditions inside the reactor due to progress in the decommissioning work, the latest revision incorporated the "fuel debris removal policy" for starting the small-scale removal work revolving around the "dry side access" method as well as the further strengthening of communication with the local community and society. Regarding countermeasures against the contaminated water, the groundwater level has stabilized at lower levels and the amount of emergence of contaminated water has declined significantly due to preventive and multi-layered countermeasures, including the installation of frozen-soil impermeable walls and pumping-up of groundwater. Based on the Mid- and Long-Term Roadmap, the government and TEPCO will continue to safely and steadily implement the decommissioning work and countermeasures against the contaminated water at TEPCO's Fukushima Daiichi Nuclear Power Station.

Furthermore, the development of base facilities for the establishment of decommissioning-related technology infrastructure has been advancing steadily, with the Japan Atomic Energy Agency (JAEA) locating the Naraha Remote Technology Development Center in Naraha Town, the International Collaborative Research Building of the Collaborative Laboratories for Advanced Decommissioning Science (CLADS) in Tomioka Town, and the Okuma Analysis and Research Center in Okuma Town. These facilities are positioned as the decommissioning-related facilities that play a part in the Fukushima Innovation Coast Framework.

Regarding compensation for people and companies affected by the TEPCO nuclear power station accident, while ensuring the fairness and competitive neutrality among beneficiaries in the environment of progressing electric power deregulation and from the

perspective of the entire nation supporting Fukushima, the government has put in place a system necessary to cover funding requirements for compensation, to be broadly borne by all consumers, for damage incurred prior to the accident at TEPCO's Fukushima Daiichi Nuclear Power Station.

In August 2016, the Fukushima Plan for a New Energy Society was formulated in order to help accelerate the new energy sector of the Fukushima Innovation Coast Framework and develop the entire Fukushima Prefecture as a base for creating a model that goes ahead of the times as a future new energy society. Japan has undertaken a demonstration research project on the technology for large offshore wind power generation off the cost of Fukushima Prefecture and key technology research at the Fukushima Renewable Energy Research Institute of the National Institute of Advanced Industrial Science and Technology. In order to help accelerate the realization of the Fukushima Plan for a New Energy Society, Japan has also been promoting new initiatives for the development of Fukushima as the base of new energy industries and technologies, including an expansion of the capacity of power transmission cables for wind power generation in the Abukuma-Futaba area, a large-scale demonstration project to produce hydrogen using the 10,000kW water electrolysis equipment, one of the largest in the world, and the building of smart communities in cities, towns and villages of Fukushima Prefecture.

On that basis, technologies and information accumulated through these measures will be shared with the international community through frameworks of multinational cooperation such as the IAEA and the Nuclear Energy Agency (NEA) under the Organization for Economic Cooperation and Development (OECD) and bilateral cooperation with the U.S., the U.K., France, and Russia, to contribute to improvement of safety and disaster prevention functions at nuclear power facilities in each country.

Under the Mid- and Long-Term Roadmap, the government will monitor the progress in the countermeasures by nuclear operators and also continue to provide necessary support for research and development in areas involving technological difficulties and requiring the government to take the initiative. Furthermore, the government will exert appropriate efforts toward improving the working environment.

In accordance with the Revised Comprehensive Special Business Plan (The Third Plan), TEPCO itself is also proceeding with efforts to complete its "non-consecutive management reform" and enhance its enterprise value. Through these efforts, TEPCO is required to fulfill its responsibilities for the Fukushima nuclear accident.

Against all tasks necessary for the restoration and reconstruction of Fukushima, both the government and TEPCO will tackle them with the stance of performing them as soon as possible, while gaining public understanding and in cooperation with local communities.

(3) Untiring pursuit of safety and establishment of stable environment for nuclear

operations

When it is required to address long-term problems, such as the stable supply of cheap electric power and global warming, it is necessary for the government to make comprehensive and responsible efforts to deal with a variety of issues surrounding the nuclear power industry, including resumption of nuclear power plant operations, measures to deal with spent nuclear fuels, the nuclear fuel cycle, final disposal of spent nuclear fuels and the decommissioning of nuclear power reactors.

In case that the NRA confirms the conformity of nuclear power plants with the new regulatory requirements, which are of the most stringent level in the world, GOJ will respect the judgment and will proceed with the restart of the nuclear power plants. In this case, GOJ will make best efforts to obtain the understanding and cooperation of relevant parties including host municipalities.

The industrial circles, including nuclear operators, need to set up business schemes to persistently pursue safety and make efforts to foster safety culture that places top priority on the safety of nuclear facilities. GOJ will play necessary roles such as developing a stable business environment that make these activities possible.

Each nuclear power operator, with a firm resolve that it will never let another nuclear accident happen, should establish a system to appropriately manage risks associated with nuclear power, sophisticate objective and quantitative risk assessments methods such as probabilistic risk assessment (PRA), develop a foundation for risk informed decision-making (RIDM) and practice it on work sites. Nuclear operators are also called upon to strive toward the persistent enhancement of safety through friendly competition among them by accumulating the experiences of peer review activities to mutually point to problems with their safety management systems. In addition, in exerting stronger efforts toward enhanced safety, nuclear operators need to have proactive exchanges of views with the Nuclear Regulation Authority (NRA) to make such efforts consistent with nuclear power-related safety regulations and what such regulations should be in the mid- and long-term.

Furthermore, in order to assist individual operators in their individual efforts, nuclear operators should strengthen cross-industry cooperation, inclusive of manufacturers, such as the establishment of a new organization, aggregate knowledge, identify problems that should be dealt with by the industry, formulate, implement and assess action plans, and put the plan-do-check-act (PDCA) cycle into practice. Based on these activities, nuclear operators should also strengthen interactive communication with the Nuclear Regulation Authority and society. At the same time, government policymakers are called upon to provide support to them, including “visualization” of safety-enhancing efforts.

Nuclear operators are also required to i) maintain high-level nuclear technologies and human resources, ii) smoothly go through decommissioning work, which will increase in the future, iii) quickly take the best safety measures in response to regulations reinforced

after the TEPCO's Fukushima nuclear accident and iv) contribute to global warming countermeasures and stable electricity supply utilizing base-load power sources. Thus, even under the environment of progressing competition with electric power system reform, the government will continue to study how the business environment should be to allow nuclear operators to cope with these problems by possibly using overseas examples as a reference.

Already, the government has developed the accounting system designed to keep nuclear operators from balking at decisions on the decommissioning for financial reasons and to facilitate the smooth decommissioning. It also enacted the Spent Nuclear Fuel Reprocessing Fund Act to allow the reprocessing of spent nuclear fuels to proceed without delay into the future. In light of the progress in electric power system reform, the government will continue to take necessary response measures toward establishing the stable business environment, including back-end measures.

Maintaining and developing high-level nuclear technologies and human resources is imperative for smoothly decommissioning aged nuclear power plants, which are expected to increase in the future, as well as TEPCO's Fukushima Daiichi Nuclear Power Station. As the utilization of nuclear power is expected to continue expanding internationally even after the TEPCO Fukushima Daiichi Nuclear Power Station accident, and the scale of the introduction of nuclear power is remarkable particularly in China, India and other emerging economies, where energy demand is increasingly sharply. As an advanced nation in the utilization of nuclear power and also in light of its experience with the nuclear power plant accident, Japan is expected to make contributions in such areas as safety, nuclear nonproliferation and nuclear security as well as from the perspective of countermeasures against global warming. Furthermore, as the enhancement of nuclear safety in countries surrounding Japan directly means the securing of safety of Japan, Japan should maintain and strengthen the high levels of personnel familiar with nuclear power, nuclear technologies and the nuclear industry foundation through the development of technologies in view of varied social demands, and should also maintain and strengthen on-site capabilities to find and solve problems, through the resumption of operations of suspended nuclear power plants and the decommissioning of nuclear power plants no longer fit to operate. Regarding the disposal of radioactive waste from the decommissioning of nuclear power plants, it is basically the responsibility of nuclear operators to steadily proceed with efforts to secure the locations of disposal sites, including the disposal of low-level radioactive waste, under the principle that the waste generators are responsible. In order to facilitate the smooth disposal, the government will promote measures to ensure the safety, including creation of a regulatory environment and promotion of necessary research and development activities. The government will also continue to promote development of technologies and secure human resources necessary for the processes of the smooth and safe decommissioning.

Regarding the nuclear damage compensation system, in consideration of the importance of participation in the work to build an international system for nuclear damage compensation and the development of an environment to gather the expertise and wisdom from overseas for the decommissioning and countermeasures against the contaminated water, the Japanese government concluded the Convention on Supplementary Compensation on Nuclear Damage (CSC) in January 2015. Regarding the review of the compensation system, in view of the actual situation of compensation related to the TEPCO Fukushima Daiichi Nuclear Power Plant accident and the electric power system reform and on the premise that adequate compensation is provided promptly, the government will continue its comprehensive study and take necessary measures in consideration of the division of roles between nuclear operations and the government and in light of the perspectives of minimizing the public financial burden related to compensation for people suffering from the nuclear accident and ensuring the predictability for nuclear operators.

Regarding regional disaster prevention plans and evacuation plans formulated on the basis of the basic disaster prevention plan and the nuclear emergency preparedness guidelines pursuant to the previsions of the Disaster Countermeasure Basic Act and the Act on Special Measures Concerning Nuclear Emergency Preparedness, the government will establish the Regional Nuclear Emergency Preparedness Council for each priority area of nuclear emergency preparedness around nuclear power plants, with relevant central government ministries and agencies and local governments as members, and the national and local governments should work cooperatively to flesh out and improve these plans. The Regional Nuclear Emergency Preparedness Council should confirm that the regional disaster prevention and evacuation plans are specific and reasonable, and the Nuclear Emergency Preparedness Commission (NEPC), chaired by the Prime Minister, authorizes them. The government, in cooperation with relevant parties, including local governments, should continuously improve and expand the formulated regional disaster prevention plans and evacuation plans through training.

(4) Steady approach without putting off implementing measures into the future

Regarding the situation of spent fuels, even when we only consider those of OECD/NEA member states, there are approximately 227,000 tons of spent fuels as of 2015, and how to manage spent fuels is a global challenge. As spent fuels are sure to be produced through the use of nuclear energy, it is essential to implement measures to resolve this challenge as a responsibility of the current generation so that the burden is not passed on to future generations. Therefore, Japan will drastically reinforce and comprehensively promote efforts to resolve the challenge of how to manage and dispose of spent fuels.

GOJ will take the initiative in dealing with high-level radioactive waste and proceed

with measures toward final disposal. In July 2017, the Japanese government released the "Map of Scientific Characteristics" in connection with the final disposal of high-level radioactive waste. Following the release, the government will further strengthen efforts to help deepen the understanding of the Japanese people and relevant local communities about the radioactive waste disposal.

GOJ will reinforce its efforts to increase the capacity of storing spent fuels, as safely managing spent fuels until their final disposal is an important process of the nuclear fuel cycle. Furthermore, GOJ will promote development of technologies for reducing the volume and harmfulness of radioactive waste in order to secure a wide range of options in the future.

Regarding the nuclear fuel cycle policy, GOJ will steadily promote reprocessing and plutonium use in Light Water Reactors (LWRs) while taking into consideration the past history and seeking the understanding of the relevant municipalities and the international community, and it will flexibly address measures in the mid- to long-term basis.

1) Drastic reinforcement of measures for achieving solutions and promotion concerning spent fuel management

i) Drastic reinforcement of measures for final disposal of high-level radioactive waste

Japan currently stores about 18,000 tons of spent fuels. These, combined with the spent fuels that have already been reprocessed, represent radioactive waste equivalent to about 25,000 canisters of vitrified waste. However, a survey for selecting a disposal site has not yet been started 10 years after the system for final disposal of radioactive waste was established.

The GOJ decided to revise the Basic Policy on the Final Disposal of Designated Radioactive Wastes (Cabinet Decision in May 2015) and take leadership to find proper solutions for the final disposal of high-level radioactive waste, as part of the current generation that is responsible for creating said waste, without putting off the problem to future generations.

Pursuant to the Basic Policy on the Final Disposal of Designated Radioactive Wastes, following a meeting of the Inter-Ministerial Council for the Final Disposal of High-Level Radioactive Waste, the government released the "Map of Scientific Characteristics" concerning the final disposal of high-level radioactive waste. With the release of the map as a turning point, the government, under the collaboration of relevant ministries and agencies, will strive to persuade multiple areas to accept a survey for selecting a final disposal site by further strengthening efforts, including the promotion of various dialogue activities, in light of the public interest.

Each country is taking its own action toward geological disposal of high-level radioactive waste, based on international understanding that i) final disposal not dependent upon long-term institutional management (human management) should be used whenever

possible to minimize the burden on future generations and ii) geological disposal is currently the most promising method of disposal. Following the continuous consideration based on the accumulation of scientific knowledge, Japan has also decided to adopt geological disposal. On the other hand, it is important to eliminate the situation that the professional assessment of the technical reliability of geological disposal is not fully shared by the public. For this reason, the government will make efforts toward the premised geological disposal while seeking to gain public understanding by explaining this particular disposal method to the general public, and it will secure reversibility and retrievability so that the future generation will be able to select the best disposal method when a better solution is found in the future.

Based on this concept, the most up-to-date scientific knowledge concerning the technical reliability of geological disposal will be periodically and continuously evaluated and reflected in the policy. The government will steadily promote study and research on alternative disposal options of spent fuels, including the direct disposal method of spent fuels, from the perspective of allowing flexible responses. Additionally, research and study on the impact to be produced if retrievability is maintained without closing disposal sites will be implemented in order to identify the specifics of the appropriate state of management of high-level radioactive waste for the period until the closure of disposal sites.

From the standpoint of securing the expertise and knowledge necessary to realize the disposal of high-level radioactive waste, the government will reinforce the research and development structure, including the Nuclear Waste Management Organization of Japan (NUMO), the responsible entity to undertake the disposal work. To that end, the government will strive for the inheritance of research results and development of human resources, seek to share the methods of dialogue with other countries beset with common problems, and step up international cooperation, including the promotion of mutual utilization of the research infrastructure both at home and overseas.

In view of these efforts being made by the government and NUMO, electric power companies, which bear the basic responsibility for having generated the radioactive waste, are required to undertake their own activities to seek understanding from local residents and explain the necessity of the final disposal site to the whole nation.

ii) Expanding storage capacity of spent fuels

As the current generation that has produced radioactive waste, GOJ will reinforce measures toward final disposal of high-level radioactive waste and take the initiative in solving this problem. However, the process will take a long time. In the meantime, spent fuels produced by nuclear power generation must be safely managed. It is therefore necessary to expand the capacity forstoring the spent fuels and is urgently important to broaden the range of choices for managing the spent fuels while ensuring safety. It will

make flexibility of policies and response, and contribute to medium-term energy security.

Based on this concept, the storage capacity of spent fuels will be expanded. Specifically, while studying a wide range of locations as possible sites, regardless of whether they are inside or outside the premises of a power plant, GOJ will strengthen its effort for facilitating construction and utilization of new intermediate storage facilities and dry storage facilities.

In October 2015, the government called a meeting of the Inter-Ministerial Council for the Final Disposal of High-Level Radioactive Waste and adopted an action plan on measures for the disposal of spent nuclear fuel. Pursuant to the plan, nuclear operators formulated plans to promote the measures for the disposal of spent nuclear fuel and are proceeding with efforts to expand the capacity to store spent fuels, including interim storage facilities and dry storage facilities. With a view to the acceleration of these efforts, the government will remain proactively involved while paying heed to the intentions of relevant local governments, and individual nuclear operators exert their own efforts while seeking to further strengthen cooperation among nuclear operators. Thus, the public and

iii) Promotion of technology development on volume reduction and mitigation of degree of harmfulness of radioactive waste

Regarding spent fuels, including those which have already been produced, appropriate measures must be taken with due consideration given to the following issues: 1) the fuels must be safely managed and appropriately processed and disposed of on a long-term basis; and 2) volume reduction and mitigation of degree of harmfulness of radioactive waste are important for lowering long-term risks. Promoting the development of technologies that can give solutions to these issues and enhance the safety, reliability and efficiency of the treasures has significance so that the technologies could secure a wide variety of options and may become one of the pillars of processing and disposing of spent fuels in the future.

Therefore, GOJ will promote technology development on volume reduction and mitigation of degree of harmfulness of radioactive waste. Specifically, the development of technologies for decreasing the radiation dose remaining in radioactive waste over a long period of time and enhancing the safety of processing and disposal of radioactive waste, including nuclide transmutation technology using fast reactors and accelerators, will be promoted by utilizing global networks of personal contacts. Also, while the government examines the situation of study and progress in terms of final disposal, it will continue to study the feasibility of integrated implementation of the R&D for final disposal and reduction of volume, international research cooperation and development of human resources for research.

2) Promotion of the nuclear fuel cycle policy

i) Promotion of reprocessing and plutonium use in LWRs

The basic policy of Japan is to promote a nuclear fuel cycle that reprocesses spent fuels and effectively utilizes the plutonium etc. retrieved, from the viewpoint of effective utilization of resources and reduction of the volume and harmfulness of high-level radioactive waste.

Regarding the nuclear fuel cycle, many issues have arisen, including delays in completion of the Rokkasho Reprocessing Plant. Regarding the Monju prototype fast breeder reactor, the government decided to change course to its decommissioning. It is important to take this situation seriously and resolve the issues one by one. In order to resolve the issues related to the reprocessing and disposal of spent fuels and mitigate the risks for and the burden on future generations, the government will make efforts to wards a nuclear fuel cycle that contributes to the reduction of the volume and harmfulness of high-level radioactive waste and effective utilization of resources while adequately taking the past history into consideration and continuing to gain the understanding of relevant municipalities and the international community, and will promote reprocessing and plutonium use in LWRs.

Specifically, GOJ will promote plutonium use in LWRs, and proceed with such measures as completion of the Rokkasho Reprocessing Plant, construction of a MOX fuel fabrication plant, and completion of the Mutsu interim storage facility on the underlying premise of ensuring safety. The Japanese government remains committed to the policy of not possessing plutonium without specific purposes on the premise of peaceful use of plutonium and work to reduce of the size of plutonium stockpile, thereby contributing to nuclear nonproliferation and steadily proceeding with such efforts while ganining international understanding. In order to achieve this policy effectively, the government will appropriately manage and utilize plutonium through further promotion of plutonium use in LWRs and the Government’s involvement based on the framework of the Spent Nuclear Fuel Reprocessing Implementation Act newly introduced in 2016 while paying due consideration to an appropriate balance between the separation and utilization of plutonium. Along with this, the government will continue with research and development related to measures for the reprocessing and disposal of spent MOX fuel and consider the issue in light of the status of the generation and storage of spent MOX fuel, trends of reprocessing technologies, and the intentions of relevant municipalities. Furthermore, under a roadmap to be developed pursuant to the “Policy on Fast Reactor Development” (the decision by the Inter-Ministerial Council for Nuclear Power Introduction in December 2016), the government will promote R&D of fast reactors through international cooperation with the United States and France.

With respect to the Monju fast breeder reactor, the government will address the steady and systematic decommissioning of Monju by giving top priority to safety pursuant to the “Basic policy on Monju decommissioning” (the decision by Monju decommissioning promotion team).

In doing so, the government will continue its efforts to gain the understanding of residents in the community that accepted the location of the Monju reactor and the general public. In tandem with the decommissioning, the government will develop the Tsuruga area of Fukui Prefecture as the core R&D base for nuclear power and energy while obtaining the cooperation of local communities. In addition to the human resources and various knowledge and technologies that had been cultivated in the Monju project, knowledge and technologies to be obtained during the Monju decommissioning will be used as effectively as possible in fast reactor R&D in the future.

ii) Flexibility of mid- to long-term approaches

Issues related to the nuclear fuel cycle cannot be solved in a short period but require a mid- to long-term approach. Moreover, it is important to adopt a flexible approach, since it is necessary to respond to various uncertainties, including the technological trend, energy supply-demand balance and the international situation. Since these activities are closely related in particular to the outlook of the future operating situation of nuclear power plants, the amount of nuclear fuel required and the quantity of spent fuels generated, they will be conducted while taking into consideration all of these factors, as well as other factors including the reduction of the volume and harmfulness of high-level radioactive waste, effective utilization of resources and its costs, and the intentions of relevant municipalities, and ensuring strategic flexibility in accordance with the development of the situation.

(5) Establishment of confidential relationship with people, nuclear host municipalities and international community

(i) Public hearing and public relations activities based on the TEPCO's Fukushima nuclear accident

Even after a lapse of over seven years since TEPCO's Fukushima Daiichi Nuclear Power Station, distrust of and anxiety about nuclear power have yet to be cast aside, and the level of people's trust in administrative agencies and nuclear operators involved in energy remains low. Some people are urging the government to provide accurate and objective information on nuclear power.

It is necessary to take the situation seriously and enhance careful public hearings and public relations in order to establish relationships of trust. Therefore, the government will enhance public relations based on scientific evidence and objective facts with regard to such matters as the risks of nuclear power, the impacts of nuclear accidents, the situations of the regulatory requirements and safety measures developed after the TEPCO Fukushima accident, disaster management measures assuming severe accidents, problems related to spent fuels, economic efficiency of nuclear power, contribution to countermeasures against global warming, and international trends, in manners easy to

understand by the general public while proactively making use of two-way dialogue formats and public relations methods based on the Internet.

Carefully-planned public hearings and relations activities will be enhanced not only in regions with nuclear power plants but also in electricity-consuming regions that have until now received the benefits of power supply, through sincere dialogue with various stakeholders and reinforcement of measures for sharing information. In addition, GOJ will enhance education about nuclear power in order to improve understanding of nuclear power by peoples across generations.

(ii) Establishment of confidential relationship with people, nuclear host municipalities and others

To use nuclear energy in Japan, understanding and cooperation of municipalities hosting nuclear power-related facilities (nuclear host municipalities) and other relevant parties, including residents, are essential, and the previous contributions made by them to stable supply of energy should be recognized again. On the other hand, nuclear host municipalities and other relevant parties are concerned about various matters related to the accident. In addition, regions with nuclear power plants have been economically affected by the prolonged shutdown of nuclear power plants. GOJ will establish relationships of trust with the nuclear host municipalities and other relevant parties through conscientious dialogue with them. At the same time, it will promote measures to support the regions with nuclear power plants, including the creation of new industries and jobs, in a manner suited to the circumstances of the regions based on the purpose of the measures for power source locations while taking into consideration the operational status of nuclear power plants.

Therefore, it is important to transmit scientifically-proved information, and make polite discussion in terms of risk and its effect of nuclear power, and the way how to face the risk and take measures, based on the situation in each area. France introduced a “Commission Locale d’Information (CLI)” in 1981 to provide a forum for sharing of information between local communities hosting nuclear-related facilities. In the United Kingdom, there is the Site Stakeholder Group (SSG), while in Sweden, there is a local commission system.

On the other hand, local areas hosting the nuclear power plants have been economically affected by the suspension of operations of nuclear power plants, halt to construction of new nuclear power plants and the prolongation of such measures as well as the decommissioning of nuclear power plants no longer fit to operate. The government will establish relationships of trust with the nuclear host municipalities and other relevant parties through conscientious dialogue with them. At the same time, it will promote measures to support the areas with nuclear power plants, including the creation of new industries and jobs, in a manner suited to the circumstances of the regions based on the

purpose of the measures for power source locations while taking into consideration the operational status of existing nuclear power plants and the changing environment.

The areas hosting nuclear power plants that have been supporting the supply of electric power in Japan are faced with a host of problems quite different from those of power-consuming areas, including regional economic development measures such as the development of regional resources and attraction of tourists that should lead to sustainable development of the regional economies, mitigation of the impacts on the regional economies of the prolonged suspension, resumption of operations, extended operations or the decommissioning of nuclear power plants, and improvement of disaster prevention schemes, such as development of evacuation roads and procurement of materials and equipment necessary for disaster prevention activities. The government will seriously deal with their problems and seek to solve them by steadily proceeding with such efforts as budgetary measures for industrial promotion of the areas hosting nuclear power plants, improved welfare of local residents and disaster prevention plans as well as the utilization of the Act on Special Measures concerning Development of Areas around Nuclear Power Plants and Other Facilities. By re-acknowledging the fact that the suitable supply of energy is founded on the understanding and cooperation of local governments of areas hosting nuclear power plants and other relevant parties, nuclear operators should push ahead with efforts in favor of industrial revitalization and regional symbiosis in accordance with the prevailing conditions of the hosting areas and take sincere responses inductive to the solution of various regional problems. Amid the expectations about the improved living environment for people, including the realization of cheap power rates by the resumption of operations of nuclear power plants, efforts remain required to build the relationship of trust between nuclear operators and the areas hosting nuclear power plants.

(iii) Contribution to peaceful use of nuclear power and nuclear non-proliferation/nuclear safety in the world

Because the TEPCO's Fukushima nuclear accident has raised grave concerns in the international community, including the countries surrounding Japan, GOJ will promote dialogues with the international community on such occasions as meetings of the IAEA, where information will be promptly and accurately disseminated. While there are countries and regions that have decided to do away with nuclear power generation in the future in the world, it is also true that there still exist many countries that have made it clear to continue with the utilization of nuclear power. Particularly because nuclear power generation is expected to be increasingly used going forward in emerging economies surrounding Japan, including China, Southeast Asian nations and India, it is the responsibility that Japan must fulfill and the world expects it to fulfill to make proactive contributions to the improvement of nuclear safety, peaceful use of nuclear power, nuclear non-proliferation and nuclear security in the world and also contribute to countermeasures

against global warming, by sharing the experiences and lessons learnt from the TEPCO's Fukushima nuclear accident with the international community and also in light of the perspective of maintaining and further developing Japan's high-level technologies and human resources involved. It is imperative for Japan to proactively contribute to formulating international standards of nuclear safety, such as the IAEA standards. Japan will contribute to improvement of nuclear safety in the world by continuing to share nuclear technologies with our enhanced safety and improved safety culture with other countries based on the experiences and lessons learnt from the accident, while confirming that a proper consideration is given to nuclear facilities' safety secured mainly by hosting countries in reference to the Convention on Nuclear Safety and the IAEA safety standards when public finance is offered on providing nuclear power technologies to overseas, including exports of nuclear power plants.

By making use of its experience as a non-nuclear armed country, Japan will also proactively contribute to nuclear nonproliferation via the reinforcement of the IAEA safeguards and stringent export control as well as to the strengthening of international nuclear security through the beneficial results of the nuclear security summits and IAEA-led continuous efforts. In particular, in the non-proliferation field, it is important to intensify the efforts toward the nuclear non-proliferation by promoting international collaboration in enhancing proliferation resistance of nuclear fuel, and R&D to strengthen technology of nuclear forensics, detection and safeguards, etc. Japan will go through these efforts in cooperation with the countries such as the U.S. and France. The Japanese government will also support the development of human resources, institutional infrastructure and others for countries that will newly introduce nuclear power in an integrated manner while cooperating with international organizations such as the IAEA.

5. Efficient and stable use of fossil fuel

(1) Promotion of effective use of high-efficiency coal and gas thermal power generation

While coal thermal power generation is superior in terms of stable supply and economic efficiency, it is problematic in that it emits a large amount of greenhouse gases. In order to resolve this problem and reduce the environmental impact at the same time, efforts will be made to make use of the most advanced technology available for reducing greenhouse gas emissions and encourage the electric power industry, which has the goal of setting the emission factor compatible with the energy mix and the targets for reducing carbon dioxide emissions, to exert efforts to achieve the goal within their voluntary frameworks. On top of these voluntary frameworks of the electric power industry, Japan has introduced regulatory measures under the Act on the Rational Use of Energy and the Act on the Promotion of the Use of Non-fossil Energy Sources and Effective Use of Fossil Energy Source Materials by Energy Suppliers (the Act on Sophisticated Methods of Energy Supply Structures) in order to realize the energy mix and Japan's carbon dioxide emission reduction target. Specifically, in order to ensure the low carbonization of electricity sold, the Act for the Sophisticated Methods of Energy Supply Structures stipulates that 44% of electricity sold should come from non-fossil energy sources in FY2030. The Act on the Rational Use of Energy also calls for an improvement in power generation efficiency, requiring newly build coal thermal power plants to have the power generation efficiency equivalent to most-advanced ultra-super-critical (USC) power plants and LNG-burning thermal power plants to have the cutting-edge power generation efficiency, including an assessment of the mixed combustion with hydrogen. It also requires every electric power company to have the average power generation efficiency of 44.3% or higher for all thermal power generation plants in FY2030. In order to achieve the targeted emission factor for electric power generation in FY2030 compatible with the energy mix and the carbon dioxide emission reduction targets without fail, the government will assess the progress each year to see whether these efforts are producing material results and, when it is deemed impossible to achieve the target, will consider a possible review of the policy measures in place. In order to enhance the effectiveness of these regulatory measures, the GOJ will take specific measures, including the consideration of a mechanism to encourage fadeout for inefficient coal-fired power plants (with the power generation efficiency below USC), including an imposition of restriction on new construction of such inefficient coal thermal power plants, and the establishment of criteria for interim assessment to encourage the steady progress toward the FY2030.

The time required for the environmental assessment will be reduced from three years to one year at maximum when an existing plant is replaced.

At the same time, in order to further reduce greenhouse gas emissions into the

atmosphere, the development and practical application of next-generation high-efficiency coal thermal power generation technology, such as the integrated coal gasification combined cycle (IGCC) and the integrated coal gasification fuel cell combined cycle (IGFC), will be promoted. In light of Summary report of the director-general level conference concerning the Bids on TEPCO's Thermal Power Generation Facilities (on April 2, 2013, the Ministry of Economy, Trade and Industry and the Ministry of the Environment), research and development will be conducted with a view to practical use of the carbon dioxide capture, utilization and storage (CCUS) technology around 2020 and, with due consideration given to the possible timing of the commercialization of carbon capture and storage (CCS) technology, a study will be conducted on introducing CCS-ready facilities as early as possible. Through these measures, including steady efforts toward the demonstration of a series of CCS processes of capture, transportation, injection and storage in Japan and a study on suitable sites for storage, the introduction of coal thermal power generation that gives consideration to further reduction of the environmental impact will be promoted.

Through these efforts, Japan will promote the high efficiency and next-generation coal thermal power generation as well as the fade-out of below-USC inefficient coal thermal power generation.

Furthermore, in order to lead the global trend toward decarbonazation in light of the Paris Agreement, Japan will propose to partner countries a full range of options conducive to reductions of carbon dioxide emissions, including renewable energy and hydrogen, in accordance with their needs, and provide support commensurate with their choices. In doing so, Japan will proactively promote the use of renewable energy and hydrogen. While proactively promoting for exports of low-carbon infrastructure, including the aforementioned proposals and support, only for countries that have np71o choice but to select coal as a key source of energy from the viewpoints of energy security and economic efficiency, when such countries request for Japan’s technology for high efficiency coal thermal power generation, Japan still supports their introduction of power-generation facilities equivalent to at least the world’s most advanced USC power plants, in principle, in a manner consistent with partner countries’ energy policies and countermeasures against global warming, also in light of the rules of the Organization for Economic Cooperation and Development (OECD). In addition, Japan plans to increase coal thermal power plants with CCS in a phased manner by paying heed to the situation of the commercialization of CCS technologies.

At the same time, development of technologies for high-efficiency gas thermal power generation, efficient use of such power generation and export of such technologies will be promoted.

(2) Restructuring the business foundation of the oil and LP gas industries

(i) Business restructuring and structural reforms of the oil industry (refining and direct sale)

According to "Demand Projections for Petroleum Products, FY 2018-2022," Japan's domestic demand for oil is expected to drop by about 1.7% per year on average, while in the Asia-Pacific region, demand for oil and petrochemical products is projected to continue rising. In the East Asian region, construction of many large petroleum complexes with the advanced integration with petrochemicals is underway.

Moreover, the shale gas revolution in North America is greatly transforming the global trade structure for oil and petrochemical products.

It has been pointed out that Japanese refineries, which started operating in the postwar period of high economic growth are inferior to large petrochemical complexes that are being constructed in East Asia in economies of scale, energy efficiency and production flexibility, such as the ability to flexibly shift to production of petrochemical products.

The outlook for oil demand at home and overseas remains murky in view of tougher regulations on the sulfur concentration in marine oil fuel, scheduled to be introduced in January 2020, and over the longer term, the implementation of the Paris Agreement and the expanding introduction of electric vehicles and other next-generation automobiles.

Even under these circumstances, domestic demand for fuel for transportation, including hard-to-replace light gas oil and jet fuel, and fuel for heating, such as kerosene, in cold regions is expected to continue to exist in the future, requiring continuing efforts to secure the stable supply of petroleum products.

While the business foundation necessary for the next stage of growth is beginning to be put in place, including the integration of management within the domestic oil industry and the progressing reorganization of oil refineries, domestic demand will still continue declining. In order to secure the stable supply of oil products in Japan, it is important for Japanese oil companies to enhance their productivity to remain able to maintain the locations of domestic oil-refining facilities amid an expected intensification of competition with overseas oil refineries and also consider the advance into other business fields or overseas businesses in light of declining domestic demand.

1) Enhancement of competitiveness under the global environment

In order for Japan's oil-related industries to become competitive on a global scale in the future, it is necessary to integrate management and restructure business operations of refineries and petrochemical plants located in petroleum complexes across the barriers of capital relationships as well as geological barriers and thereby optimize the facilities and control production costs by increasing value added to products through the establishment

of a flexible system for producing fuels and petrochemical products, and to drastically and comprehensively improve their productivity through the increased introduction of digital technologies, including AI and the IoT. On top of these endeavors, it is also of importance to strengthen their exporting capabilities, including collaboration between different industries and different companies, so that they can export oil products more efficiently.

Moreover, in light of the prospect that the procurement of crude oil will diversify over the mid- to long-term, technology development and capital investment will be promoted to enable the processing of non-conventional crude oil, such as heavy crude oil and super light oil.

2) Improvement of profitability through reinforcing other business fields and advance into overseas markets

The upstream sector (resource development) accounts for a large portion of the profits earned by oil companies in Europe and the U.S., while the mid- and downstream sectors (refining, direct sales, and retail sales) account for a small portion. On the other hand, as many Japanese oil companies were under the umbrella of and received crude oil from European and U.S. oil companies ("the majors") for a long period of time after World War II, most of their profits come from the mid- and downstream sectors and face problems in terms of profitability.

In moves to prepare for the possibility of global oil demand decreasing over the long term, European and U.S. oil companies are diversifying into gas and next-generation energy businesses as well as the chemical industry, while state-owned oil companies of oil-producing countries in the Middle East are expanding into the midstream and downstream sectors of oil production as well as next-generation energy. For Japan's oil industry to boost its profitability, it must not only focus on competing in the shrinking domestic gasoline market, but also expand operations and increase collaboration in the petrochemical sector that is closely related to the oil industry and expected to grow robustly on the global market, reinforce its resource development business (oil, gas and metal minerals), increase its presence in the power generation business, including LNG and coal thermal power generation and renewable energy-based power generation, as well as in the gas and hydrogen businesses. It must also enhance its portfolio of other energy businesses. At the same time, it must begin operating petroleum complexes and sales operations abroad and it is also imperative for the industry to transform itself into a strong, profitable "comprehensive energy industry" that can secure profits by absorbing changes in the domestic gasoline market, etc.

In particular, as a single-handed advance into overseas businesses is highly risky, it

seems that Japanese oil companies should not stick to the principle of doing everything on its own and instead proceed with the expansion into the overseas markets through comprehensive and mutually beneficial bilateral relationships with oil-producing countries or through cooperation with other industry sectors. Furthermore, the business expansion into the midstream and downstream sectors of oil production overseas could improve profitability of the Japanese oil industry but also lead to the acquisition of the flexible and strong supply capabilities in the event of oil supply disruptions or in times of natural disasters from the perspective of stable supply of energy.

In addition, in seeking to improve the profitability of the domestic oil industry, it is also necessary to proceed with the consideration of ways to utilize land and equipment that become unnecessary or redundant amid the shrinking domestic demand to generate new value added.

(ii) Improved Profitability of the LP Gas Industry

Domestic demand for LP gas has been on the decrease after peaking out in FY1996. Still, the volume of ocean transportation of LP gas handled by Japanese companies accounts for some 25% of the global total, the largest in the world. In order to further increase the transaction volume and enhance the purchasing power of Japanese companies involved, it is necessary to hold seminars on the world's largest scale that bring together relevant parties from both producing and consuming countries every year to enhance the presence of Japanese companies. It is also necessary to make efforts toward enhancing Japan's energy security by diversifying suppliers to include Canada and Australia.

In addition, Japan will step up international cooperation, such as the sending of exports and the invitation of people from overseas to Japan for training programs, to help promote the overseas expansion of Japanese LP gas business operators and manufacturers of LP gas devices in order to accommodate demand in fast-growing countries in the Asian region.

(iii) Ensuring the final supply system of oil and LP gas

In the downstream sector, which supplies oil products to consumers, a drop in demand for oil products have become one of the biggest factors that pressure profits. A significant improvement in the fuel efficiency of vehicles, etc. has structurally led to a drop in demand for gasoline and other oil products. As a result, the business environment faced by oil sales companies is generally challenging.

Under these circumstances, the disappearance of service stations (SSs) from neighborhoods are causing problems in the fueling of owner-driven vehicles and agricultural machinery as well as in the delivery of kerosene to homes of elderly people without the means of transportation, giving rise to the so-called "problems of the

dwindling number of SSs" across Japan. In order to secure the access to fuels needed in local communities, business operators and community leaders should cooperate, under the leadership of local municipalities, and consider measures for maintaining the distribution networks of oil products depending on the actual conditions of local communities. The supply system of oil products on geographically disadvantaged remote islands should also be addressed as a regional issue.

Meanwhile, business operators responsible for the final stage of supplying oil products have to make continuous investments for securing facilities with a high level of safety and durability necessary for performing the supply function to a certain degree in times of emergency.

Therefore, it is necessary to provide capital investment support for service stations (SSs) that demonstrate strong willingness to play the central role in providing stable supply in both normal times and in times of emergency. In addition to delivering heating oil and selling LP gas, SSs are making various efforts, including providing various auto-related services, installing charging stands for electric vehicles, and opening daily goods stores and post offices on their own premises in regional areas. Business operators are required to further strengthen the function of SSs as local community infrastructure in light of the local circumstances by taking advantage of their direct connections with consumers to diversify their business operations. In order to provide a boost to their efforts, the government will consider how related regulations should be on the premise of safety to allow them to overcome the shortage of manpower with the use of new technologies such as AI and the IoT and to carry out safe and efficient business management and create new services.

As for LP gas, it is necessary, from the perspective of low carbonization as well, to expand the use of LP gas cogeneration systems, such as the stationary fuel cells (Ene-farm), which realize substantial energy conservation through supply of combined heat and power, and the gas heat pump (GHP) system. It is also necessary to promote business operators' advance into the electric power and city gas businesses and hydrogen fuel supply business, and export of safety equipment for LP gas to Asia. In order to cope with the delivery of LP gas to isolated places that becomes necessary due to progressing depopulation and the shortage of manpower stemming from the declining birth rate and the aging population, LP gas business operators should consider measures for efficient operations through the realization of cooperative delivery and joint security, facilitation of the acquisition of qualifications under the authorized sales business operator system by the introduction of the centralized monitoring system and promotion of bulk supply. As LP gas is currently used as the main fuel for taxis and other vehicles, it can also be expected to play a role in the diversification of fuels in the transport sector as clean marine fuel in the future.

(iv) Ensuring fairness and transparency in the oil product trading structure

Oil products are hard to differentiate in terms of quality, so competition tends to focus on prices.

For this reason, differences in wholesale prices greatly impact on the basis of competition by SSs. Problems such as differences in wholesale prices, a lack of transparency over the pricing method and the presence of SSs on which competitively disadvantageous terms of transaction have been imposed have been pointed out.

Under these circumstances, the government formulated the Guidelines for Appropriate Trade Practices in the Gasoline Industry in March 2017 for the purpose of building a fair and transparent trading environment in order to maintain and strengthen the oil supply chain and secure the efficient and stable supply of oil products even under the changing environment, including declining demand for oil products and the management integration of oil refiners/distributors. Going forward, it is necessary to optimize industry trade practices through the penetration of the Guidelines and constantly review the Guidelines in light of the progress in such optimization.

It is necessary to rigorously deal with cases where direct oil sales companies, which generally hold a superior position in business transactions, are committing violations of the Antimonopoly Act, such as imposing competitively disadvantageous terms of transactions on SS operators unfairly in light of normal trading practices, in cooperation with the Fair Trade Commission (FTC)

6. Fundamental reinforcement of measures for realizing a hydrogen society

As hydrogen can be produced from a wide variety of energy sources, including renewable energy, and can also be stored and transported, it has the potential to help diversity the primary energy structure of Japan that is highly reliant on fossil fuels unevenly distributed in a few specific countries. It can also be turned into a decarbonized source of energy by utilizing CCS technology and renewable energy technology in the production stage. Furthermore, 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. Against this backdrop, 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 society where hydrogen with these characteristics is used in everyday life as well as in industrial activities, or a "hydrogen society," 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, etc., Japan should accelerate an expansion of demand for hydrogen in mobility, centering on fuel cell-powered vehicles, in the immediate future, build an international supply chain across the full range of "production, storage, transportation and utilization" of hydrogen for reducing mid- and long-term reductions of hydrogen costs, and proceed with technology development for the introduction of hydrogen-based power generation that consumes a massive amount of hydrogen, and seek to utilize hydrogen not only in transportation but also in a wide range of sectors, including electric power generation and industrial use, as a decarbonized source of energy.

(1) Promotion of energy saving through the use of fuel cells

At present, the most prevalent hydrogen-related technology is household fuel cells (Ene-farm). Particularly, against the backdrop of the technological advantage of fuel cells, stationary fuel cells were introduced into average households in Japan ahead of other countries in the world, with over 230,000 units of such fuel cells already in use. The current price is below ¥1 million, less than one third of the initial marketing price.

Going forward, Japan will aim for the introduction of 5.3 million units by 2030 after achieving the self-reliance market by around 2020. In order to approach the realization of that goal, Japan will develop technologies for a further improvement of power generation efficiency and higher heat utilization, cultivate the markets with advantages, such as regions with large thermal demand, and further expand efforts to make power available to other consumers through surplus power trading.

In addition, for the diffusion of fuel cells for business and industrial use brought onto the market in 2017, Japan will go ahead with the development of technology conducive to

initial cost reductions to make that market self-reliant at an early date, and push for the development and actual use of equipment that has the power generation efficiency of 60% as the dispersion-type power source, higher than that of the large-scale concentrated power source.

(2) Acceleration of the use of hydrogen in the mobility sector

It is important to push ahead with fuel cell vehicles (FCVs) and hydrogen stations, the two engines of hydrogen use in the mobility sector, as the two wheels of a vehicle. Specifically, Japan will seek to install hydrogen stations at 320 locations by 2025 and make the hydrogen station business self-reliant by the second half of the 2020s. As for FCVs, Japan aims to increase the number of FCVs in the country to 200,000 units by 2025, and to 800,000 units by 2030. Toward achieving the abovementioned targets, the reduction in the supply costs of hydrogen will essentially have to be combined with mass FCV production, FCV price reductions, further increases in driving distance of FCVs and the introduction of FCV models for the volume market segment around 2025, as well as the expansion of independent hydrogen sales businesses through hydrogen station development backed by stable profit and reduced development/operation costs. To this end, the government will promote the “divine trinity” of regulatory reform, technology development and cooperation with the private sector in the strategic development of hydrogen stations.

Furthermore, from the perspectives of the horizontal spread of fuel cell technology and the effective utilization of the hydrogen station infrastructure, it is also important for Japan to go beyond already commercialized fuel cell buses and forklifts to promote the application of this technology to cover trucks and other commercial vehicles as well as ships and electric cars in the mobility sector. To that end, Japan aims to increase the number of fuel cell buses to around 1,200 units and the number of fuel cell forklifts to around 10,000 units by 2030. In the infrastructure sector, private- sector business operators, relevant government ministries and agencies and local governments will closely cooperate in the development of hydrogen stations and in organizing standards for the development of relevant equipment and in ensuring their compatibility.

(3) Building of international hydrogen supply chains and the introduction of hydrogen power generation to realize low-cost hydrogen use

Promising approaches to reduce the cost of hydrogen include combining overseas unused energy with CCS and procuring massive amounts of hydrogen from cheap renewable energy. In order to realize the above, it is necessary, as upstream initiatives to secure cheap overseas resources, to exert private-sector efforts and seek to develop relationships at the government-to-government levels, and also to develop energy carrier technologies to make the efficient transportation and storage of hydrogen possible,

including liquefied hydrogen, methylcyclohexane (MCH), ammonia and methane. To that end, Japan will seek to develop base technologies related to the production and transportation of hydrogen to make use of cheap overseas fuels, including brown coal, and develop commercial-scale international hydrogen supply chains by around 2030 to procure about 300,000 tons of hydrogen annually and reduce the cost of hydrogen ¥30 /Nm3.

Furthermore, in tandem with the building of such supply chains, it is of importance for Japan to proceed with the development of hydrogen power generation that consumes a massive amount of hydrogen stably.

Japan will expand hydrogen demand in the mobility sector including FCVs and dramatically increase hydrogen demand by introducing hydrogen power generation which will consume nation-scale amounts of hydrogen. Since the mixed combustion of hydrogen in natural gas-burning thermal power plants is possible, Japan will move to expand the introduction of hydrogen power generation, centering on efforts toward testing the mixed combustion at existing natural gas thermal power plants in the initial phase of the introduction but also including the mixed combustion of hydrogen by small-scale privately-owned power generation facilities, and develop combustors suited to the combustion characteristics of hydrogen. Japan aims to commercialize hydrogen power generation as well as international hydrogen supply chains and cut the unit hydrogen power generation cost to ¥17/kWh around 2030.

(4) Promotion of technology development toward increased use of hydrogen from renewable energy and regional revitalization by making use of regional resources

For the expansion of use of renewable energy going forward, technology to store surplus electric power is one of the keys, let alone the securing of regulated power supply. Hydrogen that makes the large-scale and long-term storage of energy possible has the great potential to perform that role, and the power-to-gas (P2G) technology that stores electricity from renewable energy as hydrogen is effective in coping with long-period changes longer than one season, which are difficult for storage batteries to handle. As it is important to reduce the costs of related facilities for full-fledged utilization of hydrogen from domestic renewable energy, Japan will push ahead with the commercialization not only on the domestic market but also in overseas markets, including Europe, which has a lead over Japan in terms of the amount of renewable energy introduced and costs. In addition, Japan will also seek to establish the technology for cutting the unit cost for water electrolysis systems, the core of P2G technology, to ¥50,000/kW by 2020 to realize the world’s highest cost competitiveness.

In addition, from 2020 onward, Japan will promote efforts toward the commercialization and installation of P2G systems from the perspective of storing surplus electricity from renewable energy, based on the achievements of a pioneering

demonstration project currently being implemented in Fukushima Prefecture. Japan aims to commercialize P2G systems by around 2032.

Furthermore, leveraging the characteristics of hydrogen that it can be made from a variety of resources, some local governments are moving ahead with efforts to build hydrogen supply chains of the local-production-for-local-consumption type designed to convert unutilized regional resources (by-product hydrogen, renewable energy and sewage sludge, etc.) into hydrogen for use in FCVs and fuel cell forklifts. These efforts should lead to regional revitalization, such as the creation of employment and regional industries, on top of the significance in terms of energy and environmental policies, including decarbonization and higher energy self-sufficiency rates in regions. For this reason, the government, assuming the future regional supply and demand of distributed energy systems that utilize hydrogen and the market size, will work toward lower costs of the core water electrolysis systems, optimization of the size of water electrolysis systems, and the use of common parts and technologies, and also support local governments that are making progressive approaches concerning the utilization of low-carbon hydrogen with the aim of realizing a hydrogen society at the regional initiative.

(5) Showcasing of a "hydrogen society" at the 2020 Tokyo Olympics

The 2020 Tokyo Olympic and Paralympic Games will be a good opportunity for Japan to demonstrate to its people and foreign visitors the extent of its forward-thinking initiatives. The Tokyo Metropolitan Government is already operating fuel cell buses and has proceeded with plans to use hydrogen in the Olympic and Paralympic villages. In Fukushima Prefecture, a demonstration pilot project has been launched on a full-fledged basis to produce hydrogen from renewable energy for use not only in the prefectures but also in Tokyo by 2020. Japan will leverage the Tokyo Olympic and Paralympic Games to demonstrate its world-leading hydrogen and fuel cell technologies to the entire world and to further accelerate innovation concerning these technologies.

(6) Stronger international cooperation for realizing the global utilization of hydrogen

Amid active movements toward decarbonization, the utilization of hydrogen has already begun globally, with many countries and regions being attracted by the great potential of hydrogen. Japan has been leading the pack in the commercialization of technologies to utilize hydrogen, as represented by "Ene-farm" and FCVs. Japan will continue to take the initiative as the front-runner and lead the world toward the promotion of the use of hydrogen. Specifically, Japan will make efforts toward joint research with other countries, harmonization of regulations and rules, and international standardization, while making use of the existing frameworks, such as the International Partnership for

Hydrogen and Fuel Cells in the Economy (IPHE). Through cooperation with the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA), Japan will also proactively send out information through international reports and other means. The government and private sectors will jointly work to demonstrate Japan’s stance of leading the world in hydrogen and fuel cell technologies by seizing on an opportunity of the Group of 20 summit meeting to be held in Osaka in 2019.

7. Promotion of energy system reform

In Japan, the supply structures of energy such as electricity, gas and heat had been characterized by the vertically segmented industrial structure by market. However, due to technological innovations, use of each energy source has become more efficient and diverse. With the problem awareness that the vertically segmented structure has contributed to the inefficient allocation of resources, Japan is promoting the three-step energy system reform for electricity, gas and heat.

The goals of the energy system reform include the securing of stable supply, maximum restraints in service rates, and an expansion of options for consumers and of business opportunities for business operators. It was also aimed at strengthening industrial competitiveness and cultivating and gaining overseas markets.

With a lapse of two years after the market deregulation for electricity and heat and one year after the market deregulation for gas, new entries increased and the appearance of new service menus helped broaden the options for consumers. Amid these developments, bearing in mind the need to make efforts toward decarbonization in line with the Paris Agreement, it is necessary to improve the market environments to respond to and make compatible such public-interest issues as securing safety and stable supply, environmental acceptability, inclusive of promotion of renewable energy, and securing fairness among consumers in the deregulated markets.

(1) Promotion of the electric power system reform

For the electric power system reform, the Electricity Business Act was revised in a three-step process (the establishment of the Organization for Cross-regional Coordination of Transmission Operators in April 2015; the establishment of the Electricity Market Surveillance Commission in September 2015, renamed to the Electricity and Gas Market Surveillance Commission in April 2016; implementation of full liberalization of electricity retail sales and the introduction of the license system for power generation, transmission and distribution, and retail sales in April 2016; and the separation of power generation and transmission, set to be implemented in April 2020), with the three pillars of reform being an expansion of the cross-regional system operation, full retail competition and full liberalization of power generation, and ensuring of neutrality of power transmission and distribution sectors through legal unbundling.

Actually, since the full liberalization of retail power sales started in April 2016, a measure of results has been already obtained, including more intense competition between existing electric power companies, an increase in the number of new entrants, diversified menus for power rates and reductions in power rates (In the period of one and a half years up to October 2017 after the liberalization, the share of new power producers and suppliers of the electricity sales volume rose from about 5% to about 12%, and the number of new

entrants increased from a little less than 300 to over 450.).

The entry into the electric power sector by crossing the industry-barriers from the gas, telecommunications and oil sectors is under way as well. Collaboration between electric power companies and collaboration across the barriers between industries or areas are also beginning to emerge, an indication that the energy system reform is steadily moving forward toward its realization.

Following the full deregulation of the power retail and power generation markets, competition is developing to a certain extent. But further improvements in the market environment are being called for to promote competition further. Under such circumstances, in the pursuit of greater competition among retail business operators, Japan is moving ahead with the creation of the base load market to provide new entrants with access to base load power sources held by former general electricity utilities and the introduction of the indirect auction system that makes it possible to transmit power in the order of lower bid prices in using inter-regional connections.

The full deregulation of the retail sales and power generation markets is helping intensify the tendency to go after short-term cost competitiveness, and is also giving rise to concerns over the potential lack of power supply and adjustment capabilities due to insufficient investment in maintenance and construction of power stations caused by declines in market power rates in association with the massive introduction of renewable energy, just as happed in other countries. In addition, there also is the issue of realizing greater efficiency through the wide-area supply and demand adjustment.

Given these conditions, Japan will seek to create the mechanism to maintain and promote investment in power sources and infrastructure, such as the capacity market to secure appropriate supply and adjustment capabilities in the mid- and long-term and the non-fossil value trading market to enable trading in the environmental value of power sources, and also seek to create the supply and demand adjustment market to help streamline supply and demand adjustments through the wide-area procurement and operation of adjustment capabilities.

Furthermore, in order to ensure the transformation into the power transmission and distribution network that can accommodate an expansion of cross-regional electricity trading and an increased introduction of renewable energy with output fluctuations, it is necessary to consider the consigned transmission system that makes it possible to thoroughly cut back on costs and secure investment that becomes necessary in the future while making the maximum use of the existing power transmission and distribution network.

In parallel with the consideration of these market designs, the Policy Subcommittee for Acceleration of Electricity System Reform also considered in 2016 how to respond to problems in the financial and accounting areas following the full market liberalization. The Policy Subcommittee decided to use the consignment charge mechanism for the

accounting system related to burdens related to the funding requirements for the nuclear accident compensation and the decommissioning, from the perspective of fairness among consumers and contributions to the restoration of Fukushima for the former and from the perspective of continuing to secure the environment for appropriate decisions on the decommissioning and smooth implementation of the decommissioning even under the market deregulation for the latter, and also took necessary institutional measures along with those for managing and securing funds for the decommissioning of the TEPCO Fukushima Daiichi Nuclear Power Station.

In addition to these efforts, in light of decarbonization beyond 2030 and the progress in digitalization innovation, it is also necessary to move ahead with the consideration and efforts to ensure the compatibility between responses to public-interest issues and competition. Specifically, as more active infrastructure investment in power sources and the power transmission and distribution network becomes necessary toward decarbonization in the future, it is necessary to develop a mechanism that facilitates such investment to improve the predictability of investment decisions and avoid underinvestment amid the growing uncertainties. It is also necessary to upgrade the entire systems with new digital technologies like AI and the IoT, and build new systems by installing new technologies on distributed network systems that utilizes regional resources. In doing so, it is required to diversify players who take charge of the development of such new systems. As ways to promote decarbonization of fuels for thermal power generation, Japan has introduced regulatory measures under the Act on the Rational Use of Energy and the Act on the Promotion of the Use of Non-fossil Energy Sources and Effective Use of Fossil Energy Source Materials by Energy Suppliers. In order to enhance the effectiveness of these frameworks, GOJ will take specific measures, including the consideration of a mechanism to encourage the fadeout of inefficient coal thermal power plants (below USC), including an imposition of restriction on new construction such inefficient coal thermal power plants, and the establishment of criteria for interim assessment to encourage the steady progress toward FY2030, and make advanced efforts toward further decarbonization, such as the development of technology for next-generation clean thermal power generation and P2G, etc.

On top of these, for the establishment of the business structure with international competitiveness with a view to global markets and international cooperation, it is required to consider the development of a better domestic business structure and institutional reform to give an extra boost to business operators who are already pushing for global business expansion. Against such background, Japan will promote the enhancement of competitiveness and international business operations of comprehensive energy companies as well as international cooperation with resources-rich countries and emerging economies. Toward the goal of decarbonization, the government needs to maintain and strengthen human resources, technologies and industrial foundations that allow the pursuit

of all options amid the increasing uncertainties and rebuild the strategy for technology development through the introduction of the principle of the market mechanism and open innovation and the strategic input of resources.

As for the relationship between the electricity system reform and the power source mix, a safe and stable use of power sources must be ensured and the world's highest quality of electricity must be maintained. For example, when measures to realize a desirable power source mix, such as expanding the introduction of renewable energy, are implemented, care must be taken to ensure that the electricity reform will be designed so as to be consistent with them.

(2) Promotion of the gas system reform

As for the gas system reform, in order to establish a gas system which ensures a safe and stable supply of gas at low cost and which provides various options, including new services, to consumers, along with the electricity system reform, the Gas Business Act was revised to implement reforms regarding full liberalization of the retail market, the improvement of access to, and promotion of the development of, natural gas pipelines as well as LNG terminals and the community gas utility business system. The full deregulation of the gas retail market was enforced from April 1, 2017.

As a result of these reform efforts, some achievements have already been noticed, including the increased number of new entries into the gas market and the emergence of new services and new gas rate menus (the share of new entrants in the gas sales volume rose from about 8% to about 11% between April and December 2017; the number of registered retail business operators came to 54 firms, of which 18 firms are planning to start the gas supply to average households (as of April 2018); and the number of switching to other companies increased from about 60,000 cases to about 840,000 cases between March 2017 and March 2018)). Going forward, the government will create the market environment for greater competition and steadily carry out the legal separation of the pipeline business divisions of large gas suppliers, set for April 1, 2022.

In the wake of the full liberalization of the gas retail market, cross-industry collaboration among gas, oil and electric power companies is emerging along with cross-regional new entries into the gas business. Furthermore, some business operators are providing new entrants with services necessary for them to advance into gas wholesale and security business. All in all, the gas system reform is making steady progress toward the realization of reform goals.

Promoting the diversification of use of gas will play an important role in the gas system reform. In addition, promotion of the use of clean natural gas represents an important direction as the key energy source pending the realization of decarbonization, requiring comprehensive and strategic responses more than ever.

For example, natural gas is expected to be increasingly used as fuel for high-efficiency

LNG thermal power plants, environmentally friendly boilers, energy-efficient industrial furnaces, natural gas cogeneration systems that realize substantial energy-saving by using combined heat and power, natural gas air conditioners that lessen the peak load on power grids as well as in the transportation sector, including ships. Natural gas may also be used as raw material for supplying hydrogen to fuel cells.

In particular, steady progress is being made currently in using LNG as the main fuel for ships. It is also important to take policy responses to such new demand for natural gas and develop infrastructure to support the use of natural gas, including the development of natural gas pipelines in view of Guideline for development trunk line network, formulated in 2016.

Furthermore, in view of the progress in the full deregulation of the gas retail market, Japan will consider policy measures for revitalizing gas transactions, including the promotion of third-party use of LNG terminals, to enable the supply of gas at lower costs, and efforts toward cheaper procurement of raw materials.

It is also of importance to develop hydrogen-related technologies for the decarbonization of gas in the future in light of the Paris Agreement.

(3) Promotion of efficient heat supply

Amid the rising interest in the effective use of heat, service formats for supplying cooling and heating air are diversifying, as shown by the introduction of regional supply of heat through region-wide installation of heat pipes and combined supply of heat and electricity pinpointed at specific buildings in ways that secure business and life functions as part of urban redevelopment projects.

In light of this situation, for the purpose of promoting the efficient supply of energy, including the combined supply of heat and electricity, the Heat Supply Business Act was revised to implement the heat supply system reform in tandem with the electric power and gas system reform. Regulations on rates were abolished, in principle, as from April 1, 2016.

Under these circumstances, for the decarbonization of energy, the interest is mounting in the effective use of heat as well as in the decarbonization of supply sources of heat itself. Regarding the industrial use of heat that mainly accounts for the high-temperature range, it is particularly important to develop manufacturing process technologies, promote the introduction of energy-saving equipment, and promote the utilization of cogeneration and cascade use of waste heat. Regarding the consumer use of heat that mainly account for the low-temperature range, it is important first of all to reduce demand for heat itself through the diffusion of energy-saving housing and buildings, and also to promote the diffusion of energy-saving equipment, including “Ene-farm” and heat pumps. On top of these, it is necessary to continue to promote the efficient use of heat through regulations under the Act on the Rational Use of Energy.

In addition, in view of the progress in the development of the environment for the

combined supply of heat and electricity by the system reform for the heat supply business, the regional use of energy in the form of local production for local consumption should be promoted to use the energy such as cogeneration and waste heat in certain regions. Furthermore, it is necessary to promote the effective use of heat from renewal energy, including biomass, solar heat and unused heat.

8. Enhancement of resilience of the domestic energy supply networks

Imported resources are supplied to consumers in the form of oil products and electricity. Therefore, regarding domestic supply networks, comprehensive policies will be pursued to secure sufficient capability to response to crises, including large-scale natural disasters, while maintaining efficiency to control costs.

In particular, pursuant to the Basic Act on Strengthening National Land in Ways that Contribute to Disaster Prevention and Mitigation in Order to Realize Robust and Flexible Life of the People and the Fundamental Plan for National Resilience, measures will be taken to strengthen domestic energy supply networks.

(1) Reinforcement of response to supply crises from abroad through oil stockpiling, etc.

While the existing oil stockpiling policy has given the top priority to quantitative improvement, the government reviewed the total stockpiling volume and the ratio of crude oil and oil products to the total volume stockpiled by the government while taking into account the domestic oil supply-demand trends and risks. The government will continue to place emphasis on improving the capability to flexibly respond to crises, while replacing the type of crude oil stockpiled by the government one better suited to refining facilities in Japan. Other measures to be taken will be enhancing training for response to specific emergencies, such as the blockade of the Strait of Hormuz, and strengthening cooperation with oil-producing nations and East Asian consumer nations.

Already, there is a framework whereby Japanese oil tanks are rented to state-run oil companies of Saudi Arabia and the United Arab Emirates (UAE) as transit or inventory bases for commercial crude oil to be supplied to East Asia and Japan has the preferential right to receive supply in the event of a supply crisis. This framework, which is positioned as the “third stockpiling system” along with the national and private stockpiling systems, will be promoted as a mutually beneficial measure to reinforce relationships between Japan and oil-producing countries.

At a time when oil demand is increasing in countries other than the IEA member states, including China and the member states of the Association of Southeast Asian Nations (ASEAN), Japan will continue to promote cooperation in oil stockpiling with China and the ASEAN countries from the perspective of ensuring energy security for the Asian region.

In addition, in anticipation of declining domestic demand for oil, the government will consider ways for the effective utilization of crude oil stockpiled by the government and facilities for national oil stockpiling.

In March 2013, the construction of two national LP gas stockpiling bases was completed,

bringing the total number of such bases to five. The first ship from the U.S loaded with LP gas associated with shale gas entered a Japanese port at the end of August to unload gas to be stockpiled at these two bases. Since then, the government steadily proceeded with the purchases and stockpiling of LP gas for the national stockpiling system. Going forward, in light of the perspective of energy security surrounding Japan as well as the perspective of administrative efficiency, the government will firmly maintain the combined 90 days' supply of LP gas for the national and private stockpiling and constantly review the efficient way of maintaining the stockpiles.

(2) Reinforcement of response to "domestic crises" (such as risks of earthquakes, heavy snow and other natural disasters)

(i) Building resilience on the supply side

Since it was recognized anew at the time of the Great East Japan Earthquake that oil, together with LP gas, serves as an energy source of last resort, measures will be taken to resolve challenges concerning both physical infrastructure and intangible assets that may constrain supply in times of emergencies, including earthquakes, heavy rain, heavy snow and other large-scale natural disasters.

First, in order to secure the necessary amount of oil supply in the event of a large-scale disaster, targets for continuing and recovering business operations related to oil supply will be set in relation to the entire supply network of each "keiretsu" corporate group in the oil industry (refiners and direct sales companies), BCP (Business Continuity Plan) and BCM (Business Continuity Management) systems will be established by "keiretsu" corporate groups including oil refineries and terminals, distribution processes and SS, and the response capability will be improved by periodically rating these systems. Moreover, the "oil supply coordination plan in case of a disaster" based on the Oil Stockpiling Act will be constantly reviewed. In doing so, on the premise that the supply amount will be limited after a disaster, the PDCA cycle of training will be promoted, including details of the concept of the prioritization of supply in response to requests from disaster areas.

Second, building resilience of petrochemical complex areas (increasing emergency power sources at refineries, improving resistance to earthquakes and liquefaction, and reinforcing the mutual supply backup functions of refineries) will be promoted, in coordination with port development projects by the Ministry of Land, Infrastructure, Transport and Tourism. At the same time, the disaster response capability of SSs that play a role in the final supply will be reinforced, through the strengthening of functions of core SSs (SSs that play the role of prioritized supply of oil to disaster response vehicles in times of disasters) and small-lot fuel delivery bases (bases that deliver fuels to medical

institutions and other important infrastructure in times of disasters) and the development of base SSs for residents (SSs that play the role of supplying fuels to residents in affected areas in times of disasters.).

Third, the Cabinet Office, the Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications, the Ministry of Land, Infrastructure, Transport and Tourism, the Defense Ministry, and the National Police Agency, as well as the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry, will work together to facilitate the supply of oil in times of crises, and also continuously conduct training that also covers the oil industry and local governments. In normal times, they strive to reinforce the disaster resistance of roads as transport routes for the supply of oil. The government also urges relevant government ministries and agencies as well as local governments, including prefectures, to strengthen the structures to open up access routes to fuel supply bases. In the event of a crisis, the government urges relevant government ministries and agencies to promptly open up access routes to fuel supply bases necessary through meetings on disaster countermeasures and disaster prevention divisions of local governments involved.

As for LP gas, in addition to the deployment of emergency power supply vehicles to LP gas import bases, the strengthening of equipment and facilities at core filling stations that serve as regional fuel supply bases in the event of a disaster should be promoted. Furthermore, a constant review of the “oil and gas supply cooperation program in case of a disaster” should be made for smooth supply cooperation in times of crises, and the prompt and certain supply system should be established, including conducting training based on the cooperation program.

As for electricity supply, the Organization for Cross-regional Coordination of Transmission Operators, established in 2015, should take the initiative in enhancing the electric power transmission infrastructure, such as frequency converters and inter-regional connection lines between eastern and western Japan. Even after the electric power system reform, recovery of investment in transmission and distribution networks will be institutionally guaranteed so as to ensure construction and maintenance of transmission and distribution networks that form the foundation of electricity supply in the event of a disaster. Moreover, evaluation of the resilience of electric facilities and measures for quick restoration of the facilities will be promoted so as to establish an electricity system resilient to disasters.

To reinforce a complementary system between LNG receiving terminals, a study will be conducted on the improvement of terminals, enhancement of their functions, and the development of transportation routes that link the Pacific and Sea of Japan coastal regions and natural gas pipelines, with the aim of reinforcing the natural gas supply system. Steps

will also be taken to increase the earthquake resistance of city gas-related facilities

Also, GOJ conducts further resilience on the supply side by utilizing an information system positively that can catch a disaster predictor or situation of the national land and facilities after a disaster through a space infrastructure such as artificial satellites and through a system with sensors that figure out the circumstance of energy related facilities/devices, and which of R&D and practical use are promoted.

(ii) Building resilience on the demand side

Assuming that traffic networks will be in confusion immediately after the breakout of a disaster, measures taken on the “supply side” alone are not sufficient to ensure supply of oil and LP gas necessary for using important infrastructure, such as communication networks, for several days following the occurrence of the disaster. For this reason, local governments and relevant central government ministries and agencies, which have primary responsibilities to take disaster response measures in affected areas, should make widely known the roles they should perform for the smooth supply of fuels in normal times as well as in times of disasters. In addition, so-called important social infrastructure, including government agency buildings, municipality buildings, and facilities for such activities as communications, broadcasting and financing, as well as base hospitals, schools, and shelters and large-scale commercial facilities, should make preparations, including stockpiling fuels such as oil and LP gas, in accordance with their own circumstances so that they can continue their operations by using emergency power sources even in the event of power outage and support the lives of people through such means as providing meals.

Therefore, necessary preparations will be studied. In addition, business operators and households will be encouraged to regularly replenish gasoline or diesel oil in passenger cars and stockpile kerosene. Furthermore, a mechanism for companies to share the use of their private power generation facilities and the stockpiling and procurement of fuels with affiliated businesses and local residents in the event of an emergency will be created. Furthermore, a mechanism for companies to share the use of their private power generation facilities and the stockpiling and procurement of fuels with affiliated businesses and local residents in the event of an emergency will be created.

Distributed energy systems that use renewable energy, cogeneration and storage battery systems enhance the emergency response capability on the demand side. Therefore, building distributed energy systems will be promoted.

9. Improvement of the secondary energy structure

Currently, the secondary energy structure is supported by electricity, heat and oil products such as gasoline. In particular, electricity, a highly convenient energy which can be generated from various energy sources, plays the central role in the secondary energy structure and is supplied to end users through networks.

On the other hand, supply of electricity relies on transmission and distribution networks in addition to the constraint of simultaneity between supply and demand. This is why there are problems such as supply disruptions due to a lack of connection with networks or network failure.

To grapple with these problems, it is important to study how to store and transport energy and the possibility of diversifying the methods of supplying secondary energy.

From this perspective, use of technologies related to storage batteries could promote the reform of the existing secondary energy structure. Therefore, it is necessary to make steady efforts with regard to such technologies while considering what the secondary energy structure should be like in order to support a future society.

(1) Promoting cogeneration to use electricity and heat efficiently

Cogeneration, which realizes efficient energy use by utilizing heat and electric power in combination on the demand side, is a hybrid secondary energy. It is not only superior in terms of energy conservation but is also harmonious with renewable energy. It mitigates the peak load in electricity supply and demand, has low transmission loss, diversifies the power source mix and is resilient to disasters. To promote introduction of cogeneration including households, introduction assistance measures will be taken and efforts will be make towards specifically facilitating trading of electricity generated through cogeneration systems, including fuel cells.

(2) Utilizing storage batteries to contribute to the expansion of renewable energy and the decarbonization of load-balancing capacity

The storage battery is a key technology in decarbonization with huge potential that contributes to introducing renewable energy and contributing to the reinforcement of the stability of the energy supply-demand structure.

Storage batteries are now increasingly used in automobiles, houses, buildings and for business operations in addition to existing uses as their safety and performance have been improved in recent years through the reduction of charging/discharging loss, the increase in energy density, and longer battery life.

Efforts aimed at their full social adoption are increasing worldwide in recent years. As further adoption of more renewable energy is expected in Japan as well, it will become necessary in introducing photovoltaics and wind power generation, whose power outputs

fluctuate with the weather, to adjust output by utilizing thermal power, pumped storage and other electricity sources in order to match supply and demand within the entire grid. If large-scale introduction of renewable energy continues, there will be greater demand for these measures against fluctuations, and issues such as the insufficiency of the existing load-matching capacity of thermal power, pumped storage and the like will become evident. Storage batteries are expected to be utilized as one of the solutions to the challenges posed by this expansion of the introduction of renewable energy.

Storage batteries are already becoming involved with the energy system in various ways such as the self-consumption of renewable energy and peak shift by households and other electricity consumers, business continuity planning (BCP), the provision of ancillary services through large size energy storage batteries and virtual power plants (VPP), and vehicle-to-grid (V2G). In order to further promote the utilization of electricity storage technology in Japan from the perspective of expanding the introduction of renewable energy and the decarbonization of the electricity system and the stable supply of energy and BCP, GOJ will promptly consider individual measures regarding matters such as developing the technology, reducing costs, and establishing the institutional framework, and go forward with initiatives to resolve the issues while sharing the vision of the future between the public and private sectors.

(3) Promoting an environment in which consumers can choose from a variety of energy sources in various fields, including vehicles

In the field of vehicles, now that biofuels, electricity, natural gas, LP gas and hydrogen are available as energy sources, an environment is being developed where choice by consumers promotes competition not only between oil products such as gasoline and diesel oil but between a wider variety of energy sources.

In this environment, consumers can not only choose a product that is better in terms of cost effectiveness and an energy source that emits less greenhouse gas but also contribute to accelerating the effort to reduce greenhouse gas emissions by promoting technology innovation so as to further improve fuel efficiency, which improved by 78% over a two-decade period from 1995 under the “Top Runner” program, even when driving vehicles were powered by oil products.

To promote competition among energy sources, it is important to create an environment in which all energy sources are provided smoothly to consumers no matter what type they are.

In spreading and expanding the introduction of next-generation vehicles (hybrid vehicles, electric vehicles (EV), plug-in hybrid vehicles, fuel cell vehicles, clean diesel vehicles, CNG vehicles, etc.), infrastructure building and deregulation are indispensable in addition to research and development. GOJ and the private sector must collaborate to disseminate energy-charging facilities necessary for EVs and plug-in hybrid vehicles.

Moreover, in the field of electric vehicles, there are high expectations for the emergence of businesses that provide services most suited to the charging of electric vehicles following the full retail competition resulting from the electricity system reform. As for fuel cell vehicles, the trinity of regulatory reform, technology development and the strategic installation of hydrogen refueling stations through public-private collaboration will be promoted to develop self-sustaining hydrogen sales businesses through the establishment of stations assured of stable revenue and the reduction of maintenance and operating costs. As for fuel cell vehicles, the installation of hydrogen refueling stations will be promoted through regulatory reform and appropriate sharing of the cost between GOJ and the private sector. These steps will be taken with the goal of increasing the share of next-generation vehicles to 50-70% of all new vehicles by 2030.

Since it is likely that a certain portion of automobiles will continue to carry internal combustion engines, biofuels will continue to be a significant means of diversifying energy sources and lowering carbon emissions in the transportation sector. In particular, GOJ will consider preferential measures for the introduction of the domestically-produced next-generation bioethanol, which is expected to go into commercial production soon, from the perspective of securing its competitivity at the initial stage of its introduction and put them in place in FY2019. The introduction of the first-generation bioethanol based on food will be investigated whenever appropriate from the perspective of consideration for the conflict with demand for food and the further reduction of the burden on the environment while taking into consideration international trends, the penetration of next-generation bioethanol, and cost-benefit analysis comparisons with other energy options. At the same time, regarding light oil, for which demand is expected to be strong for the time being, GOJ will consider the future introduction of biodiesel fuel going forward while taking into consideration R&D trends and global introduction trends of biodiesel fuel.

The measures to promote the use of these diverse energy sources in the transportation sector are projected to be furthered through the use of biofuels in airplanes and LNG and LPG as the main fuels in ships as well as vehicles. In the business and household sectors, hydrogen is used for stationary fuel cells (Ene-Farm) and large-scale fuel-cell cogeneration, and air heat is used for heat pumps using CO_2 as coolant. Under the electricity system reform, the provision of services that give consumers a choice of energy sources is making headway. In the future, diversification will proceed further

related technologies and initiatives underway around the world as well as regulatory impediments to disseminating new usages will be compiled. Strategic measures including research and development will be implemented.

10. Development of energy industry policy

(1) A major transformation of the structure of the energy industry to be triggered by institutional reforms, such as the electricity system reform

Since electricity is the most widely used secondary energy and underpins all aspects of people's lives and economic activities, the electricity system reform will have a significant impact on what other energy markets should be like.

Increasing participation by gas companies, oil companies, businesses having a private power generation capability, and renewable energy suppliers in the power generation business will dramatically change the structure, which is divided into several segments along the lines of the energy source types, with different groups of suppliers dominating the various segments. In addition, players from different fields, such as information and communications businesses that have technical expertise to meet various needs of consumers, are expected to move into the electricity retail business, raising expectations that the structure of the electricity market will undergo major change with the involvement of various industrial fields.

In advanced countries where liberalization of the electricity market has been promoted, providing a service that supplies both of electricity and gas has increasingly become popular. In the U.S., where the electricity market is regulated differently from one state to another, for example, efficient investment is realized and electricity rates are kept from rising by expanding use of an electricity supply-demand balancing system in states where the market has been liberalized.

The electricity system reform will drastically change the industrial structure by encouraging mutual participation by energy suppliers in each other's markets and the entry of new various players with new technologies and service expertise, and at the same time, will be expected to activate the market and to become a detonator for economic growth by promoting the gas system reform at the same time to create the ripple effect in other energy industries.

In Japan as well, there are expectations that a study will be conducted on the reform of the electricity and LNG markets, in addition to the oil market that was reformed in line with the oil liberalization in the latter half of the 1990s, while consideration is given to such challenges as appropriately preventing excessive inflows of speculative money so as to ensure the establishment of reliable and transparent price benchmarks that reflects energy supply and demand and that the energy futures market will be developed.

(2) Creating companies that provide comprehensive energy supply service

(i) Creating comprehensive energy companies through mutual participation by existing energy suppliers into each other's markets

By promoting institutional reforms so as to change the energy structure, which is

vertically divided into several sectors, into an integrated market structure, it will become possible to develop an environment that enables energy-related companies to enter each other's fields and to draw up a new growth strategy under which the companies will capture new demand while competing to provide a highly efficient service with high value added by taking advantage of their respective strengths.

The new competitive environment where such a future can be envisaged will encourage existing energy companies to develop into comprehensive energy companies that provide various energy services and make it possible for them to increase profits by diversifying their operations and to consolidate overlapping equipment, facilities, and business divisions they hold across business fields. Consequently, comprehensive energy companies are expected to reinforce their business foundation; become a driving force to promote new investment in order to survive the fierce competition; enhance the efficiency of the whole industry; and explore new markets through competition or cooperation with new players that come from different fields, thereby making great contributions to the economic growth of Japan.

Comprehensive energy companies that have strengthened their capability to conduct various energy-related businesses and reinforced their business foundation are also required to advance into an international market where energy demand is growing.

In Europe, where liberalization went into full force around the turn of the century, competition in the domestic markets has heated up while opportunities to expand shares in the newly-opened international market have grown. In light of this change in the business environment, European energy companies have attempted to transform themselves into comprehensive energy companies by actively entering foreign markets and moving into new fields. Going forward, it is expected that comprehensive energy companies will emerge in Japan as well with the progress in systemic reform.

Against this background, not only are energy-related businesses cross-entering electricity and gas markets but headway is being made in intercorporate collaboration in a wide variety of areas including fuel procurement and trading, overseas IPP projects, and new businesses utilizing digital technology. GOJ will continue to be thorough in establishing the environment for achieving further progress in strengthening competitivity and overseas expansion through these new forms of collaboration and initiatives towards comprehensive energy companies.

(ii) Distributed, local-production-local consumption energy systems that conduct comprehensive energy supply-demand management according to the characteristics of the local area

The distributed energy system is expanding with disseminations of distributed energy resources such as photovoltaics and cogeneration including fuel cells, EV and stationary storage batteries, and improvements in energy management technology.

Local production-local consumption type of energy systems, which use local energy effectively at the local level, are important as initiatives that contribute to promoting energy conservation and the expanded adoption of renewable energy and enhancing the resilience of the energy system. They also contribute to revitalizing the regions and creating regional circulatory coexistence zones (*Fifth Basic Environment Plan*, Cabinet Decision, April 17, 2018) through their introduction as an integral part of community building such as the construction of compact cities and transportation systems.

The core of a local production-local consumption energy system consists of the effective utilization of local energy resources, mainly thermal, and the energy management to achieve it. Thermal energy must be consumed locally since it is difficult to transmit over long distances. In addition, when consuming energy locally, it is important to promote initiatives that utilize sophisticated energy management technology such as initiatives that utilize heat thoroughly among multiple users and initiatives in demand control, under which the volume and patterns of energy consumption protocol are controlled on the demand side according to the conditions of supply.

These movements towards the diversification of the energy system will lead to activating the demand-response system and improving the efficiency of the energy supply structure. In addition, it is expected support the life infrastructure and reinforce companies' business continuity capability in times of emergency by making it possible to secure the supply of energy.

In the future, in order to achieve the dissemination of local production-local consumption energy systems, GOJ and local governments will collaborate to encourage the construction of superior systems that will serve as precedents and will work to secure the sharing of know-how concerning such matters as coordination between relevant parties necessary for building energy systems while utilizing the results of demonstration projects such as infrastructure technologies including the Community Energy Management System (CEMS) and a technique for communicating information obtained through smart meters to the Home Energy Management System (HEMS) (route B) as well as standard interfaces such as ECHONET Lite (standard for communication between HEMS and home appliances).

In addition, general adoption of distributed energy resources forms the foundation of the construction of virtual power plants (VPP), which utilize these resources at a distance through IoT for adjusting electricity supply-and-demand balances. GOJ will go forward with the dissemination of local production-local consumption energy systems and will work to create energy resource aggregation businesses, which provide new energy services.

(3) Creation of new market in the energy field and execution of a growth strategy through enhancement of international expansion

Accelerating technological innovation has made it possible to create new markets in the

field of energy. For example, improvement of the storage battery technology that drives electric appliances for a long time has enabled the use of electricity to drive automobiles, which previously used oil products as a power source. Digitalization and the increased capacity of information communication have made it possible to analyze the actual situation of energy consumption by consumers individually and in detail, giving birth to new services that enable proper control of supply and demand through energy management and to balance energy supply and demand by managing not only supply but also demand. In addition, new technologies such as AI and the IoT harbor the potential for improving supply-and-demand forecasts and optimization/further efficiency improvements at power plants as well as the construction of new, distributed energy systems. GOJ will go forward with the adoption of these new technologies in the energy field.

These technologies do not necessarily belong to the existing energy suppliers; most of them have been developed in different business fields. In the meantime, even excellent technologies have rapidly been losing their competitiveness on the international market as they have rapidly become a commodity. Therefore, it is necessary to establish, as early as possible, efficient systems to supply new products and services and business systems which always respond to the market needs and which constantly change.

System reforms including the electricity system reform have opened the energy field and expedited participation of newcomers with superior technologies which come from different business fields. This provides an important opportunity for the new comers to narrow their distance from customers in the energy field, find new value and create a new market. Through these activities, the energy field will be developed as a promising sector that drives the economic growth of Japan.

Moreover, it is necessary to promote strategic activities so as to enable Japan to grow by taking advantage of the increasing demand in Asia and other regions while helping to alleviate the problems resulting from the demand expansion by providing the region with various Japanese energy-related advanced technologies and experiences of effective operation of energy-related systems.

Technological innovation has been accompanied by a rise in the threat of cyberattacks in the energy field, particularly in electricity. Making business continuity possible even in the face of large-scale cyberattacks is essential to the stability of people’s lives and socio-economic stability and will also enhance Japanese competitivity as the location for businesses. Furthermore, sophisticated cybersecurity will be a force in emerging victorious in intense international competition in the export of infrastructure systems in the energy field. Strengthening cybersecurity countermeasures contributes to sustained economic growth in Japan. Therefore, GOJ will undertake further measures to improve cybersecurity in this field while undertaking the enhancement of efforts at the industry level, mainly in sharing information and analysis, and the enhancement of collaboration

with developed countries by the public and private sectors.

(i) Expansion of markets for advanced technologies in which Japan is the leader, such as storage batteries and fuel cells

The international market for storage batteries is expected to grow. As the use of storage batteries is expanding considerably around the world, GOJ will promote the introduction of storage batteries by reducing their cost and improving their performance through technology development and international standardization.

In Japan, the Ene-Farm stationary fuel cell system was introduced into households in general for the first time in the world against the background of the country's superiority in fuel cell technology, fuel-cell cars are being sold commercially and fuel-cell buses are in operation, and an international hydrogen supply chain using liquefied hydrogen ships is being developed. Thus, Japan is leading the world in the field of hydrogen-related technologies.

As Japan also has many advanced technologies related to energy conservation and renewable energy, it is possible to create new markets by making practical use of them. Japan will promote the creation of the world's most advanced energy-related market by implementing demonstration projects for putting new technologies into practice at the same time as carrying out institutional reforms, including the electricity system reform.

(ii)Reinforcement of global expansion of the energy industry through infrastructure exports, etc.

As global energy demand grows going forward, it is necessary to simultaneously achieve sustained economic growth and climate change countermeasures on the basis of the Paris Agreement. Given this context, it is important for Japan to take the lead in the global energy transitions and decarbonization with the technologies and know-how that it has accumulated while facing severe energy constraints. To this end, GOJ will analyze the energy situation of other countries and propose a wide range of options from Japan's superior low-carbon and decarbonization technologies that match their needs. Particularly after the full liberalization of the electricity and gas markets, electric power companies and gas companies are expanding their overseas operations. Given these circumstances, GOJ will promote the enhancement of international competitivity and expansion of international operations on the part of electric power, gas and other utility companies by undertaking the establishment of an investment environment for the expansion of international operations including the encouragement of entry by Japanese utility companies in projects using policy financing as well as institutional reform including the designing of appropriate incentives.

Businesses are required to make efforts to develop overseas markets from a broader viewpoint in order to export integrated packages of technologies and know-how, instead

of merely exporting individual element technologies and know-how.

On the other hand, in order to promote business expansion, including in regions into which Japanese companies have hardly advanced, GOJ will make maximum use of Japanese overseas personal networks and good inter-governmental relations to develop an environment that enables Japanese companies venturing into new markets to do business with a sense of security.

1) Enhancement of infrastructure export integrating technologies and know-how

Japanese industries have accumulated technologies and know-how for making efficient use of energy. However, they have seldom exported these technologies and know-how as an integrated package.

In the future, Japan will lead the world in energy transitions and decarbonization by integrating these technologies and knowhow to propose a wide range of options from its superior low-carbon and decarbonization technologies according to the needs of the respective countries.

For this reason, GOJ actively promotes strengthening competitivity through comprehensive upstream-to-downstream project operation (providing end-to-end service) and collaboration with local and third-country firms, acquisition of international standards, support for establishment of institutional systems in partner countries, dispatch of public-private missions, and partnering with local companies through overseas demonstration projects.

Particularly, it promotes expansion of energy management systems into the international markets regardless of the project scale based on the actual situation in the respective countries because they are expected to contribute to a stable energy supply-demand structure in advanced countries which face the problem of power grid instability due to large-volume introduction of renewable energy, resource-rich countries and emerging countries which have an immature energy supply-demand structure.

2) Active participation in the energy supply business in Asia and other regions around the world

Japan’s experiences of making full-fledged use of LNG ahead of the world and its well-developed infrastructure could be used as sharable assets when Asian countries would expand use of LNG in the future. When Asian countries develop institutional systems and infrastructure for LNG introduction, Japan will be able to help them efficiently establish a new energy supply-demand structure by providing financial and technical cooperation for establishing supply chains including the upstream and implementing intermediary business using storage facilities.

Japan has been constructing safe and convenient gas equipment and safety and marketing systems for LPG as well. There is potential here to contribute to the

enhancement of safety and convenience in the Asian region, where demand for LPG is growing, mainly among households, through technical cooperation and cross-border expansion through joint ventures with local vendors.

GOJ will take advantage of this situation as an opportunity for the Japanese energy industry to expand overseas business activities and connect it to the reconstruction of their business foundations.

Also, understanding the trend of demand for oil and oil products which will continue to grow in Asia, and implementing overseas petrochemical complex and marketing projects through joint ventures with local-state-owned oil companies in Asian countries, the chemical industry, trading companies, etc. can help to create a new business portfolio for the Japanese oil industry. In view of the growing supply capacity in Asia, it is considered to be necessary to immediately invest in Asia.

In order to encourage the Japanese oil industry, whose main profit sources have so far been domestic oil refining, oil wholesale and oil selling businesses, to make business decisions toward global expansion, GOJ will provide indirect support through technical cooperation and inter-governmental dialogue.

11. International energy cooperation

Global energy problems have been expanding, deepening and becoming more complicated, as exemplified by global energy demand shifting to Asia, the US shale revolution and other structural changes in international energy supply and demand, diversifying energy sources including increasing utilization of natural gas, renewable energy and nuclear power, responses to global environmental issues, and so on.

The energy supply-demand structure tends to be easily affected by international developments because of such factors as a change in the international energy supply structure, advance of global technological innovation breaking down the boundaries of the existing energy fields, global warming countermeasures and an increase in activities conducted by international consortiums due to large-scale resource development projects. Under these circumstances, it is important for countries to expand international cooperation, instead of taking actions individually, in order to make the energy supply-demand structure more stable and efficient.

In view of the changing circumstances, it is important to build a more strategic and comprehensive framework for energy cooperation, particularly with countries and organizations closely related to Japan from the viewpoint of the energy supply-demand structure.

(1) Expansion and deepening of the system of international energy cooperation

(i) Expansion of the framework of multilateral energy cooperation

It is necessary to actively contribute to the IEA, which has abundant accumulated experiences in the field of emergency response and in a broad range of energy policy fields, stable multilateral frameworks with substantial secretariat functions, such as the IAEA, and international and regional forums such as G7, G20 and the Asia-Pacific Economic Cooperation (APEC) forum.

In addition, if Japan plays a leading role in initiatives to enhance the stability of energy supply and demand in Asia, where energy demand will grow considerably, it will improve Japan’s own energy security environment. The East Asia Summit (EAS) shall be further developed into a more effective multilateral framework for discussions about energy security with the Economic Research Institute for ASEAN and East Asia (ERIA) as the core organization.

In addition, by making use of Japan’s strength in terms of policy and technology, GOJ takes the initiative in forming public opinions in the international arena under multilateral frameworks for specific themes, such as the International Energy Forum (IEF) for producer-consumer dialogue, the Clean Energy Ministerial (CEM), International Renewable Energy Agency (IRENA), and International Partnership for Energy Efficiency Cooperation (IPEEC).

(ii) Advancement of systems of bilateral energy cooperation

Concerning bilateral cooperation, GOJ enhances bilateral relations with countries rich in such resources as oil, natural gas, coal and minerals and countries which are potential markets for high-efficiency thermal power generation, nuclear power, renewable energy and energy conservation technology, energy management systems, and so on in order to secure resources and energy and promote international expansion of the energy industry. In particular, GOJ enhances relations with the U.S., Russia, and China—countries that have a major influence on the energy supply-demand structure.

1) Enhancement of Japan-U.S. energy cooperation

Resource exports from the United States to Japan are growing in LNG, LPG, and crude oil. Furthermore, in order to develop LNG demand in Asia, which is expected to grow going forward, Japan and the United States will collaborate in undertaking infrastructure and human resource development among other matters. The two countries will cooperate in developing high efficiency coal thremal power plants including CCUS. Regarding CCUS, the two countries will promote R&D and projects in third countries under the Memorandum of Cooperation (MOC) Concerning the Field of Carbon Capture, Utilization and Storage (signed in 2015, revised in 2017). In the field of nuclear power, Japan and the U.S., as partners, play a significant role in enhancing a global system for nuclear use while internationally ensuring peaceful use of nuclear power, nuclear non-proliferation, nuclear security, and so on through R&D cooperation and industrial cooperation utilizing the Japan-U.S. Bilateral Commission on Civil Nuclear Cooperation and other mechanisms.

It will also be important for Japan and the U.S. to cooperate in expanding internationally in light of the regional characteristics and needs of Asia, the Middle East, Russia, etc., instead of limiting their cooperation to bilateral matters.

In view of the future expansion of the current Japan-U.S. energy cooperation framework to cover more diverse energy sources and the expected major change in the energy supply-demand structure in the Asia-Pacific region, GOJ will further deepen energy cooperation between Japan and the United States under the Japan-U.S. Strategic Energy Partnership agreed between the heads in 2017.

2) Enhancement of energy cooperation between Japan and Russia

Regarding Russia, it is important to consider cooperation from a strategic perspective, fully recognizing the urgent issues for Russia such as the diversification of oil and gas sales routes outside of Europe, modernization of the Russian economy, promotion of energy conservation, and regional development in East Siberia and the Far East, and based on the international state of affairs. GOJ will go forward with cooperation in the fossil

fuel, energy conservation and renewable energy, and nuclear power fields.

3) Enhancement of energy cooperation with Asian countries

Enhancing cooperation with Asian emerging countries where a considerable energy demand increase is anticipated is important for enhancing the energy security of not only Asian countries but also Japan and for developing potential markets for the energy industry.

China, which has become the world's largest energy-consuming country, has been increasing its presence in the international energy market. Thus, it is important to cooperate with China, keeping in mind that its energy situation and policy orientation could impact the international energy situation. GOJ will construct an appropriate, cooperative relationship with China to tackle common issues as consumers and importers, including the construction of a flexible and transparent LNG market for procuring a reasonable supply of LNG. Japan and China will cooperate to promote the development of low-carbon energy infrastructure in third countries based on rules and in an open manner.

India is the world's third largest energy consumer and is expected to triple its power generation capacity by 2040. The Indian government plans to introduce 175GW in renewable energy by 2022, raising concerns over the destabilization of its power grid.

Japan and India have held the Japan-India Energy Dialogue nine times since 2007 and promoted comprehensive energy cooperation. Specifically, GOJ is promoting cooperation between the two countries as energy consumers, including support for the development of an energy conservation policy and systems that work to curb the increasing energy demand, support for the introduction of Japanese technologies through demonstration projects for energy conservation, renewable energy, smart community, etc., promotion of highly efficient and clean utilization of coal, construction of a stable electricity system, and a joint study on low-cost LNG procurement. In addition to inter-governmental cooperation, GOJ has been enhancing and expanding other forms of cooperation and will continue to do so, including public-private cooperation and inter-industry cooperation, such as holding a public-private roundtable and a combination of a technological exhibition and a business meeting.

Regarding energy cooperation with Asian countries, GOJ will consider the directions of energy policy and bilateral cooperation concerning the promotion of individual infrastructure projects, using the venues for bilateral energy dialogues to grasp the energy situation in each country. Moreover, GOJ will promote financial, human resource development, and other cooperation for the establishment of LNG supply chains including the upstream towards the introduction of LNG in Asia and active participation in energy supply projects such as the overseas development of petroleum complexes and marketing operations. Concerning the relations with South Korea and other Asian countries which have an energy supply-demand structure similar to Japan's structure, it is possible to

promote cooperation in many fields, including the resolution of the Asia premium on prices of natural gas, etc., securing of the safety of nuclear power plants, enhancement of energy conservation measures, and global warming countermeasures; for instance, GOJ deepens cooperation with South Korea in the field of natural gas through gas dialogue.

Particularly, the emerging countries surrounding Japan, such as China, South East Asian countries and India are looking to use nuclear power generation because of a considerable increase in energy demand. In such circumstances, securing the safety of nuclear power plants is a common challenge for the countries, and GOJ contributes to the improvement of nuclear safety and peaceful use of nuclear power in the world by sharing our experience and lessons of the TEPCO's Fukushima nuclear accident.

4) Energy cooperation with countries in other regions

Energy cooperation with countries in the Middle East region continue to be important from the viewpoint of securing stable supply of oil and natural gas, and GOJ promotes enhancement of extensive cooperative relations, including in the trade and investment fields, as typified by an "industrial cooperation task force" and the Joint Group for "Saudi-Japan Vision 2030 (SJV 2030)" with Saudi Arabia.

In addition, energy consumption is expected to greatly increase along with rapid economic development in the Middle East region. For this reason, efforts are being made to save the consumption of fossil fuels and secure crude oil for export. From this viewpoint, GOJ will support efforts toward promotion of energy conservation and cooperate in the fields of nuclear and renewable energy.

In Europe, cooperation with France in the field of nuclear energy has been proceeding, such as the response to the TEPCO's Fukushima nuclear accident and the international deployment of a jointly developed reactor, in addition to cooperation regarding the nuclear fuel cycle and the development of a fast reactor. GOJ continues to further enhance this cooperation through dialogues at the "Japan-France Nuclear Cooperation Committee," etc. As to the cooperation with the United Kingdom, GOJ shares its knowledge concerning research and development of decommissioning and other technologies and exchanges views on an appropriate business environment of nuclear power generation in a liberalized market through dialogues of the "Japan-U.K. Nuclear Dialogue," etc. Furthermore, with Europe as a whole GOJ promotes cooperation, including an exchange of information concerning common energy policy challenges, etc.

Also, GOJ further stabilizes the foundation of cooperation with Australia, etc. with which energy trade has been active at the private-sector level, and will promote the development of energy cooperative relations with all regions in the world, including Africa and Central and South American, according to the significance of securing resources and exporting infrastructure.

(2) International contribution centering on support for introduction of Japanese energy-related advanced technologies intended to bring a fundamental solution to global warming

The Paris Agreement was adopted at the 2015 United Nations Climate Change Conference (the 21st yearly session of the Conference of the Parties (COP) to the 1992 United Nations Framework Convention on Climate Change (UNFCCC); COP21) held in December 2015 as a fair and effective international framework in which all countries participate from 2020. The Agreement among other things set the goal of holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels. Countries subsequently ratified the Agreement, which entered into force in November 2016. The entry into force of the Agreement was a symbolic event that showed that many countries around the world were actively undertaking countermeasures against global warming. In June 2017, the United States announced that it would drop out of the Agreement. However, Japan announced its strong resolve to implement the Agreement, and countries worldwide reconfirmed their own commitments.

The amount of greenhouse gas emissions from developing countries has now exceeded the amount of emissions from developed countries. Therefore, to achieve a fundamental solution to the problem of global warming, it is urgently necessary not only to reduce emissions in Japan but also to drastically lower greenhouse emissions on a global scale, particularly in emerging and developing countries where emissions are increasingly rapidly.

At COP21, 22 major countries including Japan and the EU agreed to “Mission Innovation,” an initiative of the willing to encourage public and private sector investment in R&D in clean energy based on the importance of innovation in global warming countermeasures. The amount of R&D investment in clean energy by the signatories account for over 80% of the global total. Mission Innovation aims at doubling government R&D expenditures in clean energy in five years from 15 billion USD in 2016 to 30 billion USD. Japan will promote innovative technology development in clean energy such as hydrogen-related technology.

As a way to make maximum use of Japan’s position as a country with various technologies and know-how necessary for reducing the environmental impact, GOJ holds every year the Innovation for Cool Earth Forum (ICEF), which brings together leaders of industry, academia and government from around the world in order to resolve the problem of global warming by accelerating innovations. In addition, in order to promote the dissemination of low-carbon and decarbonization technologies in developing countries, Japan will also exert its leadership in accelerating technological innovations and dissemination of technologies around the world through a mechanism that enables effective use of public financing means and private funds.

In order to actually promote the adoption of cutting-edge energy technology worldwide, GOJ will lead the world in energy transitions and decarbonization by proposing a wide range of options according to the needs of the respective countries from Japan's superior low-carbon and decarbonization technology including renewable energy and hydrogen.

In order to significantly reduce greenhouse gases going forward, it is important not only to achieve the reduction of domestic greenhouse gas emissions but also to contribute to the significant reduction of global emissions by presenting products and services with superior environmental qualities that contribute to the reduction of greenhouse gas emissions. Businesses are expected to quantify its contribution to emissions reduction according to the "Guidelines for Quantifying GHG emission reductions of goods or services through Global Value Chain" formulated at the Ministry of Economy, Trade and Industry in March 2018 and connect it to further economic growth in Japan while contributing to the reduction of global emissions by distributing the information to investors, consumers, and other stakeholders. Moreover, GOJ will make active use of the Joint Crediting Mechanism (JCM) in order to quantitatively evaluate Japan's contributions to the emission reductions and absorptions of greenhouse gases achieved and to achieve Japan's own reduction target through the dissemination of technologies, products, systems, services, infrastructure, etc. necessary for reducing greenhouse gas emissions to developing countries and through the implementation of global warming countermeasures. The GOJ will also promote the reduction of greenhouse gases from international shipping and aviation while keeping the enhancement of the international competitivity of Japanese shipping in perspective based on the "Initial IMO Strategy on Reduction of GHG Emissions from Ships and Existing IMO Activity Related to Reducing GHG Emissions in the Shipping Sector" adopted by the International Maritime Organization (IMO) in April 2018 adopted under Japanese leadership and the "Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)," which uses the market mechanism for emissions reduction, adopted by resolution by the International Civil Aviation Organization (ICAO) in October 2016.

Section 3 Promotion of technology development

1. Formulation of plans and roadmaps for energy-related technology development

As far as our energy policy would be on an extension of the present technologies and supply structure with respect to the vulnerability of the energy supply-demand structure, which mostly has to rely on overseas resources, it would be difficult to find a fundamental solution. In addition, under the Plan for Global Warming Countermeasures, "Japan will lead the international community under the Paris Agreement so that major greenhouse gas (GHG)-emitting countries will undertake the reduction of their emissions under a fair and effective international framework in which all major countries participate and will aim at the long-term goal of reducing greenhouse gas emissions by 80% by 2050 while reconciling global warming countermeasures and economic growth. Such a large-scale emissions reduction is difficult to do by merely continuing existing efforts. Therefore, it is decided that Japan will pursue to the maximum solutions through innovation including the development and adoption of innovative technology that makes thoroughgoing reduction of emissions possible, encourage domestic investment, strengthen international competitivity, and aim at large-scale emissions reduction through long-term, strategic initiatives and contribute to worldwide reduction."

To fundamentally solve such difficult problems, it is imperative to introduce revolutionary energy technologies throughout the society. To do this, it is necessary to conduct long-term research and development and conduct comprehensive initiatives that involve institutional reforms.

On the other hand, challenges that affect energy supply and demand exist at various levels. Given the position of energy as the foundation of daily lives and economic activities, it is extremely important to stabilize energy supply and demand and improve safety and efficiency from short- and medium-term viewpoints.

Therefore, based on the understanding that it is important in developing energy-related technology to first set a goal as to what challenge the technology is intended to resolve and specify the timeframe for development and the measures to put the technology into practice in society, GOJ formulated the Roadmap for Energy-Related Technology Development in December 2014 as the strategy for consistently carrying out such various technology development projects based on the "Innovation Plan for Environmental Energy Technology (decided in September 2013 by the Council for Science and Technology Policy)" and other plans.

In April 2016, the Ministry of Economy, Trade and Industry formulated the "Innovative Energy Strategy," which aims to achieve the 2030 energy mix by establishing the relevant institutional framework for energy conservation, renewable energy, etc. together. In the same month, the GOJ formulated the "Energy/Environment Innovation Strategy" based

on the understanding that creating innovation that achieves thoroughgoing reduction is essential in addition to continuing current efforts to reduce greenhouse gases.

Going forward, “ambitious and flexible, multiple track scenarios” will be necessary in scenario designing for 2050 because of the existence of both potential and uncertainty. Non-continuous technology development is necessary to achieve this, but it is difficult to determine the winners of the inter-technology competition at this stage. Therefore, it will be necessary to determine and revise the development goals of the respective options and the relative importance of the options themselves while clearly assessing the latest state of affairs and the progress in technological innovation. The GOJ will swiftly undertake considerations aimed at fleshing out a scientific review mechanism (with details to be explained later) as the mechanism for this purpose.

2. Technical challenges to be addressed

As for technology development for changing the energy supply-demand structure that excessively depends on overseas fossil fuels from the long-term viewpoint, GOJ places emphasis on research and development that contribute to low-cost, high-efficiency utilization of solar power generation, wind power generation, geothermal power generation, biomass energy, ocean energy including wave and tidal power, and other renewable energy sources that are positioned as domestic energy sources, and development of various applications while uncovering and nurturing more innovative technological seeds. GOJ also advances the technique for operating power grids in order to increase the connection volume of renewable energy power generation to the existing power grids and conduct technological demonstration of power transmission and distribution equipment.

Likewise, concerning nuclear power, which is positioned as quasi-domestic energy, it is necessary to actively undertake the resolution of technological issues in response to the changes in the environment surrounding the use of nuclear energy in Japan and abroad beginning such as the enhancement of light-water reactor technology. In doing so, in addition to further enhancing safety, reliability, and efficiency, the perspective of promoting innovation of technology related to nuclear power that takes into consideration growing demands from society including coexistence with renewable energy, hydrogen production, and heat utilization is important. First of all, GOJ promotes the development of technologies that contribute to the improvement of the safety, reliability, and efficiency of LWRs including countermeasures against severe accidents in order to reduce risks in case of an accident. Under international cooperation, GOJ also facilitates R&D of technologies that serves the safety improvement of nuclear use such as high-temperature gas-cooled reactors, which are expected to be utilized in various industries including hydrogen production and which have an inherent safety. Furthermore, the GOJ will go forward with the development of new technology that will fundamentally enhance the

safety, reliability, and efficiency of using nuclear power. To support this initiative, it will strengthen the human resources, technology, and industrial foundations across industrial, academic, and administrative borders including the establishment of the test reactor necessary for human resource development and R&D. In going forward with such initiatives, strategic flexibility will be secured, with the state putting forth a long-term development vision and the private sector utilizing inventiveness and ideas to engage in a wide variety of competition between technologies and select from domestic and overseas markets while taking into consideration initiatives in the United States and Europe, where the development of innovative nuclear reactors including small modular reactors and molten salt reactors is being conducted. In addition, regarding the ITER project, which uses the tokamak and is being implemented through international cooperation, and the Broader Approach Activities aimed at realizing energy from nuclear fusion, there has been progress in on-site construction and the production of the equipment. GOJ will continue to steadily promote these activities from the long-term viewpoint. It will also promote parallel research on the helical and laser types as well as innovative concepts from the perspective of securing technological diversity. Besides, it promotes technology development, etc. required for reducing the volume and toxicity of radioactive waste and stable final disposal of radioactive waste.

In addition to these, GOJ steadily promotes technology development from mid- to long-term viewpoints so as to conduct commercial development of methane hydrate and metal minerals considered to exist in abundance in the Japanese exclusive economic zone. In addition, in order to make hydrogen an option on a par with renewable energy, GOJ seeks to expand demand from hydrogen domestically and abroad, and accelerates efforts aimed at the resolution of technological issues regarding the construction of an international end-to-end supply chain covering “production, storage, transportation, and utilization” and the promotion of hydrogen utilization in a wide range of areas including electric power and industry. Furthermore, it promotes the development of technologies for decarbonization that effectively uses existing infrastructure such as the development of technology to use ammonia directly as a fuel and methanation, which generates gas with carbon-neutral potential by combining hydrogen with carbon dioxide. Concerning mid- to long-term technology development related to future innovative energy such as the development of fundamental technologies for demonstrating the Space Solar Power System (SSPS), which provides the earth with electricity from space by the wireless power transmission and reception technology in space, GOJ constantly evaluates their positions and economic rationality as energy supply sources in a comprehensive manner and conduct necessary activities including technology development.

As for technology development to enhance safety and stability which are essential elements for making use of various energy sources, for instance, in order to advance transmission and distribution networks, which are the key to distributing electricity, which

is the core secondary energy, to final consumers, GOJ accelerates the development of basic technologies such as power grid operation technology based on advanced simulation and superconducting technology in order to deal with a future increase in power sources with output fluctuation and promote enhancement of the capacity of storage batteries and hydrogen storage capacity.

Furthermore, in order to realize a thoroughly efficient energy supply chain by enhancing energy utilization efficiency in all phases of the energy supply chain, GOJ develops technologies to realize high-efficiency coal and gas thermal power generation; technologies that support efficiency improvement, including in terms of materials and devices, regarding products that enable efficient use of energy; and technologies that support the advancement of energy management systems necessary for improving the efficiency of processes related to energy utilization and product process innovations.

While implementing measures to thoroughly improve efficiency and to enable the use of hydrogen, GOJ promotes technology development related to CCS, as a technology that captures and stores carbon dioxide that is eventually generated as a result of thoroughly efficient utilization of fossil fuels, in relation to problems that GOJ must ultimately deal with, such as the problem of global warming.

The promotion of this R&D will also be based on the comprehensive innovation strategy to be formulated based on the Science and Technology Basic Plan.

Section 4 Enhancement of communication with all levels of the society

1. Deeping of understanding of all levels of the society

(1) Desirable way to engage in energy-related public relations

Needless to say, what is most important for appropriate choice of energy is that GOJ discloses relevant information and ensures thorough transparency. GOJ must keep this point in mind.

Public concern about overall energy has been increasing since the Great East Japan Earthquake and the TEPCO's Fukushima nuclear accident. For example, power-saving efforts have taken hold after the Great East Japan Earthquake out of concern over stable electricity supply. Interest in a distributed energy system has increased from the viewpoint of enhancing the disaster response capability. Acceptance has grown as of now among the public about challenges related to the energy supply-demand structure, including the treatment and disposal of spent nuclear fuels, the still heavy dependency on overseas resources and the low energy self-sufficiency, and rising electricity rates. More recently, decarbonization has been gaining momentum worldwide with the entry into force of the Paris Agreement. As the cost of power generation from renewable energy sources decline, interest has been growing in Japan on the domestic cost of power generation from renewable energy sources and the issue of connections to transmission lines.

Given this situation, GOJ will work continuously on improvements towards an effective way of providing information so that all people can understand the overall picture of Japan's energy circumstances to some extent regardless of the degree of interest and the extent of their background knowledge and how to conduct public relations so that the people can receive the information with interest and will establish a system for providing objective and diverse information based on scientific knowledge and data so that the public can choose the most adequately organized information based on their own interest. As part of this effort, the GOJ will continuously strive to express basic terms and data, the latest developments and topics and other policy-related information concerning energy as easy-to-understand as possible and meticulously disseminate the content at all times, utilizing the Agency for Natural Resources and Energy website and other means.

In addition, while expanding understanding of the overall picture of the energy-related circumstances, GOJ will simultaneously strive to obtain understanding of the individual policies and their issues and the orientation of responses such as bearing the cost of energy security, energy cost, and environmental impacts, issues surrounding renewable energy and nuclear power, and the global warming issue.

By steadily executing these undertakings one by one, it is expected that it will deepen the understanding of energy by all levels of society, which will lead to thorough energy conservation efforts by each and every citizen, participation in the energy supply-demand

structure as suppliers of renewable energy, and deepening interest in the selection of a radioactive waste disposal sites, with the result that active undertakings by the public will spread.

Meanwhile, the “myth of safety” is a major obstacle to the effort to expand opportunities for all levels of the society to deepen their understanding of the energy circumstances. The “myth of safety” created the impression that if the criteria and requirements set by GOJ and business operators were satisfied, there would be no risk, requiring no further consideration of it.

It is necessary to deeply reflect on the fact that the previous energy-related public-relations activity failed to improve this misconception and that as a result, after the Great East Japan Earthquake and the TEPCO’s Fukushima nuclear accident, administrative agencies and business operators came under criticism in many respects, including their way of sharing information and a lack of communications with local communities, leading to a decline in public trust in them.

Therefore, concerning how energy-related public relations should be conducted in the future, it is necessary to prepare multiple sets of comprehensive energy information the volume of which is appropriately adjusted according to the degree of interest of the targeted audience. It is also necessary that such information make clear that risks always exist, to motivate the people to deepen their understanding by simulating their interest and to enable them to accurately understand risks, so GOJ makes efforts to that end.
When doing this, GOJ makes further use of an advisory board consisting of private-sector experts in order to promote the efforts while listening to pointers from third parties so as to enable the provision of more objective and appropriate information suited to the individual circumstances of the people from the “public viewpoint.”

(2) Promotion of the provision of energy-related information by a third-party organization through enhanced access to objective information and data

GOJ actively provides information to the mass media, private research agencies, non-profit corporations, etc., allow third parties to organize the information based on their unique viewpoints and provide the energy-related information to the public in various forms, thereby realizing an environment in which energy-related public relations will be conducted nationwide.

As part of the promotion of such efforts, GOJ enriches the content of its website so that information-providing entities can obtain energy-related statistical information, etc. swiftly and easily so as to understand the energy circumstances and conduct various analyses.

(3) Promotion of energy education

In expanding and deepening understanding of the energy circumstances, it is considered to be very effective to include basic energy-related knowledge as part of educational programs at schools.

Since energy is the foundation of the people's lives and industrial activity, understanding Japan's dependency on overseas energy resources from childhood is greatly useful for making appropriate judgment when the time comes to become involved in an energy policy as grown-up citizens. Accordingly, it is required that various people involved in energy issues as well as energy experts, energy business operators and administrative officials actively participate in the field of education.

As a result of such efforts, the pool of personnel who study energy as a specialty in higher education is expected to expand through energy education provided since childhood. This will also lead to the establishment of a reliable career path for training of personnel who support the future energy supply-demand structure.

2. Transparent policy planning process and enhancement of two-way communication

It is important to increase transparency over the energy policy planning process and obtain public trust in the policy while making maximum efforts to help deepen understanding of the overall picture of the energy-related circumstances. GOJ will maximize the openness of the policymaking process through advisory councils, meeting of experts and the like and enhance their transparency.

In addition, GOJ will strengthen communication to conduct the dialogue with all layers of society. For various challenges related to energy including nuclear power, the fact that the substance is highly technical and complicated is a factor that impedes understanding. Therefore, GOJ will seek to promote further understanding by careful dialogue and two-way communication instead of merely conveying information on a one-way street. It is desirable to conduct various activities to have such dialogue-based policy planning implementation processes take hold in society.

When doing this, instead of having only the national government bear responsibility for planning and implementing the energy policy, it is important to firmly position different entities, such as municipalities, business operators and non-profit corporations, in a newly constructed communication mechanism and develop the mechanism into one in which they will get involved in the processes from policy planning to policy implementation as responsible entities in view of the fact that they are involved in the energy policy in ways that exercise their own strengths. For instance, GOJ will take initiatives that allow various entities to discuss, study and deepen their understanding of a variety of energy-related challenges to push forward the policy, such as utilizing local energy councils under collaboration between the relevant government agencies and municipalities across Japan and building platforms concerning local coexistence in line with local circumstances to engage in communication concerning nuclear power.

Chapter 3 Efforts for Energy Transitions and Decarbonization towards 2050

Section 1 Ambitious multiple track scenario - Pursue every option

(1) The question now is what the moves are going forward to turn Japanese potential into reality

The competition between technologies holds the “potential” for decarbonization. At the same time, it harbors “uncertainty”; no perfect, economic and decarbonized energy technology that satisfies fluctuating energy demand has emerged at this point, and the outcome of the competition between technologies remains unclear. This technological shift also destabilizes the energy situation, and geo-economic risk will remain even after the energy transitions if Japan fails to secure its own core technology.

If the essence of the change in the situation over the last several years lies in “potential” and “uncertainty,” what is required today is to identify the risks and potential for Japan and conceptualize the moves to turn potential into reality.

Initiatives aimed at energy transitions are not about unfettered optimism. All energy sources have strengths and weaknesses. The energy structure is characterized by the complex interaction between technology, infrastructure, industrial structure, and policy system. To change it take time and expenses. Meanwhile, the inevitability of energy transitions is becoming the common challenge of humankind. A country that faces up to this reality and constructs a strategy that matches its energy environment will be at an advantage.

Resource-poor Japan has made up for its lack of resources with technology. However, emerging economies have been on the rise in the low-carbon field in recent years, and Japan’s presence has been in relative decline. As the competition in technological innovation heats up, Japan will see its risks emerge not only on carbon reduction but also on decarbonization if it hesitates to meet the challenge of the revolution in the global energy structure.

Meanwhile, decarbonization energy systems are still under development and the efforts of various countries are still in the trial-and-error stage. Japan is one of the few countries that possess the technological foundation of hydrogen, electricity storage, nuclear power, and other decarbonization technologies and have constructed close relationships with resource-rich countries, emerging economies, and industrialized countries.

The scenario up to 2050 will be considered from the perspective of how Japan should utilize these highly promising technological assets that it possesses and what the moves are that should be made to turn Japan’s potential into reality.

(2) Comparing the major economies, the effectiveness of an omni-directional,

multiple track scenario approach

Major economies have adopted scenarios that are not limited to naturally-fluctuating renewable energy sources but combine a wide range of decarbonization means including hydropower and nuclear power. As it faces the exhaustion of its North Sea oil fields, obsolescence of its coal-fired power plants, and decommissioning of its nuclear power plants, the United Kingdom has been succeeding in the reduction of its CO_2 emissions by combining the means for decarbonization such as the expansion of renewable energy, a shift to gas, maintaining nuclear power, and energy conservation.

Meanwhile, Germany has chosen to achieve decarbonization through energy conservation and the expansion of renewable energy. However, reducing demand by energy conservation has not produced significant results to date and nuclear power has declined in contrast to the increase in renewable energy, with the result that Germany currently relies on coal to meet 44% of its demand while the reduction of CO_2 emission stalls and electricity rates remain high.

Moreover, the few countries and regions that currently boast cheap, low-carbon electricity systems are not countries that have introduced large amounts of renewable energy sources with fluctuating output such as solar and wind power. Instead, they are mainly countries and states such as France, Sweden, and the state of Washington, U.S.A. This indicates that only hydro and nuclear power can be considered the main tools for decarbonization that are stable given the state of technology today and that decarbonization cannot be achieved as of now with fluctuating renewable technology alone.

(3) The energy environment unique to Japan (degree of resources, international interconnections, and surface area limitations)

Each country has its own special characteristics and uniqueness when it comes to energy choices. The energy choices of each country are determined by such factors as (i) the fossil fuel resource profile, (ii) the availability factor of fluctuating renewable energy, which is determined by natural conditions, (iii) the state of international energy interconnections such as electricity transmission networks and gas pipeline networks, and (iv) the structure of relative energy costs. Viewed from this perspective, the energy environment of Japan is closer to that of the United Kingdom, an archipelago state with limited scope for international interconnections and declining production from its North Sea oil fields, than that of Germany, which has domestic coal as well as an international power grid that makes it easy to expand its renewable energy.

One significant means to avoid absorbing renewable energy fluctuations with thermal power is to absorb the renewable energy fluctuations by effectively connecting renewable energy-rich countries with electricity-deficit countries through international interconnections to form a larger electricity pool. Germany and Denmark have expanded

their renewable energy profile while utilizing the electricity ebb and flow between their neighbors as the safety valve for electricity supply and demand. Europe is undertaking an attempt to expand international interconnections at the EU level. If these international interconnections are established, the substantial pumped storage power in Norway, which has ample hydropower, can be woven into the European power grid to be utilized as "green batteries." But even with this initiative, which promotes the introduction of fluctuating renewable energy through cross-border cooperation, the fact of the matter is that the proportion of fluctuating renewable energy in the EU as a whole remained at about 13% as of 2016. With highly efficient, low-cost battery storage technology yet to be established, some EU members may be able to significantly increase its renewable energy usage but doing so for the EU as a whole is a challenge, given the current state of the technology. A strategy that expands renewable energy by utilizing international connections has many issues in the case of Japan. Innovations in technology that can be used to control fluctuations in renewable energy output is required perforce.

In addition, Japan already has one of the highest renewable energy-to-surface area ratios in the world. Optimal siting is also a concern for renewable energy. As large amounts are introduced, renewable energy will run into surface area limitations sooner or later. To overcome this constraint, dramatic improvements in power generation efficiency through discontinuous innovation is essential.

(4) Adopting ambitious multiple track scenario approach that pursues possibilities in all options

Given the uncertainties accompanying the 2050 scenario, lessons from the state of affairs in major countries that are ahead of Japan on the timeline, and the energy environment unique to Japan, GOJ adopts an "omni-directional, multiple track scenario approach that aims at energy transitions and decarbonization" that pursues all options including renewable energy, hydrogen and CCS, and nuclear power.

Section 2 Designing of the 2050 scenario

1. Sophisticated 3E+S

Energy choices reflect the environment unique to that country.

Japan is lacking in domestic fossil fuel resources. It has no international pipelines or transmission lines. It relies on the Middle East far more than do other major economies. Even though long-term energy demand is not projected to grow quantitatively due to a declining population, the level of demand for the quality of electric power must be maintained. As a mature economy, Japan already has energy infrastructure (transmission lines, gas pipelines, gas stations, etc.) in place all over the country. Energy efficiency is very high, beginning with energy-intensive industries. The outcome of all this is the highly reliable energy technology on which supply chains have been constructed. The existence of the high-quality, highly reliable energy-related technology and industry will serve as leverage in the energy diplomacy that is about to begin in earnest with emerging economies and resource-rich countries that are taking on the challenge of energy transitions. Meanwhile, the rolling blackouts and delays in fuel supply during the East Japan Earthquake Disaster reminded us that the existing infrastructure has vulnerabilities that pose risks to the daily lives of the people and economic activities.

Based on these considerations, the fact that 3E+S is the basic policy for Japan's energy choices remains unchanged even if we take the long-term viewpoint. At the same time, it will be necessary to make energy choices under more complex and uncertain circumstances when we deal with long-term energy transitions. Therefore, in making these choices, it is appropriate to establish the following "sophistecated 3E+S" as the basis for evaluation.

Specifically, the ability to respond in a state of uncertainty will be prioritized, and the following four points will be the basis for evaluation.

1) Achieve safety first through innovation in safety through technological innovation and governance innovation.
2) Secure diversification of energy choices to enhance technological self-sufficiency in addition to resource self-sufficiency and minimize various risks[†].

[†] Supply-and-demand adjustment risk accompanying output fluctuations at intermittent power sources, accident and disaster risk, the geopolitical risk of fossil fuels, resource scarcity risk (ex. rare metals in storage batteries), the risk from relying on other countries for cutting-edge technology, etc.

3) Regarding environmental acceptability, the GOJ will undertake decarbonization.
4) Aim at strengthening the competitivity of Japanese industry in addition to limiting the burden on the Japanese public.

2. Scientific review mechanism

Even as the “ambitious multiple track scenario” towards 2050 is considered, the technological trends and the global state of affairs will fluctuate significantly in ways that are unforeseeable. In order to properly execute the energy selection that satisfies “sophisticated 3E+S” against this background, the GOJ will construct a “scientific review mechanism” that regularly grasps the latest technological trends and state of affairs and flexibly revises and determines development goals and the relative importance of each option under transparent mechanisms and procedures.

The functions that this mechanism performs are extremely important in substantiating energy selections, and must be the following, multilayered verification mechanism.

1) Collect and analyze information using human networks in Japan and abroad
2) Conduct the comparative verification of technology under a unitary yardstick
3) Evaluate the various risks that each technology embodies qualitatively and quantitatively
4) Verify the relative competitivity of domestic industries related to each technology
5) Establish development goals for each option based on the objective, multifaceted, and technical analysis concerning 1) through 4), determine the relative degree of importance of the options, and determine the focus of policy resources accordingly.

It is necessary to substantiate it by keeping in mind the following points while referencing precedents.

1) Create a human network concerning the analysis of the energy situation and the science and technology
2) Build and make public an economic and technological database concerning energy
3) Develop and make public cost/risk verification methods for comparing decarbonization energy systems
4) Provide basic material for determining the energy situation to meet the interest among the public

The GOJ will deepen understanding among the public by correctly and widely providing the latest information concerning energy and encourage each and every citizen to be able to make responsible choices regarding energy in their daily lives.

3. Cost/risk verification and dynamism among decarbonizing energy systems

In considering energy choices in the past, an approach that placed the verification of cost by power source concerning the electricity system was at the center. By contrast, the 2050 scenario will make a challenge at reducing carbon intensity and decarbonization. It is also difficult to compare costs within the overall system including the other costs that actually accrue (supply-and-demand adjustment cost, the cost of infrastructure required to

reinforce the system, etc.) if only the cost for each power source is verified.

Therefore, the GOJ will switch from “cost verification by power source” to “cost-risk verification between decarbonization energy systems.” This will make crosscutting understanding of the technological maturity of multiple energy systems such as electricity/non-electricity, and heat and transportation possible. In addition, by making it the verification of system cost, it will become possible to compare the actual overall cost.

Possible decarbonization of electricity systems include, for example, renewable energy-electricity storage systems, which place renewable energy at the center and complement it with storage batteries, hydrogen or other electricity storage systems; hydrogen-gas synthetization systems, which convert cheap energy sources such as overseas renewable energy overseas or lignite subjected to CCS into hydrogen gas or synthetic gas (methane); and existing decarbonization technology such as hydropower, geothermal power, and nuclear power.

Other possible approaches include the enhancement of energy conservation through distributed energy systems consolidated with digital technology; electrification, hydrogenation, and traffic volume control through automatic driving and other means for the decarbonization of the transportation system; and electrification, hydrogenation, and switch to synthetic gas for the decarbonization of the thermal system.

One possibility is to evaluate the maturity of these technologies using cost-risk for existing systems as the benchmark.

What can be discerned from this evaluation of the current situation using decarbonization systems is that decarbonization options such as nuclear power, hydropower, and geothermal power are in practical use, but the options to achieve the decarbonization of the overall system such as the technologies that are the key to including renewable energy in the baseload such as electricity storage and hydrogen and the technology that are the key to the decarbonization of fossil fuels such as hydrogen and synthetic gas are all still in the development stage. In addition, each option has its own risks, so it is necessary to verify the extent to which managing such risk is technically possible. If these and other points could be continuously verified technically and neutrally and the understanding of the maturity of the options can be shared broadly under the scientific review mechanism, this in itself should have the effect of accelerating the competition between the options.

In addition, this decarbonization energy system approach also has the effect of encouraging more dynamic energy transitions. If decarbonization energy system technologies such as electricity storage, hydrogen, and digitalization become viable for practical use cost-wise, the decarbonization of a wide variety of electricity sources will become possible beyond existing borders such as base-, middle-, and peak-load electricity sources, while such technologies will become available for use in the decarbonization of heat and the transportation system at low cost. In addition, making decarbonization

technology smaller will enhance the potential for distributed energy systems, in which the electricity, thermal, and transportation systems are completed within compact areas.

Section 3 Issues faced by each option and priorities in response thereto

Taking on the challenge of energy transitions and decarbonization requires nothing less than initiatives on two fronts: taking on the challenge of decarbonization of Japan's electric power, thermal, and transportation systems, and the large-scale reduction of emissions through overseas contribution to decarbonization. Meanwhile, multiple decarbonization options currently exist, but there are no options in practical use that can handle fluctuating energy demand by itself. Each and every option has its own characteristics, its strengths and weaknesses. In order to steadily achieve ambitious goals, it is necessary to discern the latest situation and technological trends, combine multiple decarbonization energy systems in the optimal manner at that point based on the "sophisticated 3E+S" basis for evaluation, and steadily promote initiatives aimed at decarbonization in Japan and overseas. To this end, the public and private sectors will join up to first strengthen the human resource, technological, and industrial foundations for all the options concerning decarbonization systems and take on the challenge of resolving the issues. The outcome of this challenge will be evaluated calmly and objectively through the scientific review system, and the options will be positioned accordingly. The GOJ will broaden the scope of Japan's energy options and make it through the difficult circumstances through the self-motivated challenge competition among the options under this understanding of the issues. Furthermore, it will appropriately choose projects that contribute to energy transitions, enhance foreseeability for the private sector, and strengthen the focused deployment of policy resources such as the enhancement of technology development and nurturing and securing human resources.

(1) Policy for resolving issues regarding renewable energy

Concerning renewable energy, for which expectations are growing as a main power source in the electricity system as the result of declining prices and progress in digital technology, the GOJ will aim at making it an economically self-supporting, decarbonized main source of electricity. It will go forward with initiatives to reinforce geothermal power, hydropower, and other stable renewable energy sources and the resolution of issues regarding photovoltaics, wind power, and other variable-output renewable energy.

To this end, the GOJ will reduce the domestic price of renewable energy to international levels and seek to end its reliance on subsidies through the FIT system, thoroughly open up the existing transmission system, and execute the early establishment of the framework for maintaining thermal power generation capacity as an auxiliary source of electricity.

In parallel with this, issues that require breakthroughs by technological innovation towards further large-scale introduction and its incorporation as an economically independent, decarbonized main power source must be fully confronted. Specifically, the GOJ will collaborate with local communities to immediately begin strengthening the

human resources, technology, and industrial foundations that will make possible the resolution of fundamental issues such as the fundamental enhancement of power generation efficiency, development of high-performance, low-cost storage batteries and hydrogen systems aimed at decarbonization of load following capacity, the development of digital technology to conduct supply/demand adjustment more precisely, the reinforcement of transmission networks according to the distribution of renewable energy, and the development of distributed network systems.

(2) Policy for resolving issues regarding nuclear power

Having experienced TEPCO's Fukushima Daiichi Nuclear Power Plant disaster, Japan will give the highest priority to safety and will lower reliance on nuclear power as much as possible while attempting to expand economically self-sustaining and decarbonized renewable energy.

Concerning nuclear power, which is an option for decarbonization that is at the practical stage, while there is some movement towards eliminating nuclear power, global initiatives are commencing to further enhance its safety, economics, and mobility in response to changes in the energy situation.

In Japan, it is essential first and foremost to recover public trust through initiatives such as the reduction of the risk of accidents through further safety enhancement and the handling of backend issues such as decommissioning reactors and processing and disposing of waste. To this end, the GOJ will immediately begin strengthening human resources, technology, and the industry foundations and go forward with the pursuit of reactors with superior safety, economics, and mobility and the development of technology aimed at the resolution of backend problems. An earnest posture and initiatives with a strong sense of responsibility that harken back to TEPCO's Fukushima Daiichi Nuclear Power Station disaster as the starting point are important and will be the keys to securing public trust in nuclear power in Japan.

(3) Policy for resolving issues regarding thermal power

As the situation changes accompanied by possiblity and uncertainty, it is forecast that fossil fuels as an energy source will remain a main energy source that will account for more than half of primary energy during the transitional period towards the achievement of energy transitions and decarbonization. The GOJ will continue independent development in response to geopolitical risk.

In this context, the policy during the transitional period will focus on shifting to the cleaner use of gas and fadeout inefficient coal thermal power generation and supporting the global trends towards low carbon approach of fossil fuels worldwide.

In addition, the challenge of long-term decarbonization will also be taken up simultaneously. Japan will take the lead in CCS and hydrogen conversion and will achieve

the use of fossil fuels through decarbonization together with resource-rich countries and emerging economies.

(4) Policy for resolving issues regarding thermal systems and transportation systems

Currently, both thermal systems and transportation systems rely heavily on fossil fuels. However, there has been progress in technology innovation that makes electrification and hydrogenation possible, and the GOJ will pursue this potential. First, it will exclude high-temperature heat, super-large-scale transportation and other difficult areas and deepen technological innovation towards electrification and hydrogenation, etc. mainly for low-to-mid-temperature heat and small and medium sized vehicles.

In addition, the transition of automobiles to connected vehicles (CV) and the distributed utilization of renewable energy and thermal energy will be incorporated and combined to make headway in the decarbonization of both systems through the best mix of electrification, hydrogenation, electric motorization, distributed digitalization, etc.

Furthermore, establishing infrastructure is an important issue. Energy infrastructures that assume the utilization of fossil fuel resources (gas pipelines, gas station networks, etc.) are in place for thermal systems and transportation systems and form the foundation of the lives of the people. It is not easy to establish electrified and hydrogenated infrastructure without harming the functions of this currently existing energy infrastructure. The GOJ will move forward in step with progress in technological innovation, uphold common goals regarding the path for infrastructure renewal, and take measures while enhancing foreseeability.

(5) Policy for resolving issues regarding energy conservation and distributed energy systems

The GOJ will increase the possibility of efficient, stable, and decarbonizing distributed energy systems that consolidate in a compact manner electricity, thermal, and transportation systems being established locally under demand-side leadership by effectively combining the downsizing and efficiency improvements in renewable energy, technological innovations in storage batteries and fuel cell systems, and progress in digitalization technology and smart grid technology that make supply-demand control at the local level possible.

Railways, communication companies, hospitals, bases and others that have taken the lead in introducing private power generation are also undertaking the development of distributed energy systems backed by innovative technology from the energy security perspective.

Local and energy security: the GOJ will assume the posture of leading the development of economic and stable distributed energy systems from these two perspectives backed by technology and proposing them worldwide.

Regarding the Top Runner system for industrial sector (a benchmark system), which establishes energy consumption per unit and other targets, the GOJ will utilize the system to further enhance Japan’s energy conservation levels, which place the country among global leaders, by verifying the benchmarks, targets, etc. that are currently established and making the necessary revisions, etc.

Section 4 All-out efforts to realize the scenario

(1) All-out efforts

The road of energy transitions and decarbonization to 2050 is full of potential, but there is plenty of uncertainty in this process. Pursuing an ambitious multiple track scenario and meeting the requirements of "sophisticated 3E+S" demand a strategic approach of always being aware of the relative position against global competitors and being the first mover.

This will be a challenging process for Japan. While it is difficult to expect the domestic energy market to grow, we must battle powerful countries and businesses in the global competition for energy transitions and decarbonization.

It is important in this context to respond through an "all-out efforts" approach. Energy is the foundation of the state, economy, and society and the starting point for all activities. First, the understanding that this energy has reached a turning point, this sense of urgency, must be shared. Then, the challenges that decarbonization systems pose must be properly extracted and met by bold attempts towards their resolution. At the same time, GOJ will make overseas contributions through decarbonization technology and create an international collaboration network for energy transitions. It will redesign energy infrastructure and will nurture both energy companies with overall strength and business groups capable of managing distributed energy systems rooted in local communities. It will gain the support of financial capital that acts from a long-term perspective. It is of the utmost importance to achieve a virtuous circle of policy, diplomacy, industry, and finance.

Technology and human resources will be the source of energy security during the energy transitions process. In the 30-odd years to 2050, people currently in their teens and 20s will form the core in 2050. The initiative towards energy transitions is nothing but the long-term strategy for technology and human resources. The public and private sectors will come together to take on the challenge of continuous technological innovation and developing and securing human resources in order to pursue the possibilities in each option, overcome the issues, and seek out the optimum energy choices.

(2) Taking care of the global underinvestment problem

While it is necessary to go forward with energy transitions and decarbonization as an all-out effort, dealing with the underinvestment issue as energy prices fluctuate is a matter that cannot be avoided.

The large amount of renewable energy that was introduced by using the subsidies under the FIT system amplifies electricity price fluctuations, and also lowers price levels by the amount of policy support that is received. This inhibits the recovery of investment in other electricity sources that would otherwise be selected by the market. In Germany, which is ahead in the large-scale introduction of renewable energy, it has been pointed out that there is the possibility that none of the investments including in renewable energy will be

recovered if this situation is left untended.

Meanwhile, there is no end to the list of investments necessary for energy transitions such as investment in technology development, investment in power generation, investment to upgrade transmission networks, investment in distributed networks, and overseas investment. In addition, efforts for carbon reduction, decarbonization, and distribution must be launched simultaneously or there will be the risk of being left behind in the global energy competition. Therefore, the GOJ will steadily design and construct a mechanism to secure the necessary investments by securing foreseeability within a difficult investment environment.

(3) Four-layered action scenario

To actually implement the all-out efforts for energy transitions and decarbonization, the GOJ will substantiate and implement initiatives concerning the four layers of domestic policy, energy diplomacy, industry/infrastructure, and financing based on the following directions.

(i) Conducting an energy policy aimed at the achievement of energy transitions

Energy policy stands on three foundations, i) the financial circulation mechanism, through which the government distributes and invests the funds secured at the expense of the public through the tax system, FIT system and the like, ii) business regulation and other regulation and systems, and iii) market design. Innovative technology development and investment will have their relative importance determined by ascertaining the progress in decarbonization energy systems subject to the scientific review mechanism. Projects that contribute to energy transitions will be aptly selected accordingly, to which the focused injection of policy resources such as amplification of initiatives for technology development and developing and securing human resources will be reinforced. Much effort will also be required in energy market design if price signals from the market are impeding risk investments. In filling out the market design, the GOJ will learn from precedents in market designs for post-liberalization of electricity, in which major countries have taken the lead. It will begin consideration of a new institutional reform that conducts the necessary transmission investments while enhancing the efficiency of the transmission business with the aim of transitioning the transmission and distribution network to the next generation. Furthermore, it will deal with the underinvestment issue regarding energy transitions, secure energy security based on technology, and achieved energy transitions from carbon reduction to one aimed at decarbonization. It will clearly set forth the will and policy of the state to establish policy for this purpose, and encourage action by the private sector by providing their investment decisions with foreseeability.

(ii) Achieving international cooperation towards energy transitions

Japan cannot achieve energy transitions and decarbonization by itself. In order for Japanese energy companies to secure sufficient investment demand necessary for energy transitions in Japan, it is essential to acquire overseas markets. Japan's CO_2 emissions of energy origin are approximately 1.1 billion tons but global emissions surpass 30 billion tons. It is effective to conduct carbon reduction and decarbonization through energy transitions not only in Japan but also overseas broadly. To this end, the GOJ will cooperate with resource-rich countries reliant on fossil fuels and emerging economies to undertake carbon reduction and decarbonization. Furthermore, Japan will propose international collaboration towards energy transitions and conduct a new energy diplomacy.

According to an IEA forecast, even under a sustainable development scenario based on SDGs, fossil fuels will account for the majority of primary energy supply in 2040, while the proportion of both renewable energy and nuclear power will increase. By having the technology for energy options in all directions from carbon reduction to decarbonization and not just a certain specific energy, it will become possible to make proposals appropriate to each economic stage. This will also lead to Japan's energy security and its contributions to global energy transitions and market acquisition. Designing incentives that encourage state-to-state cooperation towards energy transitions and decarbonization is also important. In addition to the existing bilateral offset credit system (JCM), Japan will propose fair, transparent, and effective mechanisms towards global energy transitions such as a proposal for calculating the amount of CO_2 reduction contributions through the dissemination of products and services superior in environmental friendliness.

(iii) Strengthening industries responsible for energy transitions and reconstructing energy infrastructure

Energy transitions are leading energy companies worldwide to conduct bold revisions of their strategies, revamp their business areas and portfolios, and conduct their businesses globally. By contrast, Japanese energy companies are highly reliant on the domestic market, and their initiatives such as storage batteries, hydrogen development, next-generation renewable energy, and next-generation nuclear power that transcend the existing framework are just starting. The GOJ will establish a business environment that encourages high-risk, high-potential business management, aiming at the enhancement of competitivity through new technologies, in the hopes that comprehensive energy companies that go beyond the borders between electricity, gas, and oil and conceive management strategies that take on the challenge of decarbonization will emerge.

Meanwhile, the world of distributed energy systems harbors the possibility of newly emerging businesses filled with a management mentality rooted in their respective communities. The GOJ will prepare a business environment that generates groups of comprehensive businesses that operate on the global stage and groups of businesses that develop distributed energy systems locally, these groups of businesses that operate

globally and locally, and produce a structure that accelerates energy transitions and decarbonization by playing to their strengths.

Through this process, the reconstruction of the energy infrastructure such as the transitions of the transmission network to the next generation and the development of distributed network systems will be accelerated.

(iv) Constructing a financial circulatory system towards energy transitions and decarbonization

There is now a serious movement in the financial market to discern the impact of energy transitions and decarbonization on the sustainability of industrial activity and society. Instead of responding passively to this financial market, the state should put forth a scenario to strengthen policy, diplomacy, industry, and infrastructure towards energy transitions and decarbonization, while the corporate world should propose management strategies with energy transitions and decarbonization scenarios. These proactive proposals from the state and corporations will build a financial circulatory mechanism towards energy transitions and decarbonization in which support is received from both domestic and overseas financial capital, the necessary financing is secured, and energy transitions and decarbonization led by Japan with the public and private sectors acting together are accelerated.

Conclusion

The Fifth Strategic Energy Plan is a plan that consolidates the achievement of the 2030 energy mix and the 2050 energy scenario aimed at decarbonization. In the years since the Fourth Strategic Energy Plan was formulated, the price of renewable energy has fallen, China and other emerging economies have become major players in both energy demand and supply, and geopolitical risk has grown as the Middle East situation becomes increasingly opaque. Inter-state competition regarding leadership over the development of energy technology, which is the key to decarbonization, is escalating. This Energy Plan sets forth the basic strategy regarding energy options for Japan against the background of this shift in the circumstances.

There are two perspectives that must always be kept in mind when conceptualizing the energy strategy for Japan. First, Japan, having experienced TEPCO's Fukushima Daiichi Nuclear Power Station disaster, is expected to have the attitude of reducing reliance on nuclear power as much as possible while pursuing the achievement of the 2030 energy mix and beyond for renewable energy. Second, as an archipelago state that is lacking in fossil fuel resources and has difficulty sharing energy with other countries through pipelines and transmission lines, Japan must always develop and secure energy technology as a scare resource.

Fukushima and technology: with these two as premises, maintaining all energy technology options and continuing their development even as maintaining the posture of lowering reliance on nuclear power is required will remain unchanged in the 2030 energy mix and the 2050 energy scenario.

With that as a given, the 2030 energy mix will be developed mainly with the maximum response from mainly existing technology. The achievement of a zero-emissions power source mix through renewable energy and nuclear power will be sought, but further expansion and frontloading will be pursued with a view to 2050. The 2050 energy scenario will have a response through non-continuous innovative technology in mind. This is the challenge of energy transitions and decarbonization by utilizing Japanese technology and strengthening industrial competitivity. It is important to implement the 2030 energy mix and the 2050 energy scenario while discerning the potential of existing technology for the response as well as the progress in innovative technologies. The GOJ will introduce a full-fledged scientific review mechanism and determine the focal points of energy options in a resilient manner.

In synchronicity with this review process, the GOJ will initiate development projects under public/private-sector collaboration concerning all options that lead to energy transitions and decarbonization, construct an international cooperation system, and deploy policies that encourage energy transitions investment in Japan and overseas. It will aim at

strengthening the energy industry and implement dialogue between the energy and financial industries towards energy transitions.

The GOJ will implement the Energy Basic Plan with resilience, thereby creating the foundations for the achievement of 3E+S based on technology, international contribution to decarbonization, and growth and the stability and prosperity of people’s lives.