Provisional Translation

Comprehensive Strategy on Science, Technology and Innovation 2014

– Bridge of Innovation toward Creating the Future –

June 24, 2014

Cabinet Decision

On Comprehensive Strategy on Science, Technology and Innovation 2014

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Comprehensive Strategy on Science, Technology and Innovation 2014 is determined as shown in the enclosed paper.

(The Enclosed Paper)

Comprehensive Strategy on Science, Technology and Innovation 2014

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Contents

Chapter 1 Toward Establishing a Nation Based on Science, Technology and Innovation

1. Science, Technology and Innovation Policy Management in the Past Year

(1) Basic Directions of Science, Technology and Innovation Policy Last Year

Looking back at the time when the second Abe Administration started, the socioeconomic situation around our country was becoming more severe on a medium- and long-term basis, and the feeling of despair and the sense of uncertainty were growing among the people of Japan. The economic conditions of the country were weakening due to the prolonged deflation and rise of the yen, which led some to be resigned that our country will continue to stagnate or decline. As to the field of science, technology and innovation, there was a strong sense of crisis that our country is struggling in the face of the recent recession while the global competition becomes increasingly severe.

In the above situation, the Abe Administration strongly recognized the emergent crisis, prioritized economic revitalization as the largest and the most urgent policy challenge, and has strongly promoted innovation and regulatory reform as its driving force. With regard to the policy for science, technology and innovation, the Cabinet has administered policy together with the Council for Science, Technology and Innovation (changed from the Council for Science and Technology Policy) as a headquarter since last year, while prioritizing the breakthrough in this situation by fully displaying the potential in science, technology and innovation toward economic recovery. In the process, it was decided that the government will aim to operate an exit-oriented and problem-addressing policy by returning to the starting point of the policy on science, technology and innovation, reviewing its mission entrusted by society, and considering how the effect of science, technology and innovation should contribute to the realization of the economy envisaged by people.

(2) Deployment of Policy in Science, Technology and Innovation

Since the above basic directions were decided, the government has deployed policy in science, technology and innovation in the past year mainly with the following five pillars centering on the Council for Science and Technology Policy.

1) Systematizing and prioritizing the overall science, technology and innovation policy

Under the general direction of Science, Technology and Innovation Policy based on the 4th Science and Technology Basic Plan,[1] the government established a system to annually formulate a comprehensive strategy on science, technology and innovation with a short-term timetable. With this comprehensive strategy, the government will systematically present the overall policy on science, technology and innovation and will effectively and efficiently promote the policy through prioritizing it.

2) Establishing an annual PDCA cycle directly linked to the budget

In order to make the prioritization and management of the overall policy on science, technology and innovation more effective and efficient, the government established an annual PDCA cycle[2] that is directly linked to the budget based on the comprehensive strategy. The cycle links the policy with the budget and enables the government to manage the policy with high adaptability. The comprehensive strategy is regarded as the "basic policy" for science, technology and innovation.

3) Initiatives aimed at solving key issues

In cooperation with relevant ministries and agencies, the government is prioritizing and promoting the policy on the five policy challenges (energy, good health and longevity, next-generation infrastructure, local resources, reconstruction) set for the last year's comprehensive strategy.

4) Establishment of the two pillars of "National Emphasis Program"

The government established the Cross-Ministerial Strategic Innovation

[1] The Cabinet decision dated August 19, 2011.

[2] 1) "Comprehensive Strategy on Science, Technology and Innovation" (Cabinet Decision dated June 7, 2013)
2) "Policy for Allocation of Budget and Other Resources Relating to Science and Technology for FY 2014"" (Decision of the Council for Science and Technology Policy dated July 31, 2013)
3) "Action Plan for Science and Technology Priority Measures"/"2014 Priority Measures in Creating the Environment for Innovation" (Decision of the Council for Science and Technology Policy dated September 13, 2013)
4) "Toward Formulating the FY 2014 Budget for Science and Technology" (Decision of the Council for Science and Technology Policy dated November 27, 2013)
5) "Follow-Up on the Comprehensive Strategy on Science, Technology and Innovation" (reported by the Council for Science and Technology Policy dated April 14, 2014)
The follow-up in April this year was carried out by ensuring that the content of the comprehensive strategy first formulated last year is actually reflected in this year's budget. Each measure was updated to formulate the comprehensive strategy for FY 2014 with help from relevant ministries, agencies, and experts.

Promotion Program (SIP) and Impulsing Paradigm Change through Disruptive Technologies Program (ImPACT), which are the two “National Emphasis Program” to open the way to the future of our country and will be strongly promoted by the entire government through collaboration between government, industry, and academia.

5) Reforming innovation creation environment

In order to transform our country to “the world’s most innovation-friendly country,” the government has considered the comprehensive reform of the environment for innovation together with the Council for Science and Technology Policy with a view to optimize each area of “people,” “fund,” and “system” from the perspective of Japan as a whole beyond the boundary between academia and industry.

These activities are still ongoing toward the reconstruction of a new policy for science, technology and innovation, which has been carried out in earnest since last year. For example, SIP and ImPACT in the above 4) have just entered the execution stage after systems have been developed. The government will further accelerate and enhance these activities from now on.

(3) Reinforcing of the Headquarter Function of the Council for Science and Technology

While the importance of innovation increases and the creation of the world’s most innovation-friendly country becomes an important policy challenge, the whole government is enhancing the function of the Council for Science and Technology Policy as the headquarter.

Specifically, it has been promoted in the three aspects of policy, budget, and legal system.

<Policy measures>

(a) Systematization and prioritization of the whole policy on science, technology and innovation based on the science and technology basic plan and the comprehensive strategy.
(b) Establishment of the annual PDCA cycle in direct connection with budget based on the comprehensive strategy.
(c) Promotion of the two pillars of “National Emphasis Program” (SIP and ImPACT).

< Budgetary provision>

(d) Prioritization and summarizing policy measures through resource allocation policy and action plan, etc.

(e) Collaboration and coordination of relevant ministries through the Science and Technology Budgeting Strategy Committee.

< Law revisions>

(f) Reinforcing the functions of the Council for Science and Technology Policy and the secretariat. (Revision of the Act for Establishment of the Cabinet Office[3])

In particular, (c) the two pillars of National Emphasis Program (SIP and ImPACT) and (e) the budget strategy meeting for science, technology and innovation are important and effective methods for the council to display its headquarter function. They are "three arrows" to enhance its headquarter function and will continue to be carried out from now.

2. Basic Directions of Science, Technology and Innovation Policy

(1) The Three Roles of Science and Technology Innovation

The government has strongly promoted the science, technology and innovation policy based on the above-mentioned basic directions since last year. Science, technology and innovation are expected to play the following three roles in today's economic society of Japan.

1) Driving force for ensuring economic revitalization

Japan's economy is gradually recovering and showing a positive sign that the country is breaking away from deflation. However, for continuous economic growth, it is essential to promptly bring the economy back on track for further growth, enhance the growth potential, and realize a positive-growth cycle to ensure economic revitalization. Science, technology and innovation are the core driving force, and high expectations continue to be placed on the role that the

[3] "Partial Revision of the Act for Establishment of the Cabinet Office" (enforced on May 19, 2014). The name was changed from the Council for Science and Technology Policy to the "Council for Science, Technology and Innovation," and investigation and deliberation duties on the promotion of innovation were added to its function. The function of the council as a leader in the field was enhanced, and the Secretariat's function of the Cabinet Office to support the council was also strengthened.

field can play.

2) Breakthrough of sustainable development in the future

Considering the situation from a long-term vision, Japan will face serious population decrease and an aging society with a falling birthrate. In addition, severe limitations on resources and energy and a difficult international economic environment are anticipated. In order to secure international competitiveness and continuously develop the country, there is no option other than focusing on innovation. For this reason, it is necessary to make Japan the world's most innovation-friendly country and the world's most active source of innovation.

3) Decisive factors for enhancing presence in international economic society

In order to raise the profile of Japan in today's global economy, the field of science, technology and innovation is a powerful tool. For Japan, which lacks strength in population, size, and resources compared to other countries in the world, it can be said that its excellence in human resources and technological skills is the source of Japan's national strength. For Japan in the world and Asia, it is necessary to secure income and employment by attracting the rest of the world to Japan as the innovation hub with the world's top-level technological strength. It is also necessary to contribute to the international community through solutions to global environmental issues by utilizing the world's highest-level technological strength.

(2) Recent Movement Surrounding Science, Technology and Innovation

In considering the directions to be taken for the policy on science, technology and innovation, it is necessary to acknowledge the following three points in the background.

1) Shifting from recovery/revitalization of economy to achieving sustainable growth

Although Japan's economy has been gradually recovering recently, it is necessary to continue to have a sense of crisis and work at economic recovery without complacency. At the same time, it is required to manage policy while bringing into view the next stage, which is to put Japan's economy on track for sustainable growth in the medium and long term. Furthermore, while the urgency of achieving fiscal soundness increases more and more, it is essential to

attain sustainable economic growth led by private sector.

2) Shifting to economic growth led by science and technology

Japan's economy, especially in manufacturing industry, has been centered on the "industrial economy model," which is centered on advancement of industrial technology and productivity enhancement. The process innovation and product innovation created in the model have shown high performance and served as Japan's strength in industrial competitiveness.

However, in recent years, as shown in regenerative medicine from the most advanced research including iPS cells, in the field observed as the promising new industry, the "science economy model" centered on the knowledge of science and technology is becoming increasingly important, and contributions made by science and technology are more directly influencing economic growth and the enhancement of industrial competitiveness. There have been more and more cases where groundbreaking science innovation born from fundamental research to understand scientific principles gave rise to business innovation, and the connection between the two caused industrialization.

In this situation, it is becoming difficult for companies to develop all technologies by themselves. More expectations are placed on cooperation among industry, academia, and government as well as open innovation.

In line with this, in order to fuse science innovation and business innovation and strengthen this fusion, it is becoming increasingly important in the policy to develop the fundamental research ability to find science and technology seeds and to enhance the function to link the seeds with industrialization.

Core technologies such as IT and nanotechnology are expected to bring results from the fusion of industries rather than contributing to the development of a single industry. Therefore, an issue for our country is how to foster and promote such core technologies.

3) Entering the full-fledged mega competition of "knowledge"

As some overseas countries have already been promoting innovation as part of their national strategy, companies and industries or universities and individual researchers in Japan are being involved in intense global competition. Aiming for "the world's most innovation-friendly country," our country is also required to work on the promotion of science, technology and innovation in earnest as part of the national strategy.

(3) Future Direction of Science, Technology and Innovation Policies— The Focus of the Formulation of the Strategy

The three roles of science, technology and innovation shown in the above (1) are all important, but considering the situation described above, it is necessary to manage policy by (1) securing economic recovery and (2) focusing on the role as breakthrough for sustainable development.

If we compromise in the effort to create “the world’s most innovation-friendly country,” there will be no sustainable development of our country for the future. In addition, when science, technology and innovation grow stagnant, the foundation to support the wealth, safety, and security of people’s lives can be threatened. In short, science, technology and innovation are Japan’s “anchor” and “driving force” toward the bright future of the country. Japan is therefore required to work on science, technology and innovation as part of the national strategy. While fully taking into consideration the financial conditions, the cost needs to be regarded as “advance” and “preemptive” investment required to be borne by the country as a whole. Rather, the government needs to ensure that the realization of economic growth led by the private sector through promotion and utilization of science, technology and innovation will contribute to financial reconstruction as a result through increase in tax revenues and control of expenditures.

The promotion of science, technology and innovation is not limited to activities to solve difficult problems we are facing. “Proactive” activities to create a bright and lively future are also important. For example, Tokyo can be a showcase of the world’s cutting-edge innovation when the city hosts the Olympics and Paralympics in 2020. Innovation created in Japan can be spread to the rest of the world, and people’s life, which has become more convenient and more comfortable through innovation, can be advertised in a tangible form as an “advanced country of innovation.” This is also an opportunity to proudly declare that Japan has transformed into “the world’s most innovation-friendly country” and “the world’s leading innovation hub” while acknowledging that science, technology and innovation is the special field that continues to give hopes and dreams to people. Japan will promote this type of “proactive” project as a country. The essence of innovation is “challenges” and “interactions.” In other words, in order to create innovation, it is essential that highly motivated capable individuals work unflinchingly on the challenge of creating “knowledge” and that the process creates interactions and reactions across different fields and organizations. To establish an environment to create innovation, the innovation system including

national universities and research and development corporations needs to be boldly reformed.

For that purpose, toward the realization of sustainable future development based on innovation, we need to remember that not only challenging activities are carried out on the site of research and development of science and technology or the government's policy support, but also change in awareness and new challenges with unflinching investment for future while taking risks are required and need to be supported by society as a whole.

(4) Six principles required for managing science technology and innovation policies

It is essential to focus on the following six principles in strongly promoting the policy on science, technology and innovation. Just as last year, the strategies will be formulated based on these.

<Principle 1> Build strategies with clear time frame and goals

<Principle 2> Conduct comprehensive policy management grasping the whole picture of science, technology and innovation

<Principle 3> Produce policies seamlessly covering the "upstream" and "downstream" research and development stages from the "upstream" through to the "downstream".

<Principle 4> Clarify the role of each player and establish collaboration between industry, academia, and government

<Principle 5> Coordinate and combine various policy measures

<Principle 6> Evaluate and revise the policy measures through annual PDCA process, which is directly connected to budgeting

(5) Three perspectives for promoting the science, technology and innovation policies

As to the solution of the five policy challenges (energy, good health and longevity, next-generation infrastructure, local resources, reconstruction) in science, technology and innovation, initiatives will be carried out based on the three strategic perspectives of the "shift to high functionality," "systematization," and "globalization" followed by last year's comprehensive strategy.

<Perspective 1>"Acting Smart" > "Aim at making each industry knowledge-based"

IT becomes the key to open up various potentials in the future by introducing and utilizing it in each field. Initiatives will be carried out with a view to shift a whole industry into knowledge industry or to transform the way society is rather than simply improving the efficiency, energy saving, and productivity, by not only linking information but also accumulating and utilizing information through IT.

<Perspective 2> Implementing system thinking > "Double the value by combining "strengths"

Although Japan has many products and technologies that are the number one or the only one in the world, there are some cases where suitable market share is not obtained. Competitiveness in market will be secured through market expansion by combining and systematizing advantageous products and technologies and adding high values.

<Perspective 3> Thinking global > "Look higher and into the world"

We need to bear in mind the fact that overseas countries are strongly promoting their policy packages to encourage innovation as part of their national strategies, and the great international competition of "knowledge" is being carried out. In addition, companies, research institutes, and local authorities need to become aware of the global competition and take proactive actions for overseas expansion by expanding their views to the world market. Furthermore, we need to make our country the world's platform for science, technology and innovation by not only expanding products and skills to overseas countries but also receiving human resources, skills, and funds from abroad.

(6) The Characteristics of the Formation of the Strategies

The strategies are formulated with the following characteristics.

First, the strategies have a long-term vision including the overview of the policy on science, technology and innovation (the ideal state of the economic society, policy issues, and goals) and a short-term action plan, which shows the measures to achieve them in a timetable. The long-term vision shows the ideal state of Japan's economy from the perspective of science, technology and innovation for the target year of 2030, and the timetable shown under the timeline describes specific measures to be carried out and interim targets for the solution of policy issues and the achievement of targets, which makes the PDCA cycle viable.

Second, the strategies are the comprehensive policy package for the solution of problems as well as the package to establish an environment as the infrastructure to create innovation.

Third, the strategies are the strategies of the whole country, and each of researchers, companies, universities, research institutions, and the people of the nation is playing the leading part and has an important role and responsibility. For this reason, the role of each field is clearly indicated with the idea of collaboration between government, industry, and academia, and the government also indicates the ministries and agencies responsible for the measures and shows various policy combinations including budget, tax system, financing, and regulatory reform as policy measures.

3. Future of Japan Created through Science, Technology and Innovation—Japan's ideal economic society realized in 2030 (Long-Term Vision)

The trend of the medium- and long-term change of the situation that Japan is bound to face toward 2030 is expected to be as follows: 1) A declining population and rapid aging in Japan; 2) Explosive development of knowledge society, information society, and globalization; 3) Increase of issues that threaten sustainability of the earth (population, natural resources and energy, climate change and environment change, water and food, terrorism, infectious diseases); 4) Structural changes in the international economic society due to rapid growth of emerging countries; 5) Increased urgency for preparation against natural disasters. With the tide of these changing times, what is the state of economy that Japan should aim for? The strategies aim for the following three ideal states of economy just as last year.

(1) Economy that maintains the world-top-class economic strength and develops sustainability

When innovation is actively created, the vitality of our country's industry and international competitiveness will be maintained and strengthened, which will help industrial activities expand dynamically and globally. In this way, Japan establishes its international position by winning not only demand but also trust from Japan and abroad. The employment and income to support the lives of people will be adequately secured due to the above situation. The negative factors of economic growth such as decrease in labor force population will no

longer be regarded as issues in economic activities because science and technology will complement those negative factors. The restriction of resources and energy is not a burden for growth, and energy is supplied and used safely, constantly, and efficiently. Revitalization of economy and initiatives for both revenue and expenditure are successful and the financial condition is improving. In each region, their unique “strength” is fully displayed with vitality where people can lead a high-quality life at ease and a globally attractive economy will have been established.

(2) Society where the people can enjoy wellness, security and safety

People are feeling that their standard of life is maintained and improving and a sustainable and dynamic society is realized even with population decrease, low birthrate, and an aging population. An environment where women and young people can fully display their capabilities will have been established. People are enjoying healthy, wealthy, and happy lives. In particular, the elderly are active and having a comfortable life at ease. There will be no health inequalities, and people can smoothly return to society while recovering from an illness or injury, or live at ease while alleviating pathology or disability. The whole country is enveloped with reassurance, and everyone is planning their life looking toward a bright future. Furthermore, the next-generation infrastructure will have been established, and people are assured of the security of their lives and properties from natural disasters.

(3) Economic society that harmonizes with the world and contributes to the progress of humankind

Japan will have become an exemplar to the world as an advanced country in terms of the issue of low birthrate and aging population and is living together with the international community. A low-carbon society that is friendly to people and environment and protects the global environment will have been established. Japan will be pioneering the world’s frontier of “knowledge” and contributing to the future of humankind. By producing various human resources who are active on the global stage, Japan will have established its position as “the human resource-based nation” and will have become a dynamic economic society and a platform that attracts people, goods, capital, and knowledge from the world.

While considering 2020, when Tokyo hosts the Olympics and Paralympics, as a halfway point toward the ideal state of Japan’s economic society in 2030, we will

set interim targets to be achieved and create innovation that is appropriate for an “advanced country of innovation” and actively transmit it at home and abroad.

Chapter 2 Challenges to Be Addressed by Science, Technology and Innovation

The Council for Science, technology and innovation has managed the policy based on the comprehensive strategy on science, technology and innovation decided by the Cabinet Office in June 2013 and has tried to create a new dimension of Japan. In order to strongly promote the urgent issue of economic recovery, the council has set the following five policy challenges that the policy on science, technology and innovation should focus on at the moment: I. Realization of a Clean and Economical Energy System, II.Realization of a Healthy and Active Aging Society as a Top-runner in the World, III.Development of Next-Generation Infrastructure as a Top-runner in the World, IV.Fostering of New Industries by Utilizing Regional Resources, V.Recovery and Reconstruction from the Great East Japan Earthquake. In order to contribute to the above five issues, the council led the optimization of resource allocation. Specifically, they set up the budgeting strategy committee as a control function, put together the measures of ministries before each ministry makes a budget request to avoid duplications, established the measures to be carried out through collaboration of a few different ministries in order to adjust and implement the content of implementation items by adjusting operations between ministries, and assigned them to measures in the action plan with a detailed timetable.

In connection with the induction of those measures, the council has also set up the Cross-Ministerial Strategic Innovation Promotion Program (SIP), where the Cabinet Office holds the budget and leads the measures with a top-down approach, and has established a strong cross-ministry system for the solution of the policy challenges. Although they established the annual PDCA cycle directly linked to the budget, it is necessary to link them with the “virtuous cycle of growth” by running the PDCA cycle with the detailed timetable from now, accelerating activities further and adding more activities from a fresh perspective so that the result of research and development can cause innovation in private-sector companies and will lead firmly to the enhancement of industrial competitiveness through the solution of the five policy challenges.

Thus, the Council for Science, Technology and Innovation formulates the comprehensive strategy on science, technology and innovation based on the following three perspectives to accelerate activities for the solution of the policy challenges.

(1) Taking Initiatives on the Solution of Integration Issues and the Cross-Ministry Measures and through Programming

Since the five policy challenges to be worked on through the comprehensive strategy involve various cross-ministry factors and the way to the solution is complex, it is necessary to consider all kinds of technology, knowledge, and the way to transform the economic and social system altogether and enhance the initiative by integrally regarding them as integration issues. In addressing the issues, it is required to nurture the field, which had not been regarded as a growth field, as a growth engine and develop the field in a package by considering overseas markets as the target. The policy challenges should be understood in this context.

Until now, each ministry was suggesting their measures for the presented policy challenges from their point of view and the measures were put together after adjusting them. However, from now on, the Council of Science, Technology and Innovation will be regarded as the leader that takes initiatives on the solution of policy challenges on the SIP measures that the council themselves implement. In a manner to flesh out this style, it is required to use every single measure of each ministry. As to cross-ministry measures that have been "put together," it is necessary to further enhance and develop the cooperation so that the "programmed" collaboration will thoroughly take place not only in the area of issues in research and development but also in the areas of regulation reforms, strategies on international standardization, and intellectual property. At the same time, it is required to clarify the bottleneck in the implementation of the research result for individual cases while liaising with the industry and pave the sure way for industrialization.

In proceeding with measures for each policy issue including SIP, it is important to apply policy management from the perspective of the creation of the environment that suits science, technology and innovation as shown in Chapter 3. For example, by building "a framework for cooperation beyond the boundaries of vertically divided administrative functions of government agencies and of industries, universities, and government and network-type bases," we will create an innovation hub. In the measures for research and development related to the next-generation storage battery and structural materials, which should be carried out in the all-Japan system, we have established the collaboration system for government, industry, and academia by regarding research and development corporations as a hub and we are promoting fundamental research from the perspective of the exit (problem-addressing-type fundamental

research). This system is expected to play an important function to create and develop innovative seeds. It is required to further strengthen the system as a pilot scheme, and this type of collaborative environment will also be introduced to other important measures.

(2) Advancing Cross-cutting Technology

Although resource allocation is currently focusing on the five policy challenges that the comprehensive strategy should work on, it does not clearly state the importance of cross-cutting technology, which will be applied to each issue as a common base, information and communication technology (ICT) such as information security, big data analysis, robot and control system technology, nanotechnology for developing devices, sensors, and advanced materials with new functions, and environmental technology for earth observation technologies and resource recycling. Since the field of these cross-cutting technologies is the field in which Japan has been excellent and these are the underlying technologies to create Japan's unique innovation for the above five policy challenges, this field will be a source to produce big advantages in enhancing industrial competitiveness in the future.

In line with this, it is necessary to strongly advance the technology itself rather than focusing only on the enhancement and acceleration of the use of cross-cutting technologies to solve issues.

(3) Capitalizing on the Opportunities of the 2020 Tokyo Olympic and Paralympic Games

In order to develop specific items from the above perspective, it is necessary to industrialize the result of research and development with a realistic target, and we should consider effectively using the opportunity of the 2020 Tokyo Olympic and Paralympic Games. In order to maximize the opportunity, we should review the current timetable and accelerate the work on the solution of policy challenges, so that the opportunity will be used to proudly present the innovation from Japan, attracting the wisdom of the world.

Section 1 Policy challenges

I. Realization of a Clean and Economical Energy System

1. Basic Understanding

Japan's situation with electric power energy is heavily relying on thermal power generation due to the shutdown of nuclear power stations caused by the accident at Tokyo Electric Power Company's Fukushima No. 1 nuclear power plant, and the amount of carbon dioxide emissions from power generation is increasing. As it takes a decade to develop, implement, and spread energy technologies, the spread and expansion of new energy sources are expected to take a fair amount of time. For this reason, fossil fuel is important for Japan's energy supply in the medium and long term. Increase in energy demand led by emerging economies is expected to have a major impact on the global environment. In this situation, the Fourth Basic Energy Plan was formulated to indicate a new direction as Japan's energy policy needs to be adjusted on a significant scale.

The essence of the energy policy is to realize constant energy supply, low-cost energy supply by improving the economic efficiency, and also environmental suitability on the premise of safety. From this point of view, in the comprehensive strategy, it is regarded as an important issue in the medium and long term to establish a society where clean energy such as renewable energy is supplied safely and constantly at a low cost to enhance industrial competitiveness and to enable people to lead a rich life in a sustainable way. It is also required to give maximum consideration to environmental burdens such as the emission of greenhouse gases mainly from the consumption of fossil resources and to realize a society where energy consumption is reduced by improving the energy utilization efficiency through innovative materials for energy saving or new technologies. Furthermore, the use of various energy sources can be promoted through the establishment of a society where the integration of an advanced energy network is achieved by organically fusing technologies related to energy available not only in electricity but also in the form of heat and chemicals. The above policy is important to Japan, which is highly dependent on foreign countries for fossil resources, from the perspective of reducing the outflow of national wealth.

The promotion of science, technology and innovation on the issues in the field of energy and the enhancement of international competition on core technologies are expected to contribute to the acquisition of markets by leading the world's industry, the expansion of income and employment through promoting and creating related industries, and the proposal of the new energy system. For that purpose, it is required to focus on the technological development for problem-addressing with a view to optimize the grand design for the future energy system and the whole system in accordance with the direction of policy in the Fourth Basic Energy Plan, which has recently been formulated. Initiatives on science, technology and innovation related to nuclear power will also be carried out according to the Fourth Basic Energy Plan.

2. Focused Policy Challenges

Here, the energy system is divided into three stages, namely production, consumption, and distribution. By considering the characteristics of each stage, the focused policy challenges are set for achieving the "Realization of a Clean and Economic Energy System."

At the stage of energy production, we set the focused policy challenge to "constant and low-cost supply of clean energy." As our country has few natural resources, it is required to safely, consistently, and economically secure the source of primary energy such as renewable energy and fossil resources and efficiently use the energy. In recent years, while the use of renewable energy such as solar power generation has made progress, the technology to complement the instability of output depending on weather conditions is increasingly needed. Another issue is to enhance the competitiveness including innovative technological development to win in the cost competition with overseas products. The development of the technology to supply clean and economical energy with reduced amount of greenhouse gas emissions is also effective in response to climate change. From the perspective of diversification in securing energy resources, the technological development of undeveloped energy such as ocean energy and resources and the energy conversion technology will also be important work to be carried out.

At the stage of consumption, "improvement of energy utilization efficiency and reduction of consumption through new technologies" was set as the focused policy challenge from the perspective of demand. Japan has improved energy

efficiency[4] by 40% since the oil crisis and has contributed to the enhancement of industrial competitiveness. At the time of energy restriction after the Great East Japan Earthquake, Japan reduced energy consumption and leveled power demand at the peak of power consumption. While maintaining and improving the quality of life, products for significant saving of energy and electricity are required. Therefore, it is an important issue to develop and spread the control technology to make the energy consumption on the demand side more efficient by promoting the technological development of innovative devices and structural materials, which will be the base for those products.

From the perspective of the distribution stage, the focused policy challenge was set to "integration of sophisticated energy network." In here, we aim to make energy consumption clean by connecting with the energy network established on the level of a region or a wide area. As a substantial amount of dispersion energy as the supply source is anticipated, in order to overcome the output fluctuation and provide steady energy supply, the energy carrier or the next-generation storage battery to "store" and "transport" energy, the technologies to utilize them, and the energy management technology with information and communication technology (ICT) will become important. In addition, in order to further improve energy utilization efficiency, the improvement of the technology related to the multistage use of energy such as the utilization of low-temperature heat emission is an important issue.

In addition to the promotion of research and development of each technology, in order to promote the above key initiatives, collaboration among different technologies at each stage of energy production, consumption, and distribution based on the comprehensive view to optimize the whole energy system is important. To accelerate the development and spread of the technologies, a comprehensive approach is required in both aspects of software and hardware including compliance to regulations and promotion of standardization.

In particular, as to the technologies to make the energy use highly functional on the side of demand, it is important to make efforts to create supplemental additional values other than energy such as health maintenance and securing of comfort and to make those values visible to the side of demand, and it is necessary to work together with other projects in various fields. For that purpose, "smart city," which will be the key in connecting the energy consumption stage with the distribution stage, will be promoted as a collaborative activity to provide various additional values in "development of next-generation infrastructure as a

[4] Primary energy consumption in GDP.

top-runner in the world."

In the field of energy, through the promotion of collaboration between industry and academia and different organizations, we have the set the following five themes among the SIP issues, which will play a leading role in addressing the issues at each stage of production, consumption, and distribution and contributing to economic growth by utilizing Japan's strengths.

In "innovative combustion technology," we will carry out research and development on combustion technology, which is important in further improving the utilization efficiency of energy resources. The technology is expected to play an important role in the future. We will aim to achieve the target of 50% or more for thermal efficiency by setting the internal combustion engines for automobiles, which plays a part in Japan's key industries, as an exit. By establishing a strong and sustainable collaboration system between industry and academia, which did not exist in our country, centering on this program, we will aim to establish an innovative combustion technology and enhance the international competitiveness.

In "next-generation ocean resources survey technologies," we will develop technologies to efficiently investigate mineral resources in a vast sea area. Our country has the sea area under jurisdiction, which is 12 times or more larger than the country's land area, and the existence of mineral resources in the sea area has been confirmed. However, the technology to efficiently investigate the vast sea area is still under development. In this program, we will establish investigation technologies ahead of the world through collaboration among government, industry, and academia under the leadership of the Cabinet Office and will contribute to Japan's development of ocean resources, environmental conservation, and resource security with a view to create the investigation industry of ocean resources and promote international standardization, which can be launched into the world.

In "next-generation power electronics," we will accelerate the creation of the next-generation industry of power electronics, which is expected to grow significantly in the world market and is also the key technology for energy saving. In order to secure Japan's international competitiveness, we will establish the base of research and development for collaboration between industry and academia and conduct research and development on the foundation toward the enhancement of core technologies in power electronics. By sharing the base for research and development to be established and the result and knowledge to be gained in this

program as fundamental technologies, we will further enhance the industrial competitiveness and promote the contribution to energy saving.

In “innovative structural materials,” we will work on the technological innovation related to the structural materials that play an important role supporting our country’s whole industry, while increasing presence in the export industry with particularly strong international competitiveness. Under the leadership of the Cabinet Office, we will establish a research and development structure and system to realize implementation in society in the shortest period of time from the research and development stage by gathering expertise and knowledge from government, industry, and academia and promoting exit-oriented research and will create technologies for innovative structural materials. This will not only strengthen Japan’s competitiveness but also greatly contribute to energy saving and reduction of greenhouse gas emissions in the world.

In “energy career,” toward the solution of the issue to achieve both diversification of energy sources and reduction of greenhouse gas emissions in Japan, which is highly dependent on overseas countries for energy sources, we will establish the technology to produce, transport, and store hydrogen and will aim to achieve the same level of cost competitiveness as fossil fuels. The work will involve various participants from ministries, industry, academia, local governments, and others, and it is essential to enhance collaboration and coordinate the progress of measures. For this purpose, the Cabinet Office will play the comprehensive coordination function and carry out research and development flexibly and strategically and steadily promote activities toward the realization of the goal while integrating each type of introduction scenario for each.

Realization of a Clean and Economical Energy System

Focused Policy Challenges	Focused measures
Stable and low-cost supply of clean energy (Production)	(1) Increase of the supply of renewable energies through innovative technologies
	(2) Realizing highly efficient and clean innovative technologies for power generation and combustion
	(3) Diversifying sources and resources of energy
Improved utilization efficiency and consumption reduction through	(4) Efficient energy utilization through the development of innovative devices
	(5) Efficient energy utilization through the development of innovative structural materials

new technologies (Consumption)	(6) Sophisticating technologies for energy utilization on the demand side
Integration of Advanced Energy Network (Distribution)	(7) Establishing network systems to promote diverse energy utilization
	(8) Sophisticating innovative technologies for transformation, storage and transportation of energy

3. Focused Measures

[Attached table Timetable: Energy]

(1) Increase of the supply of renewable energies through innovative technologies

[Timetable Energy (1)]

1) Details of the measure

In this measure, we will promote research and development of electric power production and supply, which is suitable to expand the use of renewable energy, storage of electricity, heat utilization, devices related to heat recovery, system technology, network technology, and the optimization of regional characteristics. We will promote floating offshore wind power generation, which is expected to bring potential energy quantity of natural resources through utilizing regional characteristics and weather conditions, innovative solar battery, highly efficient geothermal power generation, installation methods, and maintenance skills with a view to significantly enhance the economy and conversion efficiency of systems using renewable energy and will promote efforts to complement the instability of output depending on weather conditions, etc. The measure is to realize a society that fully utilizes clean renewable energies.

[Cabinet Secretariat, Ministry of Internal Affairs and Communications (MIC), Ministry of Education, Culture, Sports, Science, and Technology (MEXT), Ministry of Agriculture, Forestry, and Fisheries (MAFF), Ministry of Economy, Trade, and Industry (METI), Ministry of Land, Infrastructure, Transport, and Tourism (MLIT), Ministry of the Environment (MOE)]

2) Main measures toward social implementation

- Establishment of environment, regulations, and systems related to installation and security of renewable energy systems.
  [Cabinet Secretariat, MAFF, METI, MLIT, MOE]

- Promotion of international standardization of technical standards, authentication systems, etc., pertaining to strengthening of international competitiveness.
  [MIC, Ministry of Foreign Affairs (MOFA), METI, MLIT, MOE]
- Promotion of activities related to ensuring social acceptability.
  [Cabinet Secretariat, MIC, MAFF, MLIT, MOE]

3) Goals to be achieved by 2030

○ Solution of technical issues with renewable energy and popularization.

- Achieve practical use of the floating offshore wind power generation by around 2018 and create a world market for it.
- Partially achieve the practical use of the next-generation photovoltaic power generation technology and the cost of solar power generation of 14 yen per kWh by 2020 and achieve the power generation cost of 7 yen or less per kWh after 2030.
- Obtain 70% of the world market with geothermal power generation turbine in 2030.
- Reduce the cost of ocean energy systems. (Achieve 40 yen per kWh after 2020.)

(2) Realization of Highly Efficient and Clean Innovative Technologies for Power Generation and Combustion

[Timetable Energy (2)]

1) Details of the measure

In this measure, we will promote research and development to reduce environmental burdens by improving the combustion efficiency of thermal power generation and internal combustion engines, the energy conversion efficiency through high temperature, the efficiency of fuel cell power generation, and energy utilization efficiency through upgrading by using thermal cascading. We will also aim to establish clean fossil resource energy systems together with the practical use of the technology to collect and retain carbon dioxide. Furthermore, we will contribute to the global environmental protection by improving the international competitiveness through the realization of innovative technologies of power generation and combustion and globally expanding the technologies with a comprehensive approach including administrative work such as compliance to regulations. Through the measure related to the advancement of the power generation and combustion technologies, we will realize a society

where both stable supply of energy and reduction of environmental burdens are achieved.
[Cabinet Office, MEXT, METI, MOE]

2) Main measures toward social implementation

- Establishment of legal systems (e.g., promoting, licensing) for practical application.
  [MAFF, METI, MLIT, MOE]
- Promotion of international standardization of the technical standards, authentication systems, etc., pertaining to strengthening of international competitiveness.
  [Cabinet Office, MOFA, METI, MOE]

3) Goals to be achieved by 2030

○ Practical application of innovative high-efficiency power generation systems and application of CO_2 capture and storage technologies.

- Achieve practical use of the 1700 °C class gas turbine by 2020 and promote its introduction and export.
- Achieve practical use of the advanced ultra-supercritical thermal power generation and the highly efficient and the integrated coal gasification combined cycle with high reliability in the 2020s, and promote the introduction and export.
- Achieve practical use of the integrated coal gasification fuel cell combined cycle in the 2030s.
- Improve the efficiency and durability of the stationary fuel cell and introduce to the market 1.4 million units in 2020 and 5.3 million units in 2030.
- Achieve the practical use of technology to separate, collect, and retain carbon dioxide by around 2020.

○ Establish innovative combustion technology and reduce the amount of carbon dioxide emissions.

- Establish the elemental technology that will contribute to significant improvement of the maximum combustion efficiency by around 2020. (The maximum thermal efficiency with an internal combustion engine will be 50% or more.)
- Reduce the amount of carbon dioxide emissions from clean diesel automobiles by 30% in 2020 and by 40% in 2030 (compared to the

amount in 2010).

- Achieve the percentage of 20% to 50% in 2020 and 50% to 70% in 2030 for next-generation automobiles in new vehicle sales.

(3) Diversification of Sources and Resources of Energy

[Timetable Energy (3)]

1) Details of the measure

In this measure, we will carry out research and development for the commercialization of energy sources and resources that are not currently utilized. In particular, resources in sea areas surrounding Japan have the potential to dramatically raise the degree of self-sufficiency when commercialization is realized. We will promote research and development of the technology to search and produce seabed resources such as methane hydrate and communication technology related to this, and will promote development of the technology to effectively use low-grade coals and the development of transport and storage technologies while assessing the environmental impact. We will research and develop the innovative catalyst technology to efficiently produce energy and chemicals from various materials such as shale gas, unconventional oil, and carbon dioxide and the technology to produce energy resources from microorganisms and biomass. By promoting them while ascertaining the economic rationality, we will aim to realize a society with improved energy self-sufficiency rate and advanced energy security.
[Cabinet Office, MIC, MEXT, MAFF, METI, MLIT, MOE]

2) Main measures toward social implementation

- Evaluation of impacts on the seafloor environment.
  [Cabinet Office, MEXT, METI, MOE]
- Establishment of environment to support ocean resources development (e.g., establishment of activity bases, securing marine interests)
  [MLIT]

3) Goals to be achieved by 2030

○ Contribution to materialization of diversification of energy sources.

- Prepare the technology to realize the commercialization of methane hydrate by FY 2018 and proceed with the technological development so that projects for the commercialization led by private-sector companies will start between 2023 and 2027 while watching the international situation.

- Assess the economic efficiency of submarine hydrothermal deposits by FY 2018 and carry out the technological development, so that projects for commercialization joined by the private sector will start after 2023.
- Put prospects on the commercialization of the innovative catalyst technology by 2030.

(4) Efficient Energy Utilization through the Development of Innovative Devices

[Timetable Energy (4)]

1) Details of the measure

In this measure, we will promote the research and development and systematization of ultra-low-loss power devices (SiC, GaN, etc.), which significantly reduce the power consumption of motors and information devices, ultra-low-power-consumption semiconductor devices (three-dimensional semiconductor, nonvolatile elements, etc.), and optical devices to advance the technology to efficiently utilize electricity, and will contribute to the significant reduction of energy consumption by expanding the application of the technologies to devices in the transportation, industrial, and consumer sectors. Furthermore, bearing in mind the international expansion of the technology, we will create a new market for products with innovative devices and enhance Japan's international competitiveness through initiatives related to the promotion of popularization including the promotion of international standardization in parallel with the technology development. With this measure, we will realize a society with the advanced technology for efficient energy use, which is intended to expand internationally.
[Cabinet Office, MIC, MEXT, METI, MLIT, MOE]

2) Main measures toward social implementation

- Promotion of international standardization, normalization, and authentication systems from the technology development stages in order to assist international expansion.
  [Cabinet Office, MIC, MOFA, MEXT, METI, MLIT, MOE]

3) Goals to be achieved by 2030

○ Improvement in energy efficiency and reduction of energy consumption through innovative devices.

- Realize full-scale industrialization of the next-generation power electronics

with new materials by 2020.

- Realize new high-performance magnetics that are stronger than the current magnets by 2020 and realize energy-saving motors with high energy efficiency.

○ Increase energy efficiency and reduce energy consumption by innovative electronic devices.

- Realize the technology of normally off computing, which is about ten times more power efficient.
- Realize the ultralow power of devices.
- Achieve practical use of the technology of three-dimensional packaging of semiconductor chips.
- Achieve practical use of the photoelectric hybrid system.
- Achieve practical use of the ultrafast and low-power-consumption optical communications.

(5) Efficient Energy Utilization through the Development of Innovative Structural Materials

[Timetable Energy (5)]

1) Details of the measure

In this measure, we will develop new materials including carbon-based materials (such as carbon fibers), metal materials (such as magnesium and titanium), and innovative steel plates, and we will research and develop the design and juncture technology that is suitable for the material characteristics. By adopting these highly functional materials to transport equipment of high energy consumption, we will improve energy saving effects through weight reduction and prolonged life of the equipment. Furthermore, we will expand and spread the technology by promoting the formulation of standardization and safety assessment methods and the authorization methods according to the field to which the technology will be applied and promoting the measures to encourage the introduction by regulations and standards. With this measure, we will realize a society with advanced technology for efficient energy use, which is intended to expand internationally.

[Cabinet Office, MEXT, METI]

2) Main measures toward social implementation

- Promotion of international standardization, normalization, and authentication systems from the technology development stages in order to

assist international expansion.
[Cabinet Office, MOFA, MEXT, METI, MLIT]

- Promote energy saving through the top-runner system.
[METI, MLIT]

3) Goals to be achieved by 2030

○ Improvement in energy efficiency and reduction in energy consumption through innovative structural materials.

- Contribute to the increase of the energy utilization efficiency of transport equipment (automobiles and aircrafts) through dramatic weight reduction and prolonged life of structural materials.
- Establish and standardize the technology to evaluate the characteristics of the new materials.

(6)Sophisticating Technologies for Energy Utilization on Demand Side

[Timetable Energy (6)]

1) Details of the measure

In this measure, we will research and develop the technology to promote the improvement in energy utilization on the side of demand in the unit of community including houses and buildings. In particular, while focusing on houses and buildings, where energy consumption has been increasing since the oil crisis, we will promote research and development related to efforts to promote energy saving and the shift to high functionality in utilizing energy with the technology of storage battery. We will also carry out development and demonstration toward the establishment and realization of a smart community in a region with highly functional houses (smart houses) and buildings (smart buildings). In order to popularize these technologies, we will encourage the introduction with regulations and standards and will aim to expand those technologies to the world by packaging them with initiatives related to the promotion of international standardization. We will also promote technology development related to the increase in energy utilization efficiency in the production process at plants and factories. With this measure, we will aim to create a society where autonomous and stable energy supply and demand are realized.

[MIC, MEXT, METI, MLIT, MOE]

2) Main measures toward social implementation

- Promotion of international standardization, normalization, and authentication systems from the technology development stages in order to assist international expansion.
  [MIC, MOFA, MEXT, METI, MLIT, MOE]
- Promotion and expansion of international standards for energy management system, environmental protection, etc..
  [METI, MLIT, MOE]
- Promote energy saving through the top-runner system.
  [METI, MLIT]
- Relax the regulations that form a bottleneck in system integration and commercialization, and develop a system.
  [MIC, MAFF, METI, MLIT, MOE]

3) Goals to be achieved by 2030

○ Improve energy utilization in houses, buildings, and communities.

- Realize ZEH[5] in typical new houses by 2020 and in average new houses by 2030.
- Realize ZEB[6] in new public buildings by 2020 and in average new buildings by 2030.
- Realize the environment where electric power demand can be significantly controlled at peak times in the early 2020s through the popularization of smart meters and the reform of the electric power system.

○ Establish the technology of innovative energy saving process.

(7) Establishing Network Systems to Promote Diverse Energy Utilization

[Timetable Energy (7)]

1) Details of the measure

In this measure, we will establish a wide-area energy network where a backbone energy network, renewable energy including sunlight and biomass, and local energy networks such as thermal energy utilization systems are combined.

[5] Net zero-energy house: A house where the net amount of the annual primary energy consumption becomes zero through the combination of high heat insulation performance, high-performance facilities and control mechanism, etc.

[6] Net zero-energy building: A building where the net amount of the annual primary energy consumption becomes zero by reducing the amount of the primary energy consumption through the enhancement of the energy-saving performance of the building and facilities, the use of regional energy network, and the use of renewable energy on-site.

In particular, we will promote research and development to establish an advanced network system for energy utilization by using information and communication technology, large-scale battery technology, and load control technology, which are the technological elements related to power systems to support the introduction and expansion of renewable energy, which has large power variations. For further increase in energy utilization efficiency, we will also improve technologies to use cogeneration, which produces both heat and electricity, and to use the energy that has not been utilized such as low-temperature heat emission. With this measure, we will realize a society where the energy network system to promote various types of energy utilization is established.
[MIC, MEXT, MAFF, METI, MLIT, MOE]

2) Main measures toward social implementation

- Establishment and expansion of the framework for wide-area application including municipalities.
  [Cabinet Secretariat, Cabinet Office, MIC, MEXT, MAFF, METI, MLIT, MOE]
- Promotion of international standardization for system components and system technologies.
  [MIC, METI, MLIT]
- Establishment of regulations and systems that become bottlenecks for integration or commercialization of the system.
  [MIC, MAFF, METI, MLIT, MOE]

3) Goals to be achieved by 2030

○ Implementation of advanced technologies related to power systems.

- Establish the technology of the energy information communication network.
- Reduce the cost of batteries for power systems to 23,000 yen or less per kWh in 2020.

○ Popularization of renewable energy, cogeneration, etc.

(8)Sophisticating Innovative Technologies for Transformation, Storage and Transportation of Energy

[Timetable Energy (8)]

1) Details of the measure

In this measure, we will promote the technology development to safely and economically convert, store, transport, and use energy in the form of electric energy, thermal energy, or chemical energy to complement temporal

fluctuations and spatial deviations in supply and demand in the use of dispersed energy sources. In particular, we will promote research and development of the technology to use energy carriers that store and transport secondary energy such as hydrogen by converting it to chemical substances; the next-generation battery, which effectively stores electric energy; the thermoelectric conversion technology, which corresponds to thermal energy by storing, insulating, and collecting heat; and the technology of power transmission by superconductivity, which reduces transmission loss. While formulating the introduction scenario related to the advanced technology, ascertaining research and development against the scenario, and carrying out research and development and relaxation of regulations according to the progress of technologies, we will steadily proceed with the measure toward the realization of a society where the technology to convert, store, transport, and utilize energy is established to promote the utilization of clean energy.
[Cabinet Office, MIC, MEXT, METI, MLIT, MOE]

2) Main measures toward social implementation

- Mitigation of regulations and inspection and review of safety standards which become bottlenecks of industrialization.
  [Cabinet Office, MIC, METI, MLIT]
- Promotion of international standardization, normalization, and authentication systems from the technology development stages in order to assist international expansion.
  [MOFA, MEXT, METI, MLIT]

3) Goals to be achieved by 2030

○ Diffusion and development of hydrogen infrastructure.
- Establish basic technologies on new energy carriers.
- Develop hydrogen infrastructure.
- Reduce the cost of hydrogen stations.
- Establish the technology to assess safety.

○ Implementation of next-generation battery technologies.
- Companies in Japan to obtain 50% (20 trillion yen) of the world battery market.

○ Achieve the practical use of high-performance insulation materials, heat storage materials, and the technology of heat management.

○ Implementation of superconductor electricity transmission technologies.

II. Realization of Healthy and Active Aging Society as a Top-runner in the World

1. Basic Understanding

Japan has become a super-aged society ahead of the world. The change in the composition of population has already had various impacts on Japanese society and economy, but it is expected that the impact will further increase in broader sectors than today.

The recent progress in science and technology brought about globally innovative medical technologies in succession, and Japan is also expected to create innovation in the medical field. Especially in medical research, which aims to control diseases and establish a healthy society, the Goal is to develop medical technologies to be utilized in clinical sites. In order to apply the research results of basic science to triumph over disease, we need to establish a circulation between basic research and clinical sites.

Based on this social background and the role of medical research, the urgent issue is to promote the development of world's cutting-edge medical technologies by expanding Japan's fundamental scientific research, realize the extension of healthy longevity through medical care by applying the research results, and secure the sustainability of health-care systems.

At the same time, it is required to develop industries related to the field of medical and health care as the strategic industry and show the world an example of overcoming a super-aged society through contribution to economic growth. These concerns led to the consideration of measures on research and development for new medical fields, and specific activities have started.

For this reason, on August 2, 2013, the Cabinet decided to establish the Office for Health Care and Medical Strategy inside the Cabinet, which is led by the Prime Minister and will be the headquarter function in the promotion of growth strategies related to health care and also in the research and development in the medical field.

On August 8, 2013, the Office for Health Care and Medical Strategy decided to hold a specialist committee meeting on research and development in the medical field in order to carry out investigation and review on technical items related to the formulation of comprehensive strategies on research and development in the medical field from scientific and technical perspectives. Since

then, the specialist committee has had reviews and formulated the "comprehensive strategy on research and development in the medical field (report)" on January 22, 2014.

Furthermore, on May 23, 2014, the Act to Promote Health Care and Medical Strategy, which is to legally establish the Office for Health Care and Medical Strategy, and the Independent Administrative Institution Japan Medical Research Development Institution Act, which is to establish an independent administrative institution to carry out research and development in the medical field and conduct administrative duties to develop environment, were adopted. With this background, as to the "realization of a healthy and active aging society as a top-runner in the world," in accordance with the "Health Care and Medical Strategy," which will be decided by the Cabinet based on the "Act to Promote Health Care and Medical Strategy," and with the "Research and Development Promotion Plan in the Medical Field," which will be decided by the Office for Health Care and Medical Strategy, Japan will pursue the realization of medical care that extends healthy longevity of people and meets expectations of people/society, and medical care that makes the best use of the nation's technological capabilities, as well as promoting improvement of competitiveness in the drug and medical equipment development fields, and international cooperation and contribution in medical care.

The Council for Science, Technology and Innovation will work together with the Office for Health Care and Medical Strategy so that synergistic effects will be produced from the collaboration toward the realization of a healthy and active aging society, taking lead in the international community.

2. Focused policy challenges

A research and development system is established for new medical fields to discover good seeds from basic research and bring them consistently to commercial application to deliver specific results. For this reason, a bridge to clinical research and trial is required from the start of the measure, and strategies for the introduction to the industry need to be carried out based on adequate preparations.

Among the diverse projects for research and development in the medical field, the "cross-ministry collaboration project," which was adopted on August 30, 2013, by the Office for Health Care and Medical Strategy and started in FY 2014, coordinates related research and development programs of each ministry in an

integrated manner and integrally operates them as one project. Since the establishment of the Independent Administrative Institution Japan Medical Research Development Institution, all projects are managed by the institution. Before the establishment of the institution, the administrative department of each ministry liaised with each other and developed a system for integral promotion including the establishment of a joint promotion committee for programs related to each ministry. For execution, KPI will be set for each project. To achieve the KPI, authority and discretion will be given to the PD on the start of individual research and development and the change of policy. Under the PD, each research team will search and select seeds looking at the exit and carry out research and development based on the strategy for each seed. At a setback, by selecting alternative seeds, it is expected that a management where each team always carries out research and development on several seeds will be established. The following KPIs are set for the collaboration project. In the future, these KPIs can be considered and verified further or reviewed as necessary according to the situation. KPI will also be set on the cross-ministry collaboration project to be started from now on.

For measures other than the cross-ministry collaboration project, we will steadily promote them based on the main purpose of the "Health Care and Medical Strategy" and the "Research and Development Promotion Plan in the Medical Field."

Although there are risks, support is expected to be given to realize innovation on issues that have dramatic potentials.

To promote these measures, resources will be allocated and the management and regulatory science will be enhanced in order to respond to rapid progress in research or epoch-making development in related science and technology while developing basic research on diseases.

By using the expenses[7] to promote science, technology and innovation creation, we will have reserve fund in budget for research and development in the medical field and will flexibly and efficiently allocate the budget across ministries based on the progress status of research and the content of the research to be invited.

[7] The Council for Science, Technology and Innovation, the headquarter function of the policy on science, technology and innovation, requested the fund to the Cabinet Office as the budget required to promote the "Cross-Ministerial Strategic Innovation Promotion Program (SIP)."

Realization of Healthy and Active Aging Society as a Top-runner in the World

Focused Policy Challenges	Focused measures
Reinforcing the development of drugs/medical equipment	Drug development
	Medical equipment development
Improving the support system for clinical research and trial	Developing bases for developing innovative medical technologies
Realizing the world's cutting-edge medical care	Realizing regenerative medicine
	Realizing custom-made/genomic medicine
Reinforcing research for preventing diseases	Research on cancer
	Research on mental/neurological disorders
	Research on emerging/reemerging infectious diseases
	Research on intractable disease

3. Focused Measures

[Attached table Timetable: Health and Longevity]

(1) Drug Development

[Timetable Health and Longevity (1)]

1) Details of the measure

Develop the support infrastructure for creation of pharmaceutical products such as a drug discovery support network and promote seamless support from basic research to practical use as a pharmaceutical product.

2) Goals to be achieved by FY 2015

- Consultation/seeds evaluation: Total 400 cases.
- Support drug development for promising seeds: Total 40 cases.
- Introduction to companies (licensing out): 1 case.

3) Goals to be achieved by 2020

- Consultation/seeds evaluation: Total 1,500 cases.
- Support drug development for promising seeds: Total 200 cases.
- Introduction to companies (licensing out): 5 cases.
- Identification of drug development Goal: 10 cases.

(2) Medical Equipment Development

[Timetable Health and Longevity (2)]

1) Details of the measure

On Japan's excellent medical equipment, with medical needs in mind, we will promote the development and practical use of medical equipment while displaying Japan's strength in manufacturing technologies and develop a system to link research and development with the practical use.

2) Goals to be achieved by FY 2015

- Formulate ten new guidelines to develop medical equipment and promote the practical use.
- Expand the market size for medical equipment in Japan (2.4 trillion yen in 2011 → 2.7 trillion yen).

3) Goals to be achieved by 2020

- Double the export amount of medical equipment (500 billion yen in 2011 → about 1 trillion yen).
- Implement five or more kinds of innovative medical equipment for practical use.
- Expand the market size of medical equipment in Japan: 3.2 trillion yen.

(3) Developing Bases for Developing Innovative Medical Technologies

[Timetable Health and Longevity (3)]

1) Details of the measure

By creating a new project through the collaboration of the Ministry of Education, Culture, Sports, Science, and Technology and the Ministry of Health, Labor, and Welfare, we will establish a system where epoch-making results of basic research in academia are always linked with the practical use and develop a system to carry out and support internationally high-standard clinical research and trial on seeds at the development stage, while using the strengths of both ministries.

2) Goals to be achieved by FY 2015

- The number of notifications of clinical trials led by doctors: 21 cases per year.
- First-in-human (FIH) tests (including clinical tests by companies): 26 cases per year.

3) Goals to be achieved by 2020

- The number of notifications of clinical trials led by doctors: 40 cases per year.
- First-in-human (FIH) tests (including clinical tests by companies): 40 cases per year.

(4) Realizing Regenerative Medicine

[Timetable Health and Longevity (4)]

1) Details of the measure

While providing seamless support from the basics to the clinical stage, we will increase the efficiency in developing a new drug by developing the infrastructure for the projects related to regenerative medicine and promoting the support for the use of iPS cells as a support tool for drug discovery.

2) Goals to be achieved by FY 2015

- The number of transitions into clinical research or trial in research with human stem cells: About 10 cases.
  (e.g., age-related macular degeneration, corneal disease, knee meniscus injury, bone/cartilage regeneration, blood disease)
- Development of the technology for drug discovery with iPS cells.

3) Goals to be achieved by 2020

- Apply new therapeutic agents created by using the technology of iPS cells to clinical sites.
- Increase the number of pharmaceutical approvals on regenerative medicine.
- Expansion of the diseases to be transferred to clinical research and trial (total about 15 transfers).
- Implement equipment and devices related to regenerative medicine for practical use.
- Propose international standardization of the method to assess the cardiotoxicity of the pharmaceutical products to which the technology of iPS cells is applied.

(5) Realizing Custom-Made/Genomic Medicine

[Timetable Health and Longevity (5)]

1) Details of the measure

With the rapidly advancing technology of analyzing the genome level, we will enhance the analysis infrastructure and promote the explication of a particular disease and the application to the clinical site in order to promptly contribute back to people the result of investigation on the relationship between diseases and genetic or environmental factors.

2) Goals to be achieved by FY 2015

- Establish cooperation between BioBank Japan, National Center Biobank Network, and Tohoku Medical Megabank.
- Establish the whole genome/diversity database on diseases.
- Identify the standard genomic sequence of Japanese people and identify prognosis genes.
- Establish presumptive diagnosis of the side effects of antiepileptic agents.

3) Goals to be achieved by around 2020 –2030

- Dramatically improve lifestyle diseases (diabetes, stroke, heart attack, etc.).
- Establish the presumptive diagnosis of carcinogenesis and the presumptive diagnosis of the response to a treatment or the side effects of an anticancer drug.
- Start clinical research on depression and dementia.
- Development of innovative methods to diagnose and treat incurable neuromuscular disease.

(6) Research on Cancer

[Timetable Health and Longevity (6)]

1) Details of the measure

With the “10-Year Cancer Research Strategy” (checked by the three ministers involved in March 2014) formulated based on the Basic Plan to Promote Cancer Control Programs (the Cabinet Decision in June 2012), we will integrally promote the whole process from the basic research to clarify the essence of cancer to the research for practical use in cooperation with related research projects controlled by the related ministries and agencies.

2) Goals to be achieved by FY 2015

- Obtain ten different types of promising seeds of new anticancer drugs.
- Obtain five different types of early diagnosis biochemical marker and immunotherapy prediction marker.

- Decrease the death rate from cancer by 20% (reduce 20% in 2015 compared to the age-adjusted death rate of the people under 75 years old in 2005).

3) Goals to be achieved by 2020

- Lead to ten or more types of clinical trials to create innovative cancer remedies from Japan within five years.
- Lead to six or more types of clinical trials to implement unapproved and off-level remedies for practical use regarding pediatric cancer, refractory cancer, and orphan cancer.
- Have one type of or more pharmaceutical approvals or add effects regarding remedies for pediatric cancer and orphan cancer.
- Dissolve so-called drug lag and device lag.
- Establish standard remedies for children's and elderly people's cancer and orphan cancer. (Create three or more guidelines.)

(7) Research on Mental / Neurological Disorders

[Timetable Health and Longevity (7)]

1) Details of the measure

We will establish innovative methods of diagnosis, prevention, and treatment to overcome dementia and mental diseases by strongly proceeding with research and development and the development of infrastructure through cross-ministry cooperation in order to understand the cranial nerves, neural circuit, and functions related to the occurrence of neuropsychiatric diseases such as dementia and depression.

2) Goals to be achieved by FY 2015

- Establish the method to diagnose ultra-early-stage dementia by molecular imaging.
- Discover at least one new biochemical marker related to the diagnosis of the mental disease, a response to and side effects of medication, and complete clinical assessment for the identification process.

3) Goals to be achieved by 2020

- Start clinical trials on candidates for fundamental therapeutic agents from Japan for mental illnesses such as dementia and depression.
- Establish an objective method to diagnose mental illness.

- Establish appropriate medication for mental illness.
- Complete a map on the structure and activity of neural circuit of the whole brain.

(8) Research on Emerging/Reemerging Infectious Diseases

[Timetable Health and Longevity (8)]

1) Details of the measure

In order to protect the people of Japan and people in the world from infectious diseases such as new influenza, we will promote research on infectious diseases at home and abroad through collaboration among ministries and enhance the measures against infectious diseases by more efficiently and effectively linking the result of the research with the development of therapeutic agents, diagnostic agents, and vaccines.

2) Goals to be achieved by FY 2015

- After establishing a system to share global pathogen and clinical information, we will establish the whole genome database on pathogen, understand the physiological and clinical pathology, and create a map of pathogens in Asia (to improve the capability to respond to public health against influenza, dengue fever, infection marked by diarrhea, drug-resistant bacteria).

3) Goals to be achieved by 2020

- Identify the target site of the pharmaceutical and development and implementation of the new speedy method of diagnosis based on the whole genome database of pathogen gained (from influenza, dengue fever, infection marked by diarrhea, drug-resistant bacteria).
- Carry out clinical and nonclinical tests on norovirus vaccine and nasal influenza vaccine and apply for pharmaceutical approval.

4) Goals to be achieved by 2030

- Development of a new vaccine.
  (e.g., a universal vaccine for influenza)
- Development of a new antibacterial agent and antivirus agent.
- Achievement of extermination and elimination of infectious diseases such as polio and measles in cooperation with WHO and other foreign countries.
  (For tuberculosis, the Goal is for 2050.)

(9) Research on Intractable Disease

[Timetable Health and Longevity (9)]

1) Details of the measure

In order to overcome rare and incurable diseases (intractable disease), we will understand the pathology of those diseases, develop new effective remedies, and apply and expand the current remedies by providing seamless support for the whole research process through cross-ministry cooperation in the field where research progresses slowly due to a small number of patients.

2) Goals to be achieved by FY 2015

- Achieve seven or more cases that led to new clinical trials for pharmaceutical approvals.
  (Severe pulmonary hypertension, prion disease such as Creutzfeldt-Jakob disease)

3) Goals to be achieved by 2020

- Achieve eleven or more cases of pharmaceutical approvals of new medical agents or application and expansion of existing medical agents.
  (ALS, distal myopathy, etc.)
- Promote international joint clinical trials linked with databases in Europe and America.

III. Development of Next-Generation Infrastructure as a Top-Runner in the World

1. Basic Understanding

To develop next-generation infrastructure as a top-runner in the world, based on the basic understanding shown below, it is necessary to take measures on a wide scale and in an interdisciplinary manner. At the same time, it is also necessary to comprehensively study the way to reform all the technology and knowledge, and socioeconomic systems. The development of next-generation infrastructure shall be therefore considered as a whole, as an integration issue.

Population decline, declining birthrate and aging population, the changing industrial structure, global environmental problems, resource and energy problems, need for preparation for large-scale natural disasters, the social

environment surrounding our country is changing rapidly, and the requirements for social infrastructure to address these issues are also changing significantly in terms of quality.

In addition, it is assumed that the infrastructure developed during the high-economic-growth era such as roads will require renovation, and that a large investment demand related to the maintenance and repair or renewal of that infrastructure will occur from now on. Due to the worsening financial condition, however, the public sector's financing power for investment in infrastructure is weak.

Furthermore, regarding large-scale natural disasters, the “Basic Act for National Resilience Contributing to Preventing and Mitigating Disasters for Developing Resilience in the Lives of the Citizenry” was enacted in December 2013 to ensure that measures related to national resilience are promoted comprehensively and systematically.

If you turn your eyes to the world, you will find that in rapidly developing emerging countries, various social problems are occurring as a result of rapid urbanization.

To properly respond to the changing situation described so far and develop a safe, secure, and sustainably vibrant society, it is necessary to strategically and efficiently develop social infrastructure that is in harmony with the environment and necessary for growth, including a recycling-based social system for zero emission and a regional comprehensive health-care system that continuously provides medical care, nursing, preventive care, housing, and daily living support services. For that purpose, integration issues need to be solved as a whole and addressed with concerted efforts and comprehensively in a wide range of fields, such as natural sciences, social sciences, and human sciences. For research and development in the above process, it is necessary to adopt the approach of validating the results while applying them in actual fields.

In addition, it is important to build infrastructure for promoting Japan’s economic growth by using technologies and experiences being accumulated, and to develop them into leading export industries in the world. For overseas expansion, for that matter, it is also important to promote software including human resources development as well as hardware.

Science, technology and innovation in the above is expected not only to sophisticate or improve the efficiency of existing operation, functionality, or service, but also to realize operation, functionality, or service that cannot be supported by the present technology.

2. Focused policy challenges

In view of the situation in which the social environment surrounding us is rapidly changing and the requirements for social infrastructure are greatly changing, this section sets focused policy challenges for the “development of next-generation infrastructure as a top-runner in the world.”

To address the problems facing the Japanese society, including safety and security, environment and energy, and health and longevity, as social infrastructure that makes full use of sophisticated technologies such as ICT, it is important to realize sophistication of energy utilization technologies on the demand side, systems based on various types of energy usage, advanced transportation system, and environment-friendly and comfortable services. Being related to a recycling-based social system for zero emission and a regional comprehensive health-care system that continuously provides medical care, nursing, preventive care, housing, and daily living support services, the smart city market in the world is expected to grow into a huge market in the future. Especially, it is expected that technologies for supporting community development (such as technology for supporting medical welfare service using ICT and cyclic use of water and waste for zero emission) can be promoted as a package project to overseas countries including rapidly developing emerging countries. For that reason, “realizing smart city toward development of next-generation community” is set as a focused policy challenge. In this issue, the advanced transportation system is an important element to realize a smart city at a higher level, because it is linked with various components that make up a smart city. The SIP challenge “automated driving system” is therefore positioned as a challenge to take the lead in addressing focused policy challenges. In addition to the SIP measures, through adoption of the results of research and development of other related technologies in such fields as traffic safety support and anti-traffic congestion, the government shall aim to realize a comprehensive advanced transportation system.

A large-scale earthquake might occur along the Nankai Trough, which is assumed to cause tremendous human suffering and physical damage around western Japan. A capital inland earthquake might hit Tokyo and the surrounding area. And large-scale wind and flood damage might occur due to abnormal weather conditions. To protect people’s lives and property and the industry from these large-scale natural disasters, it is an urgent need to increase the national

resilience with recovery power added to preventive power, and build a strong and flexible society in terms of both hardware and software based on public-private partnerships. The existing level of stock of infrastructure in the country reaches 800 trillion yen. And the cost of infrastructure renewal required for 50 years from now on is estimated at approximately 190 trillion yen. To promote measures to address the aging infrastructure and increase the reliability of infrastructure under recent financial conditions, it is necessary to sophisticate soundness evaluation and remaining life evaluation so as to optimize infrastructure repair and renewal and establish technologies for long life. To promote research and development for the above, it is important to share data, etc., regarding experiments conducted on the actual structures of infrastructure and have feedback on the findings made on-site.

For that purpose, “development of resilient society” is set as a focused policy challenge. To minimize damage, it is important to predict disasters in real time by making maximum use of the latest science and technology and share real-time disaster information. The SIP issue “Enhancement of societal resiliency against natural disasters” which helps organically link the Cabinet Office and the ministries together to promote research and development, is therefore positioned as a challenge to take the lead in addressing focused policy challenges. In addition to the SIP measures, through adoption of the results of research and development of other related technologies in such fields as enhancement of earthquake resistance; observation, analysis, and prediction; disaster information acquisition and dissemination; and disaster response, recovery, and restoration, the government shall aim to develop a resilient society with comprehensive disaster prevention and disaster risk reduction functionality.

To realize systematized, sophisticated infrastructure management, it is important to promote research and development of fundamental technology and asset management technology based on close collaboration between the Cabinet Office and the ministries. The SIP issue “Infrastructure maintenance, renovation and management" is therefore positioned as a challenge to take the lead in addressing focused policy challenges. In addition to the SIP measures, through adoption of the results of research and development of other related technologies in such fields as inspection, monitoring, and diagnosis, structural materials, repair, and renewal, the government shall aim to realize comprehensive infrastructure maintenance and renewal.

Development of Next Generation Infrastructure as a Top-Runner in the World

Focused policy challenges	Focused measures
Realizing smart city toward development of next-generation community	(1) Sophisticating energy utilization technologies and developing a network system that promotes various types of energy usage
	(2) Realizing integrated transportation systems
	(3) Realizing environment-friendly and comfortable services
Development of resilient society	(4) Developing a resilient society that responds to natural disasters
	(5) Realizing effective and efficient maintenance and renewal of infrastructure

3. Focused Measures

[Attached table Timetable: Next-Generation Infrastructure]

(1) Sophisticating Energy Utilization Technologies and Developing a Network System That Promotes Various Types of Energy Usage

[Timetable Next-Generation Infrastructure (1)]

1) Details of the measure

This measure is aimed at conducting research and development for technologies that promote sophistication of energy usage on the demand side on a house, building, or community basis. It is also aimed at carrying out development and demonstration toward the establishment and realization of a smart city in a region with highly functional houses (smart houses) and buildings (smart buildings). Furthermore, the government shall build a wide-area energy network that merges the backbone energy network with regional energy networks such as systems using renewable energy sources like sunlight and biomass as well as using thermal energy. In this measure, the government plans to build a smart energy network and energy management system that make derivative benefits (profit) visible and realize a smart city capable of energy supply and demand control optimization.

[MIC, MEXT, MAFF, METI, MLIT, MOE]

2) New measures for social implementation

- Promote international standardization, other standardization, and authentication systems for international expansion from the stage of technology development.
  [MIC, MOFA, MEXT, METI, MLIT, MOE]
- Expand and promote the application of international standards for energy management and environment.
  [METI, MLIT, MOE]
- Promote energy saving through the top-runner system.
  [METI, MLIT]
- Establish and develop a framework for wide implementation including local governments.
  [Cabinet Secretariat, Cabinet Office, MIC, MEXT, MAFF, METI, MLIT, MOE]
- Promote the international standardization of system components and system technology.
  [MIC, METI, MLIT]
- Relax the regulations that form a bottleneck in system integration and commercialization, and develop a system.
  [MIC, MAFF, METI, MLIT, MOE]

3) Goals to be achieved by 2030

○ Sophisticating energy use in houses, buildings, and regions.

- For standard new houses, realize ZEHs by 2020. For new houses on average, realize ZEHs by 2030.
- For new public buildings, realize ZEBs by 2020. For new buildings on average, realize ZEBs by 2030.
- Introduce smart meters to all households and offices in the early 2020s. By setting various electricity rates that are more effective through retail business liberalization by the present electricity system reform, realize an environment in which peak power demand can be controlled significantly.

○ Establishing innovative energy-saving technology.

○ Implementing technology for sophisticating backbone interconnections.

- Establish energy information communication network technology.
- Reduce the battery cost for power system to approximately 23,000 yen/kWh or lower in 2020.

○ Promoting the use of renewable energy, co-generation, etc.

(2) Realizing integrated transportation systems

[Timetable Next-Generation Infrastructure (2)]

1) Details of the measure

This measure is aimed at promoting the development of more advanced technologies by sophisticating ITS technology in the following fields: traffic safety support and anti-congestion, automated driving, traffic information concentration and distribution, traffic control, and convenience improvement. Especially, the automated driving technology, which uses sensor information, etc., in a sophisticated manner, shall be treated as technology development leading to a smart city. In this measure, while trying to quickly provide both pedestrians and vehicles with information and support related to traffic safety, reduce traffic congestion, and improve convenience, the government shall aim to achieve zero fatalities from traffic accidents and realize a society achieving the highest-level traffic safety and convenience in the world. Also, the government shall promote the development of advanced technologies in other traffic-related fields such as railways and aviation.

[Cabinet Secretariat, Cabinet Office, National Police Agency (NPA), MIC, MEXT, METI, MLIT]

2) New measures for social implementation

- Develop systems for commercialization and promotion.
  [Cabinet Secretariat, Cabinet Office, NPA, MIC, METI, MLIT]
- Take measures for international standardization and international expansion the stage of technology development.
  [Cabinet Secretariat, Cabinet Office, NPA, MIC, MOFA, METI, MLIT]

3) Goals to be achieved by 2030

- Through sophistication of ITS technology, traffic congestion shall be reduced by 2020.
- Through sophistication and spread of safety driving support systems and devices, traffic accidents shall be reduced drastically by 2020.

(3) Realizing Environment-Friendly and Comfortable Services

[Timetable Next-Generation Infrastructure (3)]

1) Details of the measure

This measure is aimed at promoting technologies that support community development including the development of a regional comprehensive health-care system using ICT, from the following perspectives: medical care, nursing, preventive care, housing, and daily living support services; education and child rearing; and cyclic use of water and waste for zero emission. By this measure, the government shall aim to efficiently realize services that enable all people including seniors and people from abroad to live healthy and comfortable lives, develop a regional society that is environmental friendly, sustainable, and attractive, and promote such services in the overseas market.

2) New measures for social implementation

- Implement the data health plan.
  [MIC, MHLW, METI]
- Deploy the medical information network all over Japan.
  [MIC, MHLW]
- Develop systems for commercialization and promotion.
  [MIC, MEXT, METI, MLIT, MOE]
- Take measures for building an international framework and promoting international standardization and international expansion from the stage of technology development.
  [MIC, MEXT, METI, MLIT, MOE]

3) Goals to be achieved by 2030

- Realize infrastructure for a recycling-based society.
- Create and develop an industry for creating next-generation housing and community.
- Ensure that a variety of medical care, nursing, and daily living support services are provided.
- Narrow the gap between the average life expectancy and healthy longevity.
- Promote the health-care industry.

(4) Developing a Resilient Society That Responds to Natural Disasters

[Timetable Next-Generation Infrastructure (4)]

1) Details of the measure

This measure is aimed at promoting the development of technologies for increasing the country's resilience in the following fields: enhancement of earthquake resistance for infrastructure, etc.; observation, analysis, and prediction using Earth observation data and geospatial information from satellites; minimization of damage when a disaster occurs by quick and secure disaster information acquisition and dissemination; and safe, quick, and appropriate response as well as recovery and restoration after disaster occurrence. This measure helps make preparations for natural disasters such as evacuation in advance, and makes it possible for victims and rescuers to take action quickly and safely when a disaster occurs. By this measure, the government shall aim to realize a society that can respond to various disasters and make people feel safe and secure.

[Cabinet Secretariat, Cabinet Office, MIC, MEXT, MHLW, MAFF, METI, MLIT]

2) New measures for social implementation

- Take measures for building an international framework and promoting international standardization and international expansion from the stage of technology development.
  [Cabinet Secretariat, Cabinet Office, MIC, MOFA, MEXT, METI, MLIT]
- Demonstrate the practicality of the results of technological development using actual fields and take the lead in introducing the said results in public procurement.
  [Cabinet Office, MAFF, MLIT]

3) Goals to be achieved by 2030

- Realize a society that can minimize the damage due to disasters.
- Introduce disaster response robots that can be operated remotely using ICT by FY 2018 and make them sophisticated one after another.
- Demonstrate the introduction of escape guidance and firefighting using geospatial information by FY 2016 and realize the said introduction by FY 2020.

(5) Realizing Effective and Efficient Maintenance and Renewal of Infrastructure

[Timetable Next-Generation Infrastructure (5)]

1) Details of the measure

This measure is aimed at promoting the development of technologies in the following fields: prediction of remaining life by effectively and efficiently inspecting and diagnosing the deterioration and damage of structures; repair and renewal of infrastructure; and improvement of the durability of infrastructure structural materials. It is also aimed at promoting the development of a systematic management system intended to minimize life cycle cost by using these technologies. The measure helps one to not only safely and appropriately respond when a disaster occurs and attend to points difficult to check, but also strategically deal with the deterioration due to the age of infrastructure, which has become serious recently on considering the balance between cost and safety. By this measure, the government shall aim to realize a society in which infrastructure can be used for a long time without concern.

[Cabinet Secretariat, Cabinet Office, MIC, MEXT, MAFF, METI, MLIT]

2) New measures for social implementation

- Take measures for international standardization and international expansion from the stage of technology development.
  [Cabinet Office, MIC, MOFA, MEXT, MAFF, METI, MLIT]
- Demonstrate the practicality of the results of technological development using actual fields and take the lead in introducing the said results in public procurement.
  [Cabinet Office, MAFF, MLIT]

3) Goals to be achieved by 2030

- Realize infrastructure that supports the lives of people and industries sustainably at low cost.
- Sophisticate inspection and repair by using sensors, robots, nondestructive inspection, and other technologies in all the important infrastructure and aging infrastructure in the country.
- Achieve zero critical accidents caused by deterioration due to age in important infrastructure.
- Gain 30% share of the world market for sensors and robots designed for inspection and repair.

IV. Fostering of New Industries by Utilizing Regional Resources

1. Basic Understanding

Management resources such as “people, assets, and communities” in regional communities all over the country form an important industrial base that becomes a source for supporting the country’s economic revitalization and leveraging its international competitiveness.

However, regional communities today are faced with various problems: depopulation; aging; reduction in employment opportunities resulting from weakened regional economies and decline in local industries; and failure to take advantage of the unique characteristics of regional communities, which increases the homogenization of regional communities across the nation.

On the other hand, as shown by the fact that “Washoku (traditional Japanese cuisine)” was registered as a UNESCO Intangible Cultural Heritage, there is a growing global interest in the food culture that took root in our country and has been handed down so far. For that reason, it is hoped that new business taking advantage of the unique characteristics of regional communities will be promoted on a global scale.

For the agriculture, forestry, and fisheries industry, which is a major core industry in a regional society, with the aim of strengthening its competitiveness and developing it as a growth industry, the “Plan for Revitalization of Agriculture, Forestry, Fisheries, and Rural Areas” [8] was decided so as to implement measures related to export promotion, sixth sector industrialization, farmland consolidation, etc. The government shall utilize “food safety and security” (a strength of our agriculture, forestry, and fisheries industry); “Washoku or Japanese food, representing Japanese traditional culture” (registered as a UNESCO Intangible Cultural Heritage); and “expert techniques of exemplary good farmers.” While doing so, the government shall build a value chain in the agriculture, forestry and fisheries industry, and the food industry (hereafter called a “food and agriculture value chain”) to provide attractive products and improve productivity, with an eye toward the growing overseas food market. And the government

[8] A summary of the results of study conducted by “Headquarters, Vitalization of Agriculture, Forestry, Fisheries, and Rural Areas” on six issues facing the agriculture, forestry, and fisheries industry, including domestic and overseas demand expansion and farmland consolidation, drafted on December 10, 2013, as a grand design for the policy reform for vitalization of agriculture, forestry, fisheries, and rural areas.

shall aim to increase income in the agriculture, forestry, and fisheries industry and in rural areas as well as expanding existing industries and creating new industries.

New manufacturing technologies that conquer time constraints or geographical constraints are spreading and advancing, such as a three-dimensional shaping technique. Also spreading and advancing are new manufacturing systems that increase productivity using ICT and robots. Expectations are growing that these tendencies can increase the potential for innovation with regional communities positioned as places of designing and manufacturing.

To solve various problems facing regional communities, in the fields mentioned above such as the agriculture, forestry, and fisheries industry and the manufacturing industry, through innovation in science and technology, a variety of resources possessed by regional communities shall be put in the spotlight to increase their added value, so that the conversion of the said resources into “assets” is accelerated. To promote the above innovation, it is important to conduct research and development by actively promoting the collaboration between the Cabinet Office and the ministries, the industry-academia-government collaboration, and technology integration between different fields. And it is also important to implement a cutting-edge project, business operation, or business model using regional communities as places for demonstration. In addition, tremendously large results can be achieved by applying the results obtained in the above places for demonstration to other regional communities or industries, or by building a network between regional communities with different “assets.” Developing and strengthening regional industries through the measures mentioned so far helps not only recover the vitality of the regional economies in the past, but also develop fields not regarded as fields of growth before as growth engines. Furthermore, it is hoped that with the global market also set as an exit, by actively promoting their strengths overseas, regional communities will attract globally flowing people, assets, capital, and knowledge.

2. Focused policy challenges

Export promotion, sixth sector industrialization, farmland consolidation, and other measures are supposed to be implemented to establish the agriculture, forestry, and fisheries industry (a major core industry in a regional society) as a growth industry and make it a new core element for growth that leads the

country's economy and regional communities. From the perspective of promoting technological innovation in synchronization with these policies, realizing innovation in science and technology in the agriculture, forestry, and fisheries industry, and converting it into a growth industry, "fostering agriculture, forestry, and fisheries as a growth engine" is set as a focused policy challenge.

To address the said issue, measures shall be taken to promote the development of cutting-edge breeding technology, etc., and to create new products and merchandise that properly respond to various needs, achieve high performance and highly-value-added, and take advantage of the unique characteristics of regional communities (product innovation). In such processes as production and product processing, through introduction of innovative technology, productivity improvement and environmental load reduction shall be pursued. At the same time, measures shall be taken to increase added value and the competitiveness of products and merchandises in the process chain from production to product processing and to distribution mentioned above. It is hoped that being taken in collaboration with companies in various business fields and in an integrated manner with the previously mentioned policy, these measures will contribute to income increase in the agriculture, forestry, and fisheries industry and in rural areas; revitalization of regional economies through industry expansion and creation; and presence enhancement in the global market. Furthermore, the development of high-performance agricultural, forestry and fishery products and foods that respond to an aging society also contributes to the improvement of people's living in the nation, generating a synergy effect on exercise. It is also hoped that with the results of these measures combined, technological contribution will be made to addressing food problems on a global scale.

In implementing the measures mentioned so far, collaboration between the Cabinet Office and the ministries, integration of different fields, and bridging between fundamental research and applied research shall be implemented strongly, with the following as core elements: the realization of smart agriculture using cutting-edge technology and information; the provision of revolutionary products using new breeding technology, etc.; the SIP measure "Technologies for creating next-generation agriculture, forestry and fisheries," that is based on future demand creation by developing new functionality.

It is also important to build a new manufacturing system that takes advantage of various resources possessed by regional communities, especially excellent technology and know-how possessed by local companies. However, for

manufacturing from now on, it is difficult to win competition with rapidly catching-up emerging countries simply by improving the technological capability. It is necessary to determine “what to manufacture” by assuming value to the user and then promote measures in which value design, design, and production technology are linked together appropriately. For that reason, innovative manufacturing technology capable of flexibly manufacturing various, highly-value-added products and materials in small quantities is expected to be introduced. At the same time, it is also important to build a design and production system or business model that can explore value to the user and quickly and flexibly respond to the needs.

To develop the above innovative manufacturing system or business model into an industry that leads to the revitalization of regional communities, that system is required to be optimized as a system that takes advantage of the unique characteristics of the said regional communities. To that end, various types of support for commercialization are also required, namely the development of a demonstration and actual platform based on the industry-academia-government collaboration in which companies in regional communities and other various organizations participate and the creation of a network. With these in mind, “strengthening industry competitiveness that leads to revitalization of local communities” is set as a focused policy challenge.

Through the various measures promoted to solve the above issue, a new competitive edge is added to the services based on attention to detail and high-quality and high-performance manufacturing Japan has been good at, so as to create a new market in which Japan can become world No. 1.

In implementing these measures, collaboration between players in various phases is demanded, including collaboration between manufacturing processes such as design technology and production technology; collaboration between cutting-edge technologies that have been developed based on public-private partnerships and excellent technologies possessed by local companies; and systems that deliver a product to users and reflect its use value in designing. The SIP issue “Innovative design/manufacturing technologies” is therefore positioned as a challenge to take the lead in addressing focused policy challenges. And the government shall aim to establish a new manufacturing system based on the industry-academia-government collaboration including the Cabinet Office, the ministries, and local companies.

Fostering of New Industries by Utilizing Regional Resources

Focused Policy Challenges	Focused measures
Fostering agriculture, forestry and fisheries as a growth engine.	(1) Developing high-performance and highly-value-added agricultural, forestry and fishery products that become a source of competitiveness.
	(2) Sophisticating production, processing, and distribution systems for agricultural, forestry and fishery products that help expand the market and wealth.
Strengthening industry competitiveness that leads to revitalization of local communities.	(3) Optimizing the manufacturing system to contribute to value creation, and promoting regional business.

3. Focused Measures

(1) Developing High-Performance and Highly-Value-Added Agricultural, Forestry and Fishery Products That Become a Source of Competitiveness

[Timetable Regional Resources (1)]

1) Details of the measure

Considering such factors as the target market and technology competition in the world, while bridging between fundamental research and research for commercialization to achieve their mutual collaboration, this measure is aimed at strategically promoting the development of new breeding technology, etc., that realizes the provision of revolutionary products in the following fields: analysis of genomes and metabolites; development of an information base such as database creation; identification of useful genes; development of DNA markers; bioinformatics and engineering; and utilization of genome editing techniques. Since the source of technological innovation in the agriculture, forestry, and fisheries industry is utilization of biotic potential, in this measure, basic research shall be promoted to secure and enrich genetic resources and elucidate principles of life that shall be brought to technological innovation in the agriculture, forestry, and fisheries industry.

In addition, from the perspective of creating future demand, this measure is also aimed at developing highly-value-added new materials that can be used for industrial and medical purposes, from agricultural, forestry and fishery products or unused resources potentially existing in regional communities. Furthermore, with an eye toward an aging society, for the functional components contained in agricultural, forestry and fishery products and related to health and antiaging, brain function activation, and physical locomotion function maintenance, acquisition of scientific evidence by clarifying their effectiveness shall be promoted. In addition, the development of next-generation functional foods, and of meal recipe and exercise menus, and the construction of a supply system for them (business model) shall also be promoted by utilizing the obtained results.

By these measures, the government shall aim to create attractive products that respond to diversifying customer and market needs due to an aging society and changing lifestyle, increase productivity, create new industries, and increase income in rural areas. Furthermore, while strategically dealing with technological competition in such a field as biotechnology that is rapidly growing globally including in emerging countries, the government shall strengthen international activities such as spreading related industries including breeding and making technological contribution for addressing world food problems.
[Cabinet Office, MAFF, MEXT, METI, MHLW]

2) New measures for social implementation

- Strengthen a system of collaboration between researchers in companies, universities, research and development corporations, and public experimental and research institutes in the following fields: breeding, pests, quality, cultivation management, molecular biology, bioinformatics, engineering and measurement technology, etc.
  [Cabinet Office, MEXT, MAFF, METI]
- Spread breeding technologies responding to the characteristics and needs of regional communities.
  [MAFF]
- Strategically utilize and protect intellectual property related to new breeds and new technologies.
  [Cabinet Office, MAFF]
- Consider how to treat new breeding technologies under existing regulations and promote international harmonization.
  [Cabinet Office, MAFF]

- Support the implementation of safety and effectiveness evaluation for medical raw materials in collaboration with related organizations in such fields as medical sciences, pharmacy, nutritional science, and exercise and sports; conduct cohort and other studies for epidemiologic investigations; and develop and commercialize a system for supplying food, etc., according to the health condition of individuals.
  [Cabinet Office, MHLW, MEXT, MAFF, METI]

3) Goals to be achieved by 2030

- Speed up the development of new breeds by 2020.
- Improve the productivity of the agriculture, forestry, and fisheries industry by 2020 through reduction in production cost using genome information.
- Develop revolutionary agricultural, forestry and fishery products such as a rice plant with super-high-yielding ability.
- Create new industries with functional agricultural, forestry and fishery products positioned as core elements, and improve the quality of people's life in the nation.
- Expand overseas business for the seeds and seedlings industry, etc.
- Make technological contribution for addressing world food problems.

(2) Sophisticating the Production, Processing, and Distribution Systems of Agricultural, Forestry and fishery Products That Help Expand the Market and Wealth

[Timetable Regional Resources (2)]

1) Details of the measure

This measure is aimed at actively applying cutting-edge technologies and fundamental and base technologies in different fields including engineering technologies such as ICT and robots to the agriculture, forestry, and fisheries industry. In this measure, a database shall be built by collecting and analyzing various types of information through sensing, etc., and by converting farmers' tacit knowledge into explicit knowledge. Through refinement of cultivation management, power saving, energy conservation, and continuous pests control based on such information, this measure shall promote the development of highly profitable production systems that are also environmental friendly (an automated work technology system, plant factory, new plant protection technology, etc.). In addition, large-scale farming and productivity improvement shall be accelerated by implementing these technological innovations in an

integrated manner with the relevant policy. And it is important that a new production system is developed with its users (people working in the area of agriculture, forestry, and fisheries), so that “user innovation” (technological innovation develops users themselves) occurs.

Besides, to revitalize the forest industry, the following shall be promoted: the development of a production and distribution system that considers the function of forests to serve the public interest, based on smart and certified timber production; and the improvement of efficiency in lumbering and wood material production processes. To contribute to addressing world food problems, the following shall be promoted: the farming of eels, tuna, and other fishes; and the development of a large-scale complete aquaculture system independent of fry.

In addition to agricultural, forestry and fishery product export expansion, with an eye toward the promotion of agricultural technologies and infrastructure originating in Japan in the overseas market, an intellectual property strategy shall be promoted that combines breeding and cultivation technologies (know-how) and evaluation technologies (value information identification and visualization). Furthermore, the government shall promote the strategic technological development in which related companies including food companies and companies in different business fields participate, and in which technologies in such phases as production, processing, distribution (logistics, storage, etc.), each accompanied by information, link together.

By these measures, the government shall develop the agriculture, forestry, and fisheries industry into a “smart industry” and “knowledge and information industry” and, at the same time, contribute to creating a new food and agriculture value chain based on the market trends in Japan and abroad as well as the consumer needs.

[Cabinet Office, Cabinet Secretariat, MAFF, MEXT, METI, MIC]

2) New measures for social implementation

- Build a system for implementing large-scale demonstration of ICT or robot introduction.

  [Cabinet Office, Cabinet Secretariat, MIC, MAFF, MLIT]
- Organize intellectual property matters related to the know-how converted into explicit knowledge by AI and consider international standardization for it.

  [Cabinet Office, MIC, MAFF, METI]

- Expedite EU HACCP [9] accreditation for the fishery product production and processing facilities in our country, which is one of the obstacles to fishery product export to EU.
  [MHLW, MAFF]

3) Goals to be achieved by 2030

- By 2020, realize significant reduction in labor cost and workload, productivity improvement, and environmental load reduction using IT and robot technologies.
- By building a food and agriculture value chain, increase people newly engaged in farming, increase income in all rural areas, and expand related industries.
- Commercialize the complete farming of eels, bluefin tuna, and other fish by 2020.
- Promote the agriculture, forestry, and fisheries technologies and the infrastructures originating in Japan such as plant factories in overseas markets.

(3) Optimizing the Manufacturing System to Contribute to Value Creation, and Promoting Regional Business

[Timetable Regional Resources (3)]

1) Details of the measure

This measure is aimed at promoting the development of production-related technologies, which are the base technologies to mainly form the basis of this country's industries. Examples of innovative processing and production technologies to be developed are as follows: production technologies that make it possible to manufacture various highly-value-added products and materials in small quantities, by using a three-dimensional shaping technique that can reflect the wisdom and sensibilities of local companies and individuals, and robots that can flexibly handle multiple jobs, as well as processing technologies that can process materials whose processing used to be difficult with precision. The development of composite technologies consisting of the above technologies and the technologies inherited by the local industries of regional communities is also anticipated. To develop these production technologies, while considering manufacturing cost, high-quality and high-performance products and materials not available in the market before shall be produced by selecting free shapes

[9] Hazard analysis and critical control points

and diverse materials. It is also necessary to develop innovative design methods capable of modeling complex shapes in three dimensions or quickly and easily reflecting an original design in designing.

Furthermore, it is noteworthy that a new manufacturing service system is developed by applying the know-how of service engineering. In this system, the value to the user is explored from the data collected at points of product use and service provision and analyzed, and then applied for the purpose of designing the most appropriate business model. This system is expected to create new value to the user, help produce highly competitive products and materials or provide highly competitive services by anticipating the needs, and increase the growth potential and competitiveness of not only the manufacturing industry but also various types of regional business.

By developing an innovative manufacturing system or building a new business model as described above, the government shall increase the value of regional resources, which are the country's industrial base, to contribute to developing new industries with an eye also toward the overseas market.
[Cabinet Office, MEXT, METI, MAFF, MIC, MHLW, MOFA]

2) New measures for social implementation

- Create opportunities for local companies, businessmen, individuals with entrepreneurship to learn innovative production technologies.
  [Cabinet Office, METI, MEXT]
- Develop evaluation criteria for the product standards and safety of materials that contribute to manufacturing high-quality and high-performance products.
  [MHLW, METI]
- Standardize newly developed design and production technologies and new materials to be used, and manage their intellectual property rights.
  [Cabinet Office, METI]
- Introduce technologies related to and develop a system for the use and protection of digital design data on products, etc.
  [Cabinet Office, METI]
- Develop a system for products requiring approval for use.
  [MHLW, METI]
- Implement a research and development project related to large-scale data collection and analysis for user value exploration.
  [Cabinet Office, MIC, MEXT, MHLW, MAFF, METI, MLIT]

- Standardize a benchmark method for evaluating the quality and efficiency in provision of service.
  [METI]

3) Goals to be achieved by 2030

- Spread cutting-edge processing technologies and realize composite technologies combined with existing technologies to vitalize regional manufacturing industries and promote business in the overseas market.
- Realize a flexible manufacturing system capable of manufacturing various high-value-added products in small quantities by 2020 and create new industries utilizing the said system.
- Develop a new business model with the focus placed on value to the user by 2020, develop regional manufacturing industries and service industries into growth industries based on the new business model, and promote business in the overseas market.

V. Early Recovery and Revitalization from the Great East Japan Earthquake

1. Basic Understanding

The Great East Japan Earthquake on March 11, 2011, was an unprecedented disaster caused by multiple factors; in addition to a massive earthquake and tsunami, radioactive materials released due to a nuclear plant accident badly affected the environment. Its social and economic impact spread not only in the disaster-affected areas but also throughout the country. Achieving early recovery from the Great East Japan Earthquake and revitalizing people's lives and industries are pressing and important issues for the country. Accelerating such recovery and revitalization further is strongly demanded.

In view of the above, for recovery and revitalization, assuming that there are opportunities for further growth by learning from the disaster, and hoping that the disaster-affected areas will become "places of new creation and possibility," it is necessary to actively implement the results of cutting-edge innovations in science and technology by synchronizing with the measures for the policy challenges from I to IV mentioned in this section.

2. Focused policy challenges

To achieve early recovery and revitalization of the disaster-affected areas, it is important to take measures widely and quickly for the issues facing them. From this perspective, the following five issues are set as focused policy challenges:

(1) Realizing a society where residents' health are protected from disasters and children and the elderly people are sound and healthy
(2) Establishing energy system resilient against disasters
(3) Developing new business models in local industries
(4) Establishing next generation infrastructures resilient against disasters
(5) Mitigating and readdressing influences by radioactive material

When the issues are worked on, to accelerate recovery and revitalization, for short-term measures, their results shall be obtained quickly and applied immediately for recovery and revitalization of the disaster-affected areas. For medium- and long-term measures, too, their results shall be applied one after another. It is important to take measures that contribute to new technologies in the future and new industries in the disaster-affected areas such as the "Innovation Coast" plan[10]. And such information about results and use examples shall be actively disseminated throughout Japan or abroad, so that the disaster-affected areas can present an exemplary model for recovery and revitalization in the world. For radioactive materials, measures shall be taken to reduce and eliminate their effects, and risk communication is important.

Early Recovery and Revitalization from the Great East Japan Earthquake

Focused Policy Challenges	Focused Measures
(1) Realizing a society where residents' health are protected from disasters and children and the elderly people are sound and healthy	Developing medical technology, R&D on proper methods of medical provision and health maintenance, R&D on how to properly support those vulnerable in disasters including expecting and nursing mothers, infants and elderly people in the event of disasters.

[10] Created by "Fukushima International Industrial City (Innovation Coast) Plan Study Group" chaired by the director-general of the local nuclear emergency response headquarters and comprised of local representatives and advisors from the industry, academia, and the government sector. This plan is intended to create new industries and employment opportunities mainly along the Hamadori coastal area in Fukushima Prefecture by developing a research and development center based on the industry-academia-government collaboration in diverse fields.

(2) Establishing energy system resilient against disasters	Developing renewable energy in consideration of climates and characteristics of the regions.
(3) Developing new business models in local industries	Reinforcing industrial competitiveness and job creation through the utilization of innovative technology and local strength
(4) Establishing next generation infrastructures resilient against disasters	Expediting the transmission of information on the occurrence of tsunamis and earthquakes, improving the resilience of structures, disposal and effective use of massive disaster wastes.
(5) Mitigating and readdressing influences by radioactive material	Effectively and efficiently decontaminating and disposing of radioactive materials, preventing exposure of workers engaging in decontamination.

3. Focused Measures

[Attached table Timetable: Recovery and Revitalization]

(1) Realizing a society where residents' health are protected from disasters and children and the elderly people are sound and healthy

[Timetable Recovery and Revitalization (1)]

1) Details of the measure

Researches are promoted for short-term to medium- to long-term disaster medical technologies based on the experiences gained from the earthquake. Disaster medical technologies include methods to appropriately provide the victims with medical care and to maintain their health in accordance with their constantly monitored health conditions, and methods to appropriately provide support for those weak in disaster, such as expectant and nursing mothers, infants, and elderly people. These activities will contribute to materializing a society where people's health is protected from disasters and children and elderly people live actively.

[MEXT, MHLW]

2) Major Goals to be achieved

○ Support related to the health condition of the survivors of the Great East Japan Earthquake and support related to health in times of large-scale disasters.

- Guidelines on support for elderly people.

To be implemented in 2015

○ Cohort studies in healthy subjects.

- Conduct cohort studies in healthy subjects and apply the results.

To be implemented as needed in 2015

(2) Establishing energy system resilient against disasters

[Timetable Recovery and Revitalization (2)]

1) Details of the measure

Development of disaster-resistant technologies, etc., related to renewable energies will be promoted, considering the natural features and characteristics of local areas. These activities will contribute to materializing a society with advanced and sustainable energy systems such as independent and widespread energy systems.

[MIC, MEXT, METI, MOE]

2) Major Goals to be achieved

○ Improved safety of oil tanks in case of an earthquake and tsunami and debris fire-extinguishing technology.

- Improve the safety of oil tanks and develop debris fire-extinguishing technology.

To be implemented in 2018

○ Project for strengthening the function of the center for renewable energy research and development in Fukushima Prefecture.

Partially put into To be implemented in 2015

- Demonstrate renewable energy technologies in an actual society.

(3) Developing new business models in local industries

[Timetable Recovery and Revitalization (3)]

1) Details of the measure

Regeneration of highly competitive agriculture, forestry and fishery industries will be promoted by developing new business models, through development and implementation of cutting-edge technologies. Strengthening industrial competitiveness of local communities by utilizing novel technologies and local “strengths” will also be promoted. These activities will contribute to the creation and expansion of job opportunities and recovery of the industries in disaster affected areas.

[MEXT, MAFF, METI]

2) Major Goals to be achieved

○ Regeneration of highly competitive agriculture, forestry and fishery industries

- Implementation of new technology systems (combination of various cutting edge technologies) to disaster-affected areas

To be diffused in 2018

○ Creation and expansion of job opportunities in disaster-affected areas by strengthening industrial competitiveness of local communities conducted by utilization of novel technologies and local “strengths”

- Development of high-efficiency rare element extraction technologies, ultra-low core loss magnetic material technologies, ultra-low friction technologies

To be implemented in 2018

○ Project for strengthening the function of the center for renewable energy research and development in Fukushima Prefecture.

Partially put into To be implemented in 2015

- Demonstrate renewable energy technologies in an actual society.

(4) Establishing next generation infrastructures resilient against disasters

[Timetable Recovery and Revitalization (4)]

1) Details of the measure

Development of the following technologies will be promoted: a) lower-cost antiliquefaction technologies, b) creation of a society that mitigates damage from tsunami, c) technologies to improve the resilience of the constructions against disasters, d) technologies to process and utilize large-scale disaster wastes, e) technologies to promptly and accurately acquire and distribute earthquake and tsunami information for prompt evacuations, f) technologies related to lifesaving at the time of disasters, and g) technologies to improve the resilience of logistics systems and information infrastructure. These activities will contribute to creating local communities that are safe and secure against disasters.

[MIC, MEXT, MLIT, MOE]

2) Major Goals to be achieved

○ Reduction of tsunami damage in towns by reflecting the geographical conditions on placement and designing.

- Perform ocean area structural explorations in the Nankai Trough and the Sea of Japan, and tsunami history investigation.

To be implemented in 2019

○ Improvement of the resilience of the constructions against disasters.

- Development of breakwater structures that are resilient against tsunami.

To be implemented in 2015

○ Swift and smooth processing or utilization of large-scale disaster wastes.

- Develop processing technologies and a system for quick and smooth processing as well as effective use of disaster waste.

To be implemented as needed in 2015

○ Accurate acquisition of earthquake information and its prompt and appropriate distribution

- Improvement in prediction accuracy of earthquake early warning

To be implemented in 2015

○ Swift and accurate acquisition of tsunami information

- Advancement in tsunami prediction information

To be implemented in 2015

○ Preparation and provision of information for conducting evacuations swiftly and appropriately

- Advancement in earthquake and tsunami simulations

To be implemented in 2018

○ Swift and reliable lifesaving activities at the disaster sites

- Development of fire engines, etc., that enable traveling and lifesaving in areas filled with rubble and/or water

To be implemented in 2018

○ Establishment of base technologies for securing resilient logistics systems that function rapidly and appropriately

- Development of systems for utilizing high-resolution observation data obtained by the Advanced Land Observation Satellite-2

To be implemented in 2015

○ Acquisition of necessary data, securing resilience of communication methods

- Development of synthetic aperture radar that can be mounted on small airplanes

To be implemented in 2015

(5) Mitigating and readdressing influences by radioactive material

[Timetable Recovery and Revitalization (5)]

1) Details of the measure

This aims at reduction and dissolution of effects arising from radioactive

materials released due to the incident at the nuclear power station. For that purpose, technology development will be promoted for research studies on health related issues, prevention of exposure to decontamination workers, etc., effective and efficient decontamination and disposal of radioactive materials, and measurement, evaluation, and decontamination of agriculture and fishery products.
[MEXT, MHLW, MAFF, MOE]

2) Major Goals to be achieved

○ Relief of residents' anxiety on health effects of radioactive materials

- Development and field tests of radiation meters, etc., for detecting hot spots

To be implemented in 2015

○ Prevention of exposure to decontamination workers, etc.

- Development of methods that enable efficient and swift radio density measurement operations

To be implemented in 2015

○ Effective and efficient decontamination and disposal of radioactive materials

- Development of effective and efficient adsorbing and stabilizing materials

To be implemented in 2015

○ Swift measurement and evaluation of radioactive materials in agriculture and fishery products and industry products, swift decontamination of the products, and securing the distribution of the products

- Development of techniques for monitoring radioactive materials in foods

To be implemented (at all times) in 2015

Section 2 Cross-cutting Technologies to Strengthen Industrial Competitiveness and Address Policy Challenges

1. Basic understanding

It can be assumed that by working on the five policy challenges taken up in Section 1 in a cross-cutting manner, a new perspective is highlighted, and that addressing challenges with the said perspective leads to sources that will create great advantages also in the future for strengthening industrial competitiveness. Like a drug delivery system (which delivers the right dosage to the right region based on nanotechnology to reduce the burden to the body), introducing various technologies beyond the fields of the past issues gives rise to innovation in science and technology, and contributes to addressing issues by increasing industrial competitiveness.

In the United States, it is decided that for the budgets related to innovation in science and technology in the Federal Budget, the National Science and Technology Council (NSTC) strategically controls the budgets for information and communication technology, nanotechnology, and environment technology, through multi-agency coordination.[11] In the EU, in the Seventh Framework Programme for Research and Technological Development, in addition to calculation by theme such as energy, health, and agriculture, budgets are calculated with information and communication, nanotechnology, and environmental technology as major categories.[12]

The above categories are the areas in which results of research and development and human resources have been accumulated in Japan, and in which Japan has been strong so far; Japan has pursued performance in each area independently by radicalizing the technology in each area. However, it is possible that Japan will gradually lose competitiveness in these areas, considering the tendency of global competition in manufacturing and total optimization as a system.

While developing a clear “exit” strategy regarding how to make use of these cross-cutting technologies for addressing the five policy measures, it is important to further enhance the core technologies so that the said cross-

[11] “The 2014 Budget: A World-Leading Commitment to Science and Research,” White House Office of Science and Technology Policy, USA (http://www.whitehouse.gov/administration/eop/ostp/rdbudgets/2014)
[12] “Research & Innovation,” European Commission (http://ec.europa.eu/research/fp7/index_en.cfm?pg=budget)

cutting technologies literally go beyond the fields of issues and give rise to innovation in science and technology; maintain the strengths for the medium and long term; and create sources of competitiveness. At this point, it is necessary to sufficiently utilize mathematical sciences, system science, and photon quantum science, all of which support cross-cutting technologies.

In addition, it is important to ensure that measures for cross-cutting technologies contribute to addressing policy challenges, and to check that point to perform the PDCA cycle for the year.

The following section describes the basic understanding of each cross-cutting technology.

<ICT>

In 2011, the nominal value of domestic production in the ICT industry accounted for 9% of the value of domestic production in all industries, the largest compared to other industries.[13] On the other hand, the international competitiveness of Japan's ICT is almost on the decline.[14] If you look at the global industrial competitiveness in the areas in which the size of the global market is expanding, such as services (software, etc.), information communication terminals and equipment (LAN switches and enterprise-use routers, etc.), and devices (processors, etc.), Japan's global share is less than 5%; it can be said that the industrial competitiveness of Japan's ICT is low.[15]

While the extent to which ICT is utilized for addressing policy challenges is large now, the possibility is increasing that such utilization develops into a risk attributable to ICT. Information security technology is a typical example. Like targeted threats designed to steal a nation's classified information or a company's research and development information, and illegal access intended to take control of and remotely operate important infrastructure such as a power plant or a vehicle, cyber attacks are becoming worldwide security threats every day. And failure to respond to such attacks in time would have an immeasurable impact on the society, including economic loss to the mission-critical systems and infrastructure in our country. This risk does not occur in a specific policy

[13] Ministry of Internal Affairs and Communications: 2013 WHITE PAPER Information and Communications in Japan (http://www.soumu.go.jp/johotsusintokei/whitepaper/h25.html)

[14] For example, Japan dropped from 7th in 2007 to 13th in 2010 in the "ICT development index" ranking published by ITU (International Telecommunication Union). The "ICT development index" is based on indicators such as the number of mobile phone subscribers, PC-ownership rate, and rates of penetration of fixed-line and mobile broadband Internet services.

[15] Ministry of Internal Affairs and Communications: 2013 ICT International Competitiveness Indicators III Corporate Competitiveness (Market Share) (http://www.soumu.go.jp/main_content/000255646.pdf)

issue only, but is inherent in every policy issue. Therefore, it is important to establish core technology for immediately controlling and preventing incidents to stop them from spreading to other policy challenges.

<Nanotechnology>

To create new parts and materials commonly required for addressing various policy challenges, it is necessary to design and process devices and materials at nano level. Nanotechnology, which analyzes and controls substances at atomic and molecular levels to create devices with the desired property or functionality, plays an important role as a technology that forms the basis of the manufacturing industry in our country.

For example, to realize next-generation vehicles and information equipment whose practical use and spread have been anticipated because of efficient energy use, nanotechnology has lived up to expectations in various technologies. They concern high energy density batteries for hybrid vehicles, catalysts from which rare metals have been reduced significantly, organic EL materials for information equipment panels, and transparent conductors for touch panels. These materials and devices would have never been realized without the following technologies: measurement and analysis for visualization and comprehension of phenomena, structures, and compositions at nano level; material design at nano level to realize functionality; and processing technology that incorporates such technologies in devices or systems.

The present global position of our country's research in the field of nanotechnology and material is advantageous thanks to the measures taken so far based on public–private partnerships. To create materials that possess new functionality and develop devices that can be applied to a wide range of fields, it is strongly demanded that nanotechnology is and will be a source of the country's industrial competitiveness from now on, as a cross-cutting technology that gives support in addressing policy challenges.

<Environmental technology>

There are serious environmental problems: adverse effects on the ecosystem and food production due to climate change including global warming; the decrease of Arctic sea ice; and environmental degradation and shortage or exhaustion of resources attributable to the mining and refining of mineral resources necessary for expansion of economic activities.

To solve various policy challenges involving these problems, for environmental

monitoring and climate change prediction on a global scale, for example, by promoting the processes from development of observation technology to data utilization in an integrated manner, it becomes possible to realize a clean and economical energy system through identification of the current status of the potential capacity of renewable energy fluctuating due to change in wind conditions, and also make international contribution by creating scientific knowledge. The above can contribute to fostering of new industries by utilizing regional resources through identification of climate change for future food production management and forest protection.

There is growing global interest in how to respond to environmental problems, and international frameworks related to the environment and energy are increasing. It is possible to increase Japan's international competitiveness by promoting the advanced environmental response measures possessed by Japan together with the measures for addressing the above issues on a global scale in an integrated manner.

2. Perspectives of addressing policy challenges

ICT, nanotechnology, and environmental technology applied in a cross-cutting manner for addressing policy challenges shall be understood from the following perspectives:

<ICT>

The ICT utilization performed so far has changed the social and local infrastructure. For that reason, the perspectives for addressing the following three policy challenges shall be set based on what kind of new value is provided to socioeconomic activities and individual activities or to the social and local infrastructure supporting them, and in what area ICT will work effectively.

Primarily, to contribute to socioeconomic activities, it is necessary to have a perspective of creating new things and ideas by integrating diverse databases, such as human knowledge and material information, and performing analysis on their combinations. This shall be set as the perspective for addressing policy challenges "knowledge creation for contributing to socioeconomic activities." In this phase, contribution to "realization of a healthy and active aging society as a top-runner in the world" is expected from the perspective of newly developing potential by using man's cognitive information. In addition, contribution to "development of next-generation infrastructure as a top-runner in the world" is

expected from the perspective of creating public services using data on networks, new knowledge contributing to disaster prevention and disaster risk reduction, and unnoticed recognition in a complex system.

Second, to contribute to individual activities, it is necessary to have the perspective of realizing a system in which information equipment surrounding individuals shares sensations and emotions with the said people so that the surrounding environment supports their social activities without their awareness. This shall be set as the perspective for addressing policy challenges “support from the surrounding environment for individuals to participate in social activities.” In this phase, contribution to “realization of a healthy and active aging society as a top-runner in the world” is expected from the perspective of information equipment sharing and visualizing human sensations and emotions to support individual daily activities. In addition, contribution to “development of next-generation infrastructure as a top-runner in the world” is expected from the perspective of realizing development of a community provided with regional comprehensive healthcare based on elder-watch service using sensors, cohabitation with robots, and so on, as its functionality. Furthermore, contribution to “fostering of new industries by utilizing regional resources” is expected from the perspective of developing an environment connecting the region or the world.

Finally, to contribute to the social and local infrastructure, it is possible to assume the perspective of building a copy of the real world in a virtual space using all kinds of information collected through sensor networks, etc. and predicting the real world to provide people with new value and create completely new services. This shall be set as the perspective for addressing policy challenges “more sophisticated infrastructure and network for providing new value.” In this phase, contribution to “realization of a clean and economical energy system” is expected from the perspective of increasing efficiency in energy use by grasping the real society in a sophisticated manner using sensor networks. In addition, contribution to “development of next-generation infrastructure as a top-runner in the world” is expected from the perspective of a network that exercises prediction capability beyond human recognition creating new services.

<Nanotechnology>

To solve various policy challenges, such as efficient energy use, resource risk reduction, and environmental load reduction, it is considered important to create devices realized by nano-level laminating technologies, such as crystal growth and thin-film formation in power conductor wafers, and create materials realized

by analyzing and controlling rare-metal-reduced catalysts at atomic and molecular levels. Then, the following two perspectives for addressing policy challenges are set.

Primarily set as a perspective is “development of next-generation device systems responding to new social needs,” meaning that with an eye toward the final exit, important specific issues are identified and then policy challenges are solved using new device systems. In this perspective, it is important to realize optimization as a system by not only developing new technologies, but also including combinations of existing useful technologies. In that case, it is possible that new device systems with industrial competitiveness are born because of overlap between applied technologies for addressing policy challenges and technologies accumulated as cross-cutting technologies in such fields as materials, micromachining, and nano-level analysis and evaluation.

Power electronics is a specific measure to be taken from this perspective. It is expected to contribute to addressing energy policy challenges by realizing highly efficient transportation equipment, and to addressing infrastructure policy challenges by building new power grids. In addition, contribution to such policy challenges as realization of a healthy and active aging society and fostering of new industries by utilizing regional resources is also expected by developing and utilizing bio-sensing device systems and bio-devices interacting with organisms.

Secondly set as a perspective is “development of materials realizing new functionality,” meaning that policy challenges are solved using new materials created by deepening underlying technologies or out of developers’ free ideas. In this perspective, it is important to create new functionality by developing substitute materials for rare elements and innovative materials that are strong, light, and have heat-resistant properties. And it is important that technologies in fields such as defect control and high reliability shall be developed for deployment into production, and that together with material development, the basic technologies in the following fields shall be strengthened: nano-simulations and databases; measurement; analysis; evaluation; machining; and materials informatics. In research in fields such as nanotechnology and materials, new discoveries are often made from phenomena that are unexpected and can be said to happen by chance (serendipity). Therefore, it is also necessary to develop an environment in which researchers’ free ideas can be used and serendipity is likely to occur; change the world significantly with new ideas; and develop possibilities for the next generation.

Specific measures to be taken from this perspective include efficient energy

use realized by developing innovative structural materials and response to the shale gas revolution based on innovative catalysts. They are expected to contribute to addressing energy policy challenges. And the improvement of the durability of structures using new structural materials is expected to contribute to policy challenges including infrastructure development. Besides, there is a possibility that the ripple effect spreads, such as contribution to new policy challenges by creating materials that have not existed before.

<Environmental technology>

To solve the issues involving environmental problems mentioned in Basic understanding, the following two perspectives for addressing policy challenges are set from the perspective of influence on a global scale.

Primarily set as a perspective for addressing policy challenges is “monitoring for contributing to realization of a sustainable society and its utilization,” which means that by accelerating the advanced Earth observation research owned by our country and providing users with information obtained from that research, such as observation data, a society sustainable in the future is realized and contribution is made to the strengthening of our country’s industrial competitiveness. In this phase, the use of obtained data in various fields can be expected to contribute to addressing various issues.

For example, contribution to “realization of a clean and economical energy system” is expected from the perspective of utilization for grasping the current status of the potential capacity of renewable energy in the future. Also, contribution to “a healthy and active aging society” is expected from the perspective of reducing health risks by predicting the impact on human health of climate change. Furthermore, contribution to “development of social infrastructure” is also expected from the perspective of utilization for community development by fully considering the environment. In addition, contribution to “fostering of new industries by utilizing regional resources” is expected from the perspective of utilization for future food production management and forest maintenance.

Second, for continuous economic growth in harmony with the environment, “resources recycling contributing to continuous growth” for wastes and contaminants produced by socioeconomic activities is set as a perspective for addressing policy challenges. In this phase, contribution to “development of social infrastructure for enriching the lives of the Japanese” is expected to be made through development and deployment of technologies and rational

evaluation methods contributing to reduction in wastes and contaminants produced in resource development or urban development and to recycling and reuse of usable materials. And contribution to “creation of new employment opportunities for regional resources” is expected from the perspective of utilization of regional resources with added value.

Applying environmental technology based on these perspectives solves issues mentioned in Basic understanding. And globally promoting and expanding the advanced environmental technology owned by our country contributes to strengthening industrial competitiveness. In this case, not only promoting and expanding the technology, but also communicating its performance and effectiveness, and correct information about the side effects of its introduction together help view the added value of the existing industries in a new light and create new industries.

Cross-cutting technology

Cross-cutting technologies	Perspectives of addressing policy challenges	Related Policy challenges
ICT	(1) Knowledge creation for contributing to socioeconomic activities	- Health and longevity - Next-generation
	(2) Support from the surrounding environment for individuals to participate in social activities	- Health and longevity - Next-generation infrastructure
	(3) More sophisticated infrastructure and network for providing new value	- Energy - Next-generation
Nano-technology	(4) Development of next-generation device systems responding to new social needs	- Energy - Health and longevity - Next-generation infrastructure - Regional resources
	(5) Development of materials realizing new functionality	- Energy - Health and longevity - Next-generation infrastructure - Regional resources
Environmental technology	(6) Monitoring for contributing to realization of a sustainable society and its utilization	- Energy - Health and longevity - Next-generation infrastructure - Regional resources
	(7) Resources recycling contributing to continuous growth	- Next-generation infrastructure

3. Core technologies to be worked on

[Attached table Timetable: Cross-cutting Technology]

The core technologies to be worked on from the previously mentioned perspectives for addressing policy challenges are shown below.

To work on these core technologies, it is necessary to develop a clear "exit" strategy regarding how they should contribute to addressing the five policy challenges, and to check that point to perform the PDCA cycle for the year according to the timetable.

(1) Knowledge creation for contributing to socioeconomic activities

[Timetable Cross-cutting Technology (1)]

1) Core technologies

The following are positioned as core technologies for realizing the measures to strengthen industrial competitiveness in addressing policy challenges: "information security technology," which realizes secure information management and accurate authentication; "sophisticated network technology," which realizes highly efficient and low-power large-capacity communication and disaster-resistant flexibility by innovating devices, equipment, and communication methods, and automatically selecting the appropriate transmission route; "big data analysis technology," which includes the use of HPC[16] (necessary for use in fundamental sciences and genome analysis) and data analysis technology for elucidating complex phenomena; and "brain information processing technology," which reads a person's deep psyche from his subconscious cognitive information and sends feedback to his superficial consciousness. The measures to be promoted for these core technologies include development of a demonstration environment; international standardization and international expansion from the stage of technology development; improvement of public acceptance including personal information protection; establishment of regulations and systems for promoting utilization; and the development of people who find value in diverse kinds of data and make use of them for decision-making in the real society.

For information security technology, in particular, it is essential to establish comprehensive technology, including not only protection at the level of applications for terminals and systems, but also protection up to the level of

[16] High Performance Computing

individual devices constituting terminals and systems or up to the level of networks. Furthermore, since cyber-attack risks are becoming very high, spreading over, and becoming global remarkably, the gravity of unexpected risks is increasing. Therefore, it is necessary to take measures by going out of the box and changing dimensions. Materialization of the above shall be promoted in close collaboration with the National Information Security Center (NISC), based also on the Cybersecurity Strategy[17] and the Information Security Research and Development Strategy.[18]

2) Measures to strengthen industrial competitiveness in addressing policy challenges (Goals to be achieved by 2030)

- Establish neuromarketing, which helps present products suitable for a consumer's taste or preference

  [Contribution to health and longevity]
- Establish preventive healthcare, also covering mental disorders, by evaluating part of human understanding from brain information.

  [Contribution to health and longevity]
- Improve exercise capacity and thinking capacity by neurofeedback.

  [Contribution to health and longevity]
- Establish well-thought-out information security technology capable of properly responding to the rapidly changing situation by 2020.

  [Contribution to health and longevity and next-generation infrastructure]
- Realize a network provided with functionality capable of setting a validity period to the life of information so that information not desired any more by an individual disappears.

  [Contribution to next-generation infrastructure]
- Realize all kinds of services responding to an individual's preference and desire by using an accurate personal authentication system.

  [Contribution to next-generation infrastructure]
- Realize the quick grasping of the situation of the disaster site by information transmission processing in real time.

  [Contribution to next-generation infrastructure]

[17] Decision by the Information Security Policy Council (June 10, 2013). A strategy clarifying the necessity and policy for widely promoting measures related to cyberspace. (http://www.nisc.go.jp/active/kihon/pdf/cyber-security-senryaku-set.pdf)

[18] Decision by the Information Security Policy Council (July 8, 2011). A plan making the policy for research and development in the field of information security concrete. (http://www.nisc.go.jp/active/kihon/pdf/kenkyu2011.pdf)

* As of May 2014, under discussion by the said council for revision.

(2) Support from the surrounding environment for individuals to participate in social activities

[Timetable Cross-cutting Technology (2)]

1) Core technologies

The following are positioned as core technologies for realizing the measures to strengthen industrial competitiveness in addressing policy challenges: "communication support technology," which includes multi-language voice recognition and translation (to help individuals break the language and cultural barrier), knowledge processing, the grasping of meaning in natural language, sign language, and gesture, and of the health condition, human interface (to present information in an easy-to-understand manner), and robotics for providing physical support; "virtual communication technology," which includes high-precision, high-sensitivity recording, analysis, and transmission of multiple sensory stimuli to break the distance barrier, visualization and reproduction of sensory stimuli at a level to make people feel them as almost real, and application of the above to remote healthcare, education, and work; and "small device technology," which downsizes sensors and batteries, promotes wireless communication, and increases efficiency in power consumption to realize in-body wearable devices, support individuals in every living environment, and realize high-level safety and security. The measures to be promoted for these core technologies include international standardization and international expansion from the stage of technology development; improvement of public acceptance, including personal information protection; and establishment of regulations and systems for promoting utilization.

ICT is a cross-cutting technology covering many layers, ranging from device technology for semiconductors to software technology for realizing and operating applications. Therefore, it is important to develop the same exit strategy for the underlying technologies of all layers and specific applications, and perform coordination for total optimization as a system. Coordinating diverse needs with underlying technologies is an issue with a very high degree of difficulty. However, for Japan's ICT, it is essential to solve this issue and set technology as a platform. It is necessary to extract specific items to be realized, consider all of them without stopping, and then develop a plan for promoting them.

2) Measures to strengthen industrial competitiveness in addressing policy challenges (Goals to be achieved by 2030)

- Realize device control that can be easily performed by voice or brain.
  [Contribution to health and longevity and next-generation infrastructure]
- Realize management of health data based on cloud computing by using in-body devices that always monitor the health condition from inside the body.
  [Contribution to health and longevity and next-generation infrastructure]
- Realize communication support to provide medical care and services to people with different cultures, different languages, and/or different types of tacit knowledge.
  [Contribution to health and longevity and next-generation infrastructure]
- Utilize local production technology and realize a new education experience in an environment of communication with realistic sensations, which breaks the distance barrier.

[Contribution to regional resources]

(3) More sophisticated infrastructure and network for providing new value

[Timetable Cross-cutting Technology (3)]

1) Core technologies

The following are positioned as core technologies for realizing the measures to strengthen industrial competitiveness in addressing policy challenges: “sensing device technology,” which realizes an innovative integrated circuit not requiring standby power and autonomous sensor node in a sensor network, and low-cost, passive, highly efficient devices with both sensing and communication functions; “real-world simulation technology,” which realizes a real-time virtual space by using a positioning system with high precision, a device for storing and processing huge data at high speed, sophisticated software for operating diverse and complex systems in a reliable and energy-efficient manner, and system architecture for pursuing the most appropriate combination of them; and “sensing and recognition technology” for creating abilities for recognition and action exceeding those of human beings in the real world by high-speed and efficient sensing, high-speed data processing using hierarchical parallel distributed processing, and sophisticated information processing such as dynamic processing and forecast analysis of a wide range of information. Measures including international standardization and international expansion from the stage of technology development shall be taken to promote the above.

2) Measures to strengthen industrial competitiveness in addressing policy challenges (Goals to be achieved by 2030)

- Realize a smart city by developing a cloud computing system for regional energy management.

  [Contribution to energy and next-generation infrastructure]
- Increase the efficiency of a social system, create new industries, and realize a “cyber physical system,” which contributes to supporting civic life in many aspects.

  [Contribution to next-generation infrastructure]
- Realize pinpoint information transmission service by achieving indoor-positioning with precision to several tens of cm.

  [Contribution to next-generation infrastructure]
- Realize various applied systems in which cognition functionality and action functionality are merged.

  [Contribution to next-generation infrastructure]

(4) Development of next-generation device systems responding to new social needs

[Timetable Cross-cutting Technology (4)]

1) Core technologies

As core technologies for realizing the measures to strengthen industrial competitiveness in addressing policy challenges, development of the following shall be promoted: “power electronics,” which realizes energy conservation, such as energy conversion devices, super-low-power power devices, and motors with the amount of rare elements used in them significantly reduced; and “high-functionality sensing devices,” which collect bio-information to support health and longevity, such as bio-sensors and micro-sensors. Device-related peripheral technologies in fields such as highly efficient and highly reliable circuit design and heat design, modularization, and high-precision machining shall be developed to also promote the development of a system that responds to social needs.

In addition, it should be noted that in recent years, device systems developed by an approach not taken before have received wide attention. They include biomimetic device systems, which mimic the functionality, mechanism, or shape of organisms; drug delivery systems, which deliver the right dosage to the right region; and “nano-bio-device systems,” which are bio-devices interacting with

organisms. Measures to use these innovative devices as next-generation device systems can be expected to create a massive ripple effect in a cross-cutting manner.

To promote these devices globally, it is necessary to develop a strategy for promoting international standardization and authentication systems from the stage of technology development and an intellectual property strategy to protect intellectual property rights. It is also necessary to arrange a research and development center and shared network for effectively implementing human resources development, staff recruitment, and promotion of continuous research to support core technologies.

2) Measures to strengthen industrial competitiveness in addressing policy challenges (Goals to be achieved by 2030)

- Realize a low power consumption society by making use of super-low-power device systems.
  [Contribution to energy and next-generation infrastructure]
- Build systems that use energy highly efficiently by making use of energy conversion devices.
  [Contribution to energy and next-generation infrastructure]
- Realize energy-saving motors with high energy efficiency.
  [Contribution to energy and next-generation infrastructure]
- Realize a healthy and active aging society by making use of high-functionality sensing devices.
  [Contribution to health and longevity and regional resources]
- Realize new small and highly efficient devices that mimic organisms.
  [Contribution to energy, health and longevity, and next-generation infrastructure]
- Promote and spread drug delivery systems for various diseases.
  [Contribution to health and longevity]

(5) Development of materials realizing new functionality

[Timetable Cross-cutting Technology (5)]

1) Core technologies

As core technologies for realizing the measures to strengthen industrial competitiveness in addressing policy challenges, development of materials realizing new functionality shown as follows shall be promoted: “structural materials,” including metal, resin, composite materials, and carbon materials,

which meet the severe requirements, such as high strength, light weight, and heat resistance; and “innovative catalysts,” which respond to the shale gas revolution and solve environmental and energy problems.

And the following shall be also promoted: measures to advance the underlying technologies necessary for materials development; “nano-carbon materials” as reinforcement of technological development for practical use for the purpose of deploying developed materials into production; and “base technologies” supporting nanotechnology, such as nano-simulations and databases, measurement, analysis, evaluation; machining; and materials informatics.

In addition, it should be noted that in recent years, approaches not taken before have received wide attention. They include technology integration between different fields, molecular design technology, hybrid compounds, space and gap structure control, and self-repairing functionality. The technological development using these innovative approaches to create materials and put them into practice can be expected to create a massive ripple effect in a cross-cutting manner.

To develop new materials, it is necessary to implement the following at the same time: development of technology for collecting and processing harmful wastes, such as factory effluent and exhaust and emissions produced in the production process of new materials; and system-related arrangement to promote social acceptance, such as evaluation and control of the safety of materials and creation of standards. A research and development center and shared center platform shall be built for effectively implementing human resources development, staff recruitment, and promotion of continuous research to support core technologies. In addition, it is necessary to build a system for actively making use of cutting-edge large-scale research facilities, such as the super computer “K computer” and SPring-8.

2) Measures to strengthen industrial competitiveness in addressing policy challenges (Goals to be achieved by 2030)

- Realize innovative structural materials contributing to strengthening aircraft and generator industries.

[Contribution to energy and next-generation infrastructure]

- Sophisticate processing technologies, such as technology for bonding different materials for application of innovative structural materials to actual equipment.

[Contribution to energy, next-generation infrastructure, and regional resources]

- Realize next-generation, high-speed, low-power transportation equipment using lightweight, high-strength structural materials.

  [Contribution to energy and next-generation infrastructure]
- Develop highly biocompatible structural materials for organisms.

  [Contribution to health and longevity]
- Realize liberation from restraints of resources by promoting the use of technologies related to replacement of rare elements and recycling.

  [Contribution to energy]
- Promote the use of innovative catalysts that help efficiently produce energy and chemical products from shale gas.

  [Contribution to energy and next-generation infrastructure]
- Commercialize nano-carbon materials.

  [Contribution to energy and next-generation infrastructure]
- Establish technology for creating materials with new functionality based on elucidation of a mechanism for expressing materials properties and commercialize materials with new functionality.

  [Contribution to energy and next-generation infrastructure]

(6) Monitoring for contributing to realization of a sustainable society and its utilization

[Timetable Cross-cutting Technology (6)]

1) Core technologies

As core technologies for realizing the measures to strengthen industrial competitiveness in addressing policy challenges, the following shall be promoted: “Earth environmental monitoring and climate change forecast technologies,” which include Earth environmental information base technology and are developed from technologies such as observation technology using satellites and forecast technologies based on analysis of observation data and its results.

To be specific, underlying technologies, such as sensor technology for Earth observation and climate change forecast simulation technology, shall be improved. Base technologies for measuring and estimating information about the Earth’s environment with high precision and high resolution shall be improved, too. Moreover, user-oriented data operation shall be performed by integrating Earth observation data with various measurement data for use by researchers in each field and by companies. By promoting the above, the

Government shall aim to contribute to assisting companies in BCP[19] associated with natural disaster risks; reducing and absorbing greenhouse effect gas emissions for the future and evaluating their effects on the human health and on the ecosystem; implementing community development by fully protecting and considering the environment; and appropriately controlling food production.

To promote technologies from observation to data utilization as a whole, it is necessary to promote them based on a uniform policy from the development and research phase up to the point of addressing issues and social implementation. It is also necessary to develop engineers who can arrange various infrastructure networks, such as satellites and monitoring sites, and process and analyze various types of observation data.

2) Measures to strengthen industrial competitiveness in addressing policy challenges (Goals to be achieved by 2030)

- Realize a clean and economical energy system by expanding supply of renewable energy.

  [Contribution to energy]
- Realize a healthy and active aging society by reducing health risks.

  [Contribution to health and longevity]
- Realize community development by fully considering the environment.

  [Contribution to next-generation infrastructure]
- Realize appropriate food production control and appropriate protection of regional resources, such as forest protection.

  [Contribution to regional resources]

(7) Resources recycling contributing to continuous growth

[Timetable Cross-cutting Technology (7)]

1) Core technologies

As core technologies for realizing the measures to strengthen industrial competitiveness in addressing policy challenges, the following shall be promoted: “resources recycling technologies," which produce highly-value-added from limited resources, such as technology for evaluating material properties and technology for selecting and separating materials for recycling.

To be specific, the following shall be developed: systems for managing and collecting products that contain highly recyclable and highly harmful substances,

[19] Business Continuity Planning

such as electric and electronic equipment; technologies for efficiently processing wastes produced in resource development and materials processing; and evaluation and control methods based on scientific knowledge for chemicals whose risk is of concern. And, introduction of the following in the overseas market shall be promoted: comprehensive water resource management using ICT, technology for membranes for water treatment, and efficient utilization of water resources in areas where environmental pollution is serious.

To promote these technologies, measures shall be taken to create a system such as a legal system for putting technologies into practice or promoting their use, create an international framework from the stage of technology development, and pursue international standardization and international expansion.

2) Measures to strengthen industrial competitiveness in addressing policy challenges (Goals to be achieved by 2030)

- Realize infrastructure for a recycling-based society.
  [Contribution to next-generation infrastructure]
- Promote measures to improve the productivity of resources.
  [Contribution to regional resources]
- Develop regional industries by utilizing regional resources.
  [Contribution to regional resources]

Section 3 Capitalizing on the Opportunities of the 2020 Tokyo Olympic and Paralympic Games

(1) Significance of science and technology initiatives taken toward the 2020 Tokyo Olympic and Paralympic Games

That Tokyo was elected to be the host of the 2020 Olympic and Paralympic Games (hereinafter “the Games”) has provided positive topics to Japanese society that had been affected by negative factors, including long-term deflation and the 2011 Great East Japan Earthquake and Tsunami.

Setting a goal to capitalize on the measures introduced in Sections 1 and 2, or to realize practical applications of the technologies discussed thereof, gives research and development efforts a clearer purpose, that is, “commercialization.” Research and development of technologies will be promoted to respond to immediate necessities toward exit (practical use), not for some vague future needs. Moreover, organizing the Games will attract worldwide attention to Japan’s various activities, generating opportunities for Japan to introduce its science, technology and innovation that have been commercialized. We must see the Games as a critical goal in devising an exit strategy.

It is necessary to make the most of this opportunity and accelerate efforts to solve policy challenges. Also, we must create a stage where Japanese innovations are demonstrated to the world, and, at the same time, knowledge and expertise are gathered from the world over.

These initiatives should also include sustainable ones that will bring the “virtuous cycle of growth” to Japanese society after the Games.

(2) Basic idea of the initiatives

Applying state-of-the-art technologies to efficient hosting of the Games and comfortable and safe services provided to the visitors is the key factor in smooth operation of the Games.

Also, taking this opportunity, demonstrating our society where numerous problems have been solved by latest technologies will energize Japanese economic growth by sparking globalization of domestic industries and stimulating investment in Japan by overseas corporations. It is particularly expected that people from around the world will actually sense, by being in Japan, how Japan has been coping with issues, including problems characteristic of a graying society and risks of natural disasters.

The initiatives will be accelerated toward addressing policy challenges through

science, technology and innovation centering on the three basic concepts, “comfort, environment, and safety.”

(3) Possible projects

By combining the measures introduced in Sections 1 and 2, and accelerating the initiatives toward 2020 to ensure that the outcomes can be used to facilitate the Games or put into practical use with the Games as a stimulator, some effective projects are expected to be generated. The following are examples:

- Development of a communication support system to provide every kind of service to foreign visitors with different cultures, different languages, and/or different types of tacit knowledge; for example, international navigation system, signage, and medical services.
- Reinforcement of infectious diseases surveillance to promptly detect epidemics that may occur due to a large number of people from various regions of the world coming into the country.
- Development of prosthetic limbs with sensory functions and establishment of technologies to develop motor ability assistance, as well as practical application of a frontline healthcare system, such as real-time data acquisition and use of biological information, so as to support athletes as well as the elderly and physically challenged people.
- Practical application of a public road transport system that takes Tokyo’s growth and aging society into consideration, and walking/transport support systems for vulnerable road users.
- Establishing technologies to produce, transport, store, and use hydrogen to maximize renewable energy use, and realization of a zero-emission society using hydrogen or energy carrier for power generation, heat utilization, automobiles, etc.
- Securing safety and peace of mind by enhancing forecasting technology to predict sudden weather disasters, such as “Guerrilla” intensive rainstorms and tornadoes, and by ensuring dissemination of proper information.
- Realization of a “Cyber Physical System” that enables various supports for public life using big data acquired by real-world monitoring with sensors of different kinds. Possible applications of the system include crime investigation and counterterrorism measures.

In order to efficiently advance the initiatives, which are designed to solve

policy challenges, toward the Games, it is important that research and development are conducted to solve multiple issues in combination, not focusing on addressing one problem at a time. Such projects must also be able to generate a “virtuous cycle of growth” that lasts even after the Games.

(4) Systematic Endeavor

Targeting the Games, a taskforce will be set up under the leadership of the Council for Science, Technology and Innovation to form projects that ensure practical application of research and development outcomes. These projects must involve: regulatory reforms and other efforts to enhance law so as to enable practical application of the research and development results in a variety of fields; coordination with organizations and institutions involved; and reviews of specific initiative contents and timetables relating to science and technology development.

Chapter 3 Creating Environment Suited for Science, Technology and Innovation

1. Basic understanding

(1) Realizing sustainable innovation systems with potential of development

In the era of a highly aging society accompanied by decreased birthrate, which has resulted in a serous population decrease, it is also anticipated that we will have to face severe limitation of resource and energy availability, as well as an exacerbated international economic environment. Deploying policies centered on science, technology and innovation is the only effective way to maintain the prosperity of Japan while realizing sustainable development.

With this grim reality in its perspective, the Abe Administration has decided to transform Japan into "the world's most innovation-friendly country," and promoted its policy based on a comprehensive strategy that was decided in a Cabinet meeting in June 2013. Among other efforts made last year, introduction and promotion of a new mechanism that leads the government-wide budget strategy for science and technology development were focused on as a part of the efforts to strengthen the "headquarter" function of the Council for Science and Technology Policy. Moreover, powerful "stimuli" have been adapted, such as launches of the "Cross-Ministerial Strategic Innovation Promotion Program (SIP)," an interdisciplinary program that also transcends the boundaries of ministries, and a high-risk, high-impact "Impulsing Paradigm Change through Disruptive Technologies (ImPACT) program."

However, because an innovation is often made out of extraordinary ideas and combinations of such ideas, in order to further accelerate and make more effective the movement toward realizing "the world's most innovation-friendly country," it is necessary to make nationwide commitment toward "structural enhancement" for realizing sustainable innovation systems with development potential based on the above powerful "stimuli." While there is only so much the government can do in foreseeing "what to do" and "how to do" it in future and setting future research themes and structures in an exhaustive manner, larger innovation potential can be found through challenges of various kinds and multifaceted "interactions" beyond the government's preset coverage.

(2) Expanding opportunities for various “challenges” and multifaceted “interactions”

Because it is “people” who take on various “challenges” and interact, the role of the government toward realizing “the world’s most innovation-friendly country” is encouraging human resources motivated to science, technology and innovation, including those in private-sector businesses, to take on various “challenges” and “interact” with each other through budgeting, regulations, and institutions, and creating a social climate in which “challenges” and “interactions” are accepted positively.

Although various policies have been reviewed and related measures have been enacted as part of the reform of science and technology system, they have not necessarily been effective, because of such negative factors as the vertical structure of the ministries and agencies, insufficient inter-sector cooperation, government intention failing to be fully communicated to the actual research and development sites, and regulatory reform difficulties (though not limited to the ones related to science and technology.) What we need are the whole picture and policy operation from the perspective of innovation system optimization, and not eccentric policy operation, policies that just look new but without effects or short-sighted policies to fill gaps.

The current science and technology basic plan assumes the following three functions of the nation’s innovation systems:

1) Fostering various “knowledge” that is the source of innovations and human resources that play a central role in innovation
2) Honing “knowledge” in an environment where human resources with various skills and know-how co-generate ideas, and
3) Bringing innovations to fruition as new economic, social, and public values through demonstration, pilot experiment, and commercialization.

The government will provide various opportunities relating to “challenges” and “interactions” in every aspect, so that the potential of science, technology and innovation can be dramatically improved.

The comprehensive strategy decided in a Cabinet meeting last year sets three focused policy challenges: “fostering seeds of innovations,” “activating innovation systems,” and “bringing innovations to fruition.” While the discussion will be based on these tasks that correspond to the abovementioned three functions, this chapter will restructure some of the priority initiatives by overviewing the nationwide initiatives, including those of the private-sector

companies, and setting a strategic policy operation as a goal. Also, principal measures that must be intensely focused on or related measures that need continuous promotion under this comprehensive strategy will be presented in this chapter.

2. Focused policy challenges

In order to develop an environment suited for science, technology and innovation, discussion will be based on the structure of the comprehensive strategy described above, and the three focused policy challenges ("fostering seeds of innovations," "activating innovation systems," and "bringing innovations to fruition") will be set as core tasks. Priority initiatives for each core task are set as follows:

Creating an Environment Suited for Science, Technology and Innovation

Focused Policy Challenge	Focused measure
Fostering seeds of innovations	1) Expanding opportunities where diverse and flexible ideas and experiences are utilized
	2) Enhancing functions of universities and research and development corporations to reinforce research capability and human resources
	3) Restructuring the research fund systems
Activating innovation systems	1) Developing innovation hubs that take advantage of organizational "strength" and characteristics of each local area
	2) Reinforcing functions of public research institutions that serve as a "bridge"
	3) Enhancing the research promotion system
Bringing innovations to fruition	1) Energizing corporations that tackle new businesses
	2) Promoting regulation and system reforms
	3) Promoting international standardization and intellectual property strategy

3. Focused measures

(1) Fostering "seeds of innovations"
---Strategic development of initiatives toward reinforcement of research capability and human resources---

The important perspectives here are how to keep diversity of essential "knowledge" that would lead to innovations, how to secure human resources in organizations including private-sector companies who take on such innovations, and how to maintain and expand the system in a sustainable manner. These perspectives are directly connected to maintenance and improvement of the national development foundation, as well as improvement of the international competitiveness of the nation's industries in that they involve fostering key players of innovations in Japan, not just "innovation seeds" that form the foundation of future products and services.

In actual initiatives, providing diverse "challenge" opportunities to human resources with strong motivation to generate "knowledge" is necessary. In doing so, emphasis must be put on promotion of interdisciplinary and cross-sectional "interactions," as well as securement of "challenge" opportunities for young and female researchers, enabling them to make the most of their flexible ideas and experiences. Function reinforcing efforts must be made not only on individual level (i.e., researchers and engineers), but also on organizational level, such as universities and research and development corporations, through human resource development and R&D activities in terms of securing robustness of the innovation systems and their sustainable expandability. In addition, the current research funds allocation system needs fundamental reform.

Some speculation has been made that initiatives to solve problems Japan is facing and achieve goals as proposed in the 4th Science and Technology Basic Plan may conflict with the policy to promote basic research. However, the Plan states that these initiatives are taken by participation of diverse institutions from industry, academia, and government, and by linking activities in each stage, from basic and applied research to development, practical application, and commercialization, in a cross-cutting manner. It is inarguable that basic research, where essential "knowledge" is generated, is of importance in the science, technology and innovation policy, along with methodology to generate unique research results and develop them to create new value.

1) Expanding opportunities where diverse and flexible ideas and experiences are utilized

What is necessary to raise innovation potential is to secure and expand opportunities where human resources with diverse ideas and experiences can act independently, make the most of those ideas and experiences, and learn from each other for further improvement. Especially, contacts between diverse

human resources, such as young, female, and foreign researchers, as well as encounters between different fields and expertise will spark inspiration that contributes to generation of new “knowledge.”

Data on Nobel Prize awardees’ awarded work and ages suggest the importance of taking advantage of young researchers’ flexible ideas. It should also be noted that, although the percentage of female researchers is increasing in Japan, it is still at a lower level compared to other major countries in the world, with few in leading positions. International comparison of international co-authoring of academic papers indicates that Japan is failing to keep up with globalization of intellectual production. The government of Japan is required to accelerate and promote its efforts more intensely than ever to provide “challenge” opportunities focusing on human resources with strong motivation and capabilities to generate “knowledge,” at the same time developing an environment that enables human resources with motivation, capabilities, and experience to exercise leadership regardless of their ages, sexes, or nationalities, as well as securing re-education opportunities for working people to ensure that they have more chances to apply their skills and expertise.

In this comprehensive strategy, the main focus will be on expansion of opportunities for “challenges” for young and female workers to foster seeds of innovation. At the same time, the “Impulsing Paradigm Change through Disruptive Technologies (ImPACT) program” will be powerfully promoted, along with other related measures from the perspective of offering high-risk research and development opportunities.

<Principal Related Measures>

- Further promotion of internship at universities and active promotion of medium- and long-term internship. [MEXT, METI]
- Expansion of mechanism to secure stable employment and occupational mobility for young researchers based on fair and transparent evaluation. [MEXT]
- Expansion of opportunities for different fields to fuse together by building a temporary research system that transcends the boundaries of organizations and disciplines. Also, promotion of unique research by providing competitive funds that enable young researchers to conduct their research in an individual base. [MEXT]
- Development of an environment that promotes active involvement of female researchers, promotion of fostering of female leaders, and promotion of

appointment of women in leadership positions. These will be done by developing specific programs that set numerical targets for female executives appointed at public research institutions (including research and development corporations and public experiment and research institutions, same hereinafter in this chapter) and universities, and through establishment of role models for female researchers. [MEXT, METI, research and development corporations, ministries and agencies in charge]

- Expanding re-education opportunities for researchers and engineers of private-sector companies. [MEXT, METI]
- Review of the preferential system for highly skilled foreign professionals, such as reducing the residence required for permanent residence permit, so as to be able to accept more highly skilled foreign professionals. [Ministry of Justice (MOJ), METI, Ministry of Health, Labour and Welfare (MHLW)]
- Promotion of the development of an environment that simplifies lives of foreign researchers and their families in Japan, such as enhancing readiness of public schools to accept foreign students as well as Japanese students returned from foreign countries. Useful cases in other countries will be studied for reference. [MEXT]
- Strengthening of the international research network through strategic exchange of highly skilled young researchers. [MEXT]

2) Enhancing functions of universities and research and development corporations to reinforce research capability and human resources

Recently, international superiority of Japan in research and development has started to fade. With a sense of crisis, functions of universities and research and development corporations will be enhanced toward reinforcement of the research capability of Japan, enabling generation of essential “knowledge,” which will be a cradle of science, technology and innovation. Also, research institutions’ organizational responsibilities and management of the heads of such institutions are attracting more attention than ever. However excellent their researchers are, research institutions cannot optimize their research outcomes without good management. Therefore, it is necessary that institution heads are able to demonstrate excellent leadership and R&D management. Also, in order to reinforce human resources who play central roles in the nation’s innovation systems, university reforms will be promoted along with leveraging of research and development corporations. At the same time, factors hampering exertion of research and human resources capabilities will be analyzed in search of solutions.

As to universities, reforms such as optimization of resource allocation within each university will be carried out under the university president's management, according to the "National University Reform Plan" and other programs, aiming to strengthen the functions of universities. In doing so, the advantages and characteristics of each university must be taken into consideration. The process will include securing each university's diversity of disciplines and independence of organizational operation. Fundamental reform and reinforcement will be carried out for education in doctoral programs to nurture outstanding doctors who can act globally in every possible field regardless of industry, academia, or government.

As to research and development corporations, system reform will be carried out to ensure that the corporations can demonstrate their superiority in a global competitive environment according to the "Basic Policy to Reform Independent Administrative Institutions" (the Cabinet decision dated December 24, 2013), while taking aspects of research and development (long-term nature, uncertainty, unpredictability, and specialty) into consideration. It is of special importance to position research and development corporations who generate the world's top-level outcomes that serve as the foundation of science, technology and innovation as the special national research and development corporations (tentative name), and thus make them a powerful driving force of science, technology and innovation in Japan in the context of a national strategy. In addition, cross-sectoral deployment and mobilization of human resources using tools such as cross-appointment system, fusion of disciplines, construction of attractive software and hardware research infrastructures, and sharing of facilities and equipment with other institutions both within and outside the country will be promoted to make universities and research and development corporations play necessary roles as a core of reinforcement of research capabilities and human resources of Japan.

In this comprehensive strategy, the following advance efforts related to reforms of national university and research and development corporations will be focused on while steadily addressing other related measures.

- National universities have functioned as a core of basic research and human resource cultivation, serving as a foundation of sustainable innovations. While this function of national universities must be further enhanced, universities that carry out world-class education and research must create outstanding graduate schools. An environment that further facilitates

concatenated generation of innovations must also be developed. One example is to make a flexible human resource and payroll system that enables a wide range of researchers from universities, research and development corporations, and private-sector companies both inside and outside Japan to get together and interact with one another. While the Ministry of Education, Culture, Sports, Science and Technology will put forth the “National University Reform Plan,” it will also promote, taking each university’s advantages and characteristics into consideration, creation of outstanding graduate schools specializing in fields where Japan has international competitiveness with the highest level results as well as new fields that derive from these fields. In order to achieve the goals, enhancing governance function, as stated in the “National University Reform Plan,” and fostering an environment to constantly review resource allocation within each university must be strongly focused on. While doing so, construction of a new mechanism targeting FY2016, when the 3rd mid-term target period starts, will be considered, including review of necessary systems to boost efforts based on universities’ bold ideas.

- With regard to research and development corporation reform, the relevant ministries and agencies will re-examine and improve the new systems and the operation of the corporations, and, taking the opportunity, strive to transform those corporations into international research hubs according to the mission and role each of them has. These corporations’ collaboration with related institutions both inside and outside Japan will also be enhanced. Right now, research and development corporations are involved in various projects, such as promotion of research and development of technologies relating to national security and critical technology among others, verification of research outcomes both in Japan and abroad aiming at practical application and popularization, improvement of the research infrastructures including allocation of competitive funds and sharing of facilities, and activities to respond to international standardization. These projects will be enhanced through collaboration and by transforming the corporations into international research hubs. The Cabinet Office will establish a new system relating to the “Concepts of a Special National Research and Development Corporation (tentative name)” based on the “Basic Policy to Reform Independent Administrative Institutions” and the “Concepts of a Special National Research and Development Corporation (tentative name, decision of the Council for Science and Technology Policy

dated March 12, 2014) at the earliest possible date, and by utilizing this new system, it will promote the relevant ministries and agencies' efforts for the transformation of the corporations into international research hubs, and strengthen the collaboration between the corporations and other related institutions inside and outside Japan.

<Principal Related Measures>

- For those areas of technology that are critical to industrial policies of Japan, and yet whose academic activities and human resources have decreased, private-sector companies' research and employment needs will be clarified, and venues for dialogues between industry, academia, and government for common understanding will be established and promoted for active use through collaboration with the active efforts carried out by industry. [MEXT, METI, MLIT]
- Fundamental reform will be carried out for education in doctoral programs to nurture excellent doctoral students to become leaders who can act in every possible field regardless of industry, academia, or government, and on the global stage with originality and the ability to look at the bigger picture. This is believed to be achieved by gathering first-class teachers from inside and outside Japan with participation from industry, academia, and government to build an interdisciplinary and systematic education platform. [MEXT]
- Development of a highly appealing research environment to attract the world's top-level researchers including Japanese who are globally active, using examples from the World Premier International Research Center (WPI) Initiative and other large-scale projects that are leading global academic research. WPI is leading projects toward internationalization of universities and research and development corporations with respect to matters including implementing open recruitment of international researchers, making English the official language, enhancing clerical work support divisions, and has so far yielded successful results. It also engages in international evaluation of these efforts. [MEXT, ministries and agencies governing research and development corporations]
- Immediate implementation of possible advance measures responding to the items of operational improvement under the Basic Policy to Reform Independent Administrative Institutions. These items of improvement include compensation and salary, goal setting, performance evaluation, procurement of goods and services, income management, certifying

management efforts, allowing carryover of unused operational expenses grants to the next mid-term target period, and the actual reform will commence in April 2015. [Cabinet Secretariat, Cabinet Office, MIC, ministries and agencies governing research and development corporations]

- Promotion of development of the highest level research and development infrastructure by international standards. [MEXT, ministries and agencies governing research and development corporations]
- Continuous grasping of the careers of postdoctoral researchers through launch of doctor resources database, and contribution to improvement of young researchers' career paths. [MEXT]

3) Re-establishment of a research funding system

Reform is also needed for research fund allocation. This has to be done centering on the key words, "challenges" and "interactions," so that diverse "knowledge" cranks out innovation after innovation, which will make the nation's innovation system stronger and give it more sustainable expandability.

The government has thus far aimed at development of a competitive research and development environment under the science and technology basic plan, and presented such policies as expansion of the competitive funds, securing allowance for overhead, examination of effective combinations of basic and competitive funds, and ensuring appropriate handling of basic funds that are enabling education and research. The relevant ministries and agencies have promoted necessary measures under these policies. However, in recent years, it has been recognized that percentages of academic papers and outstanding papers authored by Japanese researchers in the total numbers of papers published worldwide are in a downward trend, and some have pointed out that these measures may not necessarily be enhancing the research capability of Japan.

In light of such circumstances, research fund system reform will be launched to ensure that the nation's innovation systems will function effectively in terms of research funds. The Council for Science, Technology and Innovation will examine the current research funds allocation and how it should be, and indicate its basic policy for the measures needed to be worked on under the next science and technology basic plan with the cooperation of the relevant ministries and agencies, while paying attention to the progress of the national university reform and research and development corporation reform. With regard to the Grants-in-Aid for Scientific Research (KAKENHI), a competitive fund system

representative of Japan, while, in a simpler and more open framework, diverse high-quality academic research will be promoted for generation of “knowledge,” reforms are targeted in connection with interdisciplinary research and international joint research based on outstanding research in different fields, lumping the fields to be reviewed for subsidization into larger groups to facilitate establishment of new academic fields, and the system for such review.

In this comprehensive strategy, competitive funds, including KAKENHI, will be re-established by giving consideration to bridges between different funding systems and usability to ensure that researchers are allowed to devote themselves to research activities and conduct research seamlessly from basic and applied study to the practical stage. In doing this, it is important to enable lumping and “metabolism” of fields while maintaining a system that is generally easy to understand for researchers. Also, other efforts will be carried out, such as enhancement of the management in fund allocation agencies, launch of a database that transcends the boundaries of ministries and agencies that enables grasping and utilization of research outcomes to a maximum extent (this will involve integration of existing databases), and sharing of research facilities and equipment purchased using competitive funds.

<Principal Related Measures>

- With respect to the competitive fund system that is implemented by ministries and agencies, the option that allows purchase of facilities to be shared by combining research funds from different systems, which is already implemented by some ministries and agencies, will be allowed to be adopted by other ministries and agencies. Also, effective sharing and utilization of the purchased facilities and equipment after the completion of the research will be promoted to improve their usability and ensure their reasonable operation. Moreover, the concept of a system that transcends the boundaries of ministries and agencies, as well as the conventional system framework, will be clarified to enable seamless provision of funds for outstanding research from the basic phase to practical application. [Cabinet Office, ministries and agencies in charge of the competitive fund system)

(2) Activating innovation systems
--Realization of a co-creation environment that transcends the boundaries of fields and organizations--

This is a function that enables key players with various knowledge, skills, ideas, and know-how to convert their research and development outcomes to economic, social, and public values while actively involving themselves in the process in which innovations are generated. To ensure that outstanding outcomes are converted into new values more effectively, it is important to connect each phase of research—basic, applied, developmental, and experimental—with flexibility. At the same time, it is of extreme importance that non-researcher individuals and organizations from different fields with different roles and expertise generate "interactions" toward innovations by forming a team where members can share outcomes and other information while complementing one another beyond the conventional framework.

To promote such "interactions," mobility of human resources must be improved to become inter-organizational so that appropriate human resources allocation can be done easily. This must be accompanied by diverse "settings" and networks that enable individuals and organizations with different ideas and know-how to collaborate toward common goals while having the same vision, and learn from each other for further improvement. It is not easy for such boundary-less "settings" and networks that are open to both inside and outside Japan to form themselves, and waiting for that to happen one day will surely make Japan fall behind in the international innovation competition.

Vertically segmented structure is dominant in sectors in Japan, where it is the tradition to secure and foster outstanding human resources by way of long-term employment. As a result, when a researcher moves to another institution, it often works against the researcher in terms of salary. This is one of the major reasons for the lower employment mobility in Japan than other countries. It also prevents appropriate allocation of non-researcher human resources who support research. Elimination of such negative structural factors to improve the research environment is one of the government's important functions, and must be worked on through collaboration beyond the boundaries of ministries and agencies.

1) Developing innovation hubs that take advantage of organizational "strength" and characteristics of each local area

Efforts will be made to create innovation hubs[20] with active participation from industry, academia, and government, taking advantage of the "strength" of

[20] "Settings" where human resources with knowledge, technology, ideas, and know-how gather to create innovation and network hubs where those people who drive innovation are connected virtually.

universities and research and development corporations as well as characteristics of local area (local private-sector companies' technologies and human resources, connections among industry, academia, and government within each local area, how clustered related institutions including research institutions are, etc.)

In this comprehensive strategy, the measures listed below will be vigorously promoted to create international innovation hubs centering on research and development corporations based on the "Reform Strategy of Innovation National System of Japan" (minister in charge of economic revitalization, April 14, 2014), and in light of the fact that the research and development corporation reform is in progress. Also, along with other related measures, the "Cross-Ministerial Strategic Innovation Promotion Program (SIP)" will be promoted as an initiative to provide a co-creation environment that transcends the boundaries of ministries, agencies, and fields.

- Building a framework for cooperation beyond the boundaries of vertically divided administrative functions of government agencies and of industries, universities, and government, centering on research and development corporations to develop the world's top-level bases for international industry–academia–government joint research and network-type bases in the field of nanotechnologies and other fields where there is intensive international competition. The Council for Science, Technology and Innovation will play a supporting role in this framework. Creation of innovation hubs, especially in areas where universities, public research institutions, and private-sector companies are clustered, will be accelerated, and the reform of the nation's innovation systems will be carried out using this acceleration momentum as a driving force.
- To ensure that mobility of researchers is enhanced, actively adopt and utilize a cross-appointment system, which allows people to work at both universities, etc. and other institutions while maintaining their positions both at universities and institutions, between universities and research and development corporations by promoting the introduction of an annual salary system and defining handling of health insurance, pension, and retirement benefit. At the same time, further utilize systems for joint research and collaborative graduate programs. Promote enhancement and utilization of a system for dual employment of university teachers and research and development corporation personnel, a system for sending personnel on loan

to private-sector companies, and sabbatical leave programs.

- Actively provide students with opportunities to participate in contracted research from private-sector companies and industry–academia–government joint research to foster innovation-oriented researchers.
- To ensure that corporations are more motivated toward revenue growth, when a corporation is expecting an increase in its income and is going to carry out a new business using the increased portion of its income, allow it to include an additional allowance for the expected expenses for the new business in its request for the operational expense grants, and reduce none of the amount appropriated for the expense from the requested amount of grants. Depending on the characteristics of each corporation, such as administration, operation, and income resources, its extraordinary income from donation, contracted research compensation and etc., of which the amounts cannot be estimated, will not be deducted in calculation of the grants. In addition, deliberations on corporations' own income will be carried out, such as measures for promotion of donation to corporations, increasing contracted research compensation, etc.

<Principal Related Measures>

- Creation of a platform for advanced R&D and an experimental environment where diverse players can participate by presenting cross-ministerial goals to induce innovations. [relevant ministries and agencies]
- Creation of hubs for industry–academia–government collaboration centering on research and development corporations. In such hubs, R&D and human resources are cultivated to accumulate outcomes with a long-term perspective, based on national strategies for the field of core technologies, which must be provided with continuous, wide-range, and long-term research and development efforts promoted by the government. [MEXT]
- Promotion of shared use of the world's highest-level research and development infrastructures. [MEXT, METI, ministries and agencies governing research and development corporations]
- Promotion of local joint research and development under the collaboration of local universities, local public research institutions and local private-sector companies, development of international science innovation hubs, etc. [Cabinet Office, MIC, MOFA, Ministry of Finance Japan (MOF), MEXT, MHLW, MAFF, METI, MLIT, MOE]
- Promotion of utilization of evaluation indices for activities under industry–

academia–government collaboration. [Cabinet Office, METI, MEXT]

- Implementation of practical cultivation of human resources to ensure that young researchers and graduate students will be equipped with entrepreneurial minds, know-how for commercialization of their ideas, and abilities to identify and solve problems, so that they can venture into innovations. [MEXT]

2) Reinforcing functions of public research institutions that serve as a “bridge”

Innovation cannot be achieved only because seeds of some revolutionary technology have been produced. Nurturing those seeds to transform them into revolutionary products through a commercialization process is an essential element. This kind of system that “bridges” seeds with commercialization is weaker in Japan when compared to Europe and the U.S., meaning that some fundamental reinforcement measures are needed.

One of the measures is to reinforce public research institutions and the like, enabling them to fully play a “bridging” role that is currently played mainly by venture corporations and through industry–academia collaborations under the “Reform Strategy of Innovation National System of Japan” (minister in charge of economic revitalization, April 14, 2014).

Specifically, adding to other related initiatives and efforts including the ones described in (2)-1), the measures listed below will be carried out first within institutions that are expected to play a pioneer role in strengthening of the “bridging” function, such as the National Institute of Advanced Industrial Science and Technology (AIST) and the New Energy and Industrial Technology Development Organization (NEDO). These measures will be carried out in light of the discussions held under the supervision of the Industrial Structure Council, while reflecting some of the items in the mid-term target revision as necessary.

The Council for Science, Technology and Innovation will grasp the progress of these measures with accuracy and perform appropriate evaluation to deploy these measures, using the result of the evaluation, in other public research institutions that will be given “bridging” function in future by taking into account target fields and characteristics of operations of each institution, etc.

- “Bridging” operation will be clearly positioned as the core mission of AIST, and evaluation of its performance will be based primarily on implementation of resources allocation with the highest emphasis on acquisition of funds from industry as well as on acceptance of funds pertaining to contracted

research, etc. from outside companies in the late stage of “bridging” research. Evaluation for researchers and teams involved in “bridging” research will be conducted, not with popular indices, such as papers and patents, but focusing on acceptance of funds from private-sector companies and other matters. As the numerical targets for acceptance of external funds, the percentages of the value of contracted research from industry and license revenue in total operational expense grants of the pertinent fiscal year will be used, with reference to the cases outside Japan such as the one reported by the Fraunhofer Society of Germany. Establishing a virtuous circle, in which these measures lead AIST’s new technologies to commercialization and also enhance AIST’s bridging function, will be pursued, modeled after the case of the Fraunhofer Society.

- Objective basic research will be conducted within AIST to pursue the basic principle while having applied research and practical application in mind. At the same time, the marketing function will be enhanced, which enables prediction of future industry and society needs by launching a department dedicated to marketing and putting personnel with adequately scaled expertise into the department. This will enable research responding to future needs performed in the first stage of “bridging” research.
- AIST will tackle management of intellectual property rights, which basically involves management of its own intellectual properties, including the ones derived from contracted research, and granting exclusive licenses in pertinent fields to private-sector companies that are advancing the technology commercialization.
- Introduction and utilization of a cross-appointment system within AIST to reinforce its collaboration with universities from the perspective of unearthing of technology seeds and cultivation of human resources for practical research. Quantitative targets in relation to outstanding researchers who work both as university teachers and AIST researchers while primarily based in AIST will be set. Also, in order to actively accept excellent doctoral students as its staff members, AIST will advance necessary measures by setting quantitative targets in relation to such students who have their primary bases for their research in AIST.
- Enhancement of the system to provide integrated technological and business support to venture companies, SMEs, and leading medium-sized companies within NEDO while collaborating with and utilizing external institutions. At the same time, nurturing and support will be worked on for

venture companies, SMEs, and leading medium-sized companies by setting numerical targets in relation to proportion of participation from and percentages of support for venture companies, SMEs, and leading medium-sized companies in newly accepted businesses in each fiscal year.

- Adoption and expansion of flexible management within NEDO. The management will cover setting appropriate stage gates, carrying out multiple options in parallel, selecting prospective technologies, fusing technologies, reviewing the necessary implementation system, etc. under managerial personnel who are given substantial authority in project management. Advance introduction of reward-driven approaches that provide settings for competition among many parties (contest) on challenging themes.

3) Enhancing the research promotion system

As science and technology have become advanced, complexity of research systems and sophistication of research infrastructure are becoming higher, while collaboration of multiple institutions is increasing. Under such circumstances, developing diversified human resources who play a bridging role between society and innovations is indispensable in raising the possibility of innovation. Such necessary human resources range from technical support providers and other human resources who support researchers' activities and ones who function as "catalyst" and "judge" (i.e., who grasp needs accurately and in a timely manner and make proposals in response), to those who conduct flexible and agile project management toward achievement of research and development goals.

Human resources capable of fully responding to the increasing coverage of their services must also be cultivated and secured. Such services are related to matters such as prevention of research misconduct and wrongful use of research expenses; ethical, legal, and social issues of research; science and technology communication; outreach activities and other social responsibilities of researchers and organizations where researchers' workplaces are; and relationship between science/technology and society. Above all, it is of utmost importance to respond to social requirements by developing support systems under appropriate governance.

It is expected that the importance of human resources with a high level of expertise and skills will continue to increase. However, it is not always easy for an institution to cultivate such human resources solo, and the numbers of

improvement opportunities one institution can offer to human resources is not sufficient either. Also, if each institution hoards its own outstanding human resources inside, nationwide appropriate allocation of human resources will be hampered.

In this comprehensive strategy, a mechanism will be developed to foster and secure human resources who engage in research management and support nationwide continuously and stably as well as to offer settings where each of such human resources can exert his/her skill with fund allocation agencies playing a central role and by collaboration with related institutions. In addition, development of a nationwide human resource network will be promoted for research support services at each institution to ensure human resource mobilization for appropriate allocation and career path diversification. In doing that, it is important to clarify knowledge and skills required in each support service so that the research support job category is established as a specialist job as important as a researcher job, thus raising social recognition.

< Principal Related Measures >

- Development of a new mechanism to cultivate human and other resources for project management at institutions including the Japan Science and Technology Agency (JST) and NEDO, while ensuring vesting such human resources with substantial authority in pursuing project management. [MEXT, METI]
- Examination of prize-based systems that allow provision of reasonable funds to researchers/institutions who have successfully achieved specific research and development goals within a scheduled period. Introduction of new systems to promote research and development of peripheral technologies by private sectors. [MIC]
- Fostering and securement of excellent technical support providers who are knowledgeable about both state-of-the-art research equipment and research tasks and capable of proposing measures responding to such tasks, not just providing technical assistance in use of research equipment. Promotion of creation of networks and platforms that enable human resources mobilization and career path development. [MEXT]
- Promotion of inclusion of names of technical support providers, the areas the technical support providers are in charge of, and description of research support structure, in paperwork required when requesting for competitive funds. Improvement of the recognition and positioning of such supportive

jobs. [ministries and agencies in charge of competitive fund system]

- Enhancement of the governance in research institutions before and after occurrence of research misconduct through thorough and effective research ethics education, paying attention not to disrupt young researchers' independent and unique research activities. Review of the guidelines to respond to research misconduct and thorough dissemination of the guidelines are the examples of effective way to achieve this. [Cabinet Office, relevant ministries and agencies]

(3) Bringing innovations to fruition
--Supporting numerous activities to utilize new values in the economy and society--

This stage sets private-sector companies as key players. The government's activities are centered on the development of an environment that facilitates concatenating generation of "challenges" by providing incentives (e.g., support in the commercialization process and utilization of regulation/systems toward promotion of innovation) to private-sector companies who take risks in creation of new values.

Especially, venture companies, SMEs, and leading medium-sized companies have characteristics different from large companies, such as the market sizes based on which the decision about commercialization is made, and speed of decision making. With these differences, they are expected to play an important role as a leader of innovations. On the other hand, in total research and development funds granted from the government to private-sector companies, the proportion of the amount granted to SMEs is smaller in Japan than other advanced nations, meaning opportunities are not sufficiently provided. Therefore, measures including expansion of systems to provide active "opportunities" for "challenges" venture companies, SMEs, and leading medium-sized companies that are R&D-oriented, and reforms of regulations and systems must be taken as important policy challenges to generate innovations that clear the air in society.

1) Energizing corporations that tackle new businesses

In practical application of research and development outcomes, roles played by private-sector companies that tackle new businesses, especially, venture companies, SMEs, and leading medium-sized companies that are R&D oriented

(hereinafter “venture companies, etc.”) are of importance, because these corporations produce and nurture innovation seeds. Japan lacks the social climate to grow entrepreneurialism, mainly due to the absence of social recognition that creation of new values is achieved after many failures. This has prevented new industries and venture companies from prospering. On the other hand, there are higher expectations for collaboration between the government and these venture companies, etc. than ever, because the need for open innovations has increased in recent years. Open innovations involve abandoning excessive independence and self-sufficiency in technology development and procuring R&D capability, technical knowledge, human assets, and funds from open external markets for effective innovations.

Whether there is a risk money provider or not is the key in activating venture companies, etc. A risk money provider is one who possesses judgment for technical capabilities and business potential of venture companies, etc., and is capable of providing hands-on support in management and commercialization. It is therefore important to produce an environment that facilitates activities of venture companies, etc. and risk money providers to ensure that activities relating to R&D and commercialization can be performed on a continuous basis. Effective utilization of tax and procurement systems is also critical from the perspective of facilitating fund procurement and demand creation at an early phase.

In light of the abovementioned matters, this comprehensive strategy will focus on expanding opportunities for “challenges” by utilizing Small Business Innovation Research (SBIR) through ministerial collaboration and encouraging participation of venture companies in research and development projects undertaken by the government.

< Principal Related Measures >

- Promotion of technology development support and the like responding to the needs of venture companies, etc. and support for creation of R&D oriented ventures. This measure includes promotion of new systems to bring in venture capitalists and specialists who are capable of giving instruction and support for venture companies, etc. so as to be able to utilize their judgment and know-how of management, commercialization, and so on. [METI, MEXT, MIC]
- Capital injection by national university corporations to companies that support ventures created by universities. [MEXT, METI]

- Enhancement of the supply of risk money through improvement of the finance intermediation mechanism and participation of Innovation Network Corporation of Japan and public-sector financial institutions (Japan Finance Corporation, Development Bank of Japan, The Shoko Chukin Bank, Ltd., etc.) [MOF, Financial Services Agency (FSA), METI]
- Enhancement of the investment environment for venture companies, etc. by improving operation of the angel tax system and other systems. Development of an environment that facilitates research and development investment as well as capital investment by private-sector companies through enhanced utilization of research and development tax system. Improvement of the environment that facilitates collaboration among universities, public research institutions, and other corporations. [METI, MIC, MEXT, MHLW, MAFF, MLIT, MOE]
- Promotion of utilization of technologies that exist in the market by such measures as mandating collaboration with private-sector companies of different scales or types of field as a requirement when applying for project grants. [MIC, METI]
- Further utilization of the bidding system that focuses on technology capabilities. One possible measure to achieve this is to use comprehensive evaluation when determining grant awardees to ensure transparency and fairness. [relevant ministries and agencies]

2) Promoting regulation and system reforms

Regulation or system that can be an obstacle in innovation creation must be reviewed from the perspective of human resources utilization, promotion of mobility and simplifying procedures, targeting generation of outstanding research outcomes and smooth application of such outcomes to society. A special zone system and demonstration test aiming at social application must also be utilized in this review. In this regard, the Council for Science, Technology and Innovation will promote collaboration with the Council on Economic and Fiscal Policy, the Industrial Competitiveness Council, Council for Regulatory Reform, and other bodies to make unified efforts targeting realization of regulations and systems that are suited to “the world’s most innovation-friendly country.”

In this comprehensive strategy, reforms for national universities and research and development corporations, as well as system reforms toward creating hubs for international joint research by industry, academia, and government centering

on research and development corporations will be vigorously pursued. At the same time, reforms of regulations and systems will be pursued in relation to social application of outcomes of the “Cross-Ministerial Strategic Innovation Promotion Program (SIP).”

< Principal Related Measures >

- Promotion of reforms of regulations and systems, including the ones listed below, in the “Cross-Ministerial Strategic Innovation Promotion Program (SIP)” toward exit (To be implemented/commercialization):
  - Next-generation power electronics
    Review energy-saving standards (energy-saving regulations) for electrical devices equipped with power devices keeping pace with the progress of research and development of power devices (elements that convert voltage, etc.) with little energy loss.
  - Energy carrier (hydrogen based society)
    Establish safety and other standards keeping pace with the development of technologies relating to long-distance transportation and handling of liquid hydrogen to ensure safe and efficient transportation and storage of hydrogen.
- Promotion of reforms of regulations and systems including the ones listed below, in collaboration with the Council for Regulatory Reform, to facilitate generation of science, technology and innovation:
  - Reform the systems relating to prices of innovative pharmaceutical products and medical equipment, specifically, proper evaluation of innovation of pharmaceutical products and medical equipment, as well as examination of a mechanism to raise price predictability from the standpoint of private-sector companies. [MHLW]
- Create systems by which practical application and commercialization of research and development outcomes are facilitated through regulatory reforms. In doing this, the results generated through utilization of the Special Zone for State-of-the-art Medical Treatment, which was operated from FY2008 to FY2012 by the involvement of the Council for Science and Technology Policy, aiming at pharmaceutical consultation and flexible research fund management by regulatory authorities from early stages, will be taken into consideration. [Cabinet Office]

3) Promoting international standardization and intellectual property strategy

In strategic promotion of innovation creation, industry–academia–government collaboration must be performed from the earliest stage of research and development with a view to international standardization and management of intellectual properties in future. It is also necessary for the government to establish science and technology that serve as a common foundation for new industry fields, whose growth will be globally expected and where Japan will be able to outshine other countries. A strategic approach for international standardization and management of intellectual properties is the key in achieving this.

The Council for Science, Technology and Innovation will lead measures related to international standardization and management of intellectual properties, track effects, and promote revamping of those measures in collaboration with the Intellectual Property Strategy Headquarters and other relevant ministries and agencies. Especially, efforts will be powerfully brought forward regarding handling of international standardization and intellectual properties one needs to engage in when outcomes from each task of the “Cross-Ministerial Strategic Innovation Promotion Program (SIP)” are applied in reality.

< Principal Related Measures >

- Strategic aggregation and packaging of intellectual properties that are dispersed or hoarded in universities and other institutions to ensure effective utilization. [MEXT]
- Examination of desired intellectual property management under national research and development projects, including use of the Japanese version of the Bayh-Dole Act. This act includes establishment of guidelines that enable third parties to use intellectual property rights that are not utilized by grant awardees. The goal is to maximize national wealth by applying all possible research and development outcomes generated in Japan to commercial uses. [METI]
- Realization of “the world’s fastest and best quality” patent examination. Promotion of internationalization of the intellectual property system. Strengthening the support for venture companies and SMEs to facilitate their activities related to international intellectual properties. Further enhancement and reinforcement of the examination systems including maintenance and securement of fixed-term examiners to achieve the abovementioned measures. Acceleration of the schedule for fundamental review of employee invention system. Overall reinforcement of protection of

trade secrets and rapid responses to the needs in this regard. [METI]

- Establishment of government-private strategies and application of strategic approach in achieving this with regard to standardization and acquisition of certification to ensure powerful promotion of creation of a new market and global expansion by leveraging Japan's high-level manufacturing technologies. [METI]

4. Toward creating "The Most Innovation-Friendly Country"

(1) Evaluation and improvement of policies overlooking the whole picture

With the global trend in which many countries are striving to enhance national strength by way of innovation, in order for Japan to maintain and expand its international competitiveness, while facing issues such as population decrease and energy and resource restriction, it is required that Japan implements a strategic policy management with an eye, in addition to the relevant ministries and agencies, on international cooperation and activities of private corporations who have 75% of researchers in Japan and use 70% of total research expenses used in Japan.

On the other hand, it often takes time for a measure implemented by the government for creation of an innovation-friendly environment to take effect, and in some cases, a measure implemented by a department decreases the effect of other measures implemented by other departments.

Reforms for national universities and research and development corporations are in progress now, which makes a good opportunity for the Council for Science, Technology and Innovation to achieve its mission to create innovation systems that have sustainable expandability and are open to the international society. In achieving this, relations between universities, public research institutions, and private-sector companies that are the center of innovation creation and cycles of human resources and funds around these entities, as well as regulations and systems must be considered as constituents of each system.

Going forward, the Council for Science, Technology and Innovation will lead government-wide policy operation, while looking at the whole nation, by packaging measures with the same goals and effect in a cross-ministerial manner and monitoring the effect and changes that may occur in the course of operation. Such policy operation will be implemented in a continued collaboration with the Industrial Competitiveness Council, the Council on

Economic and Fiscal Policy, the relevant ministries and agencies, and think tanks. Also, utilizing evidence gathered by think tanks and other bodies and opinions collected through dialogs with actual innovation drivers, such as private-sector companies and research sites, is as important as basing on data in policy designing to maintain effectiveness of the policy operation by reflecting the reality.

(2) Follow-ups by the Council for Science, Technology and Innovation

In order to utilize the limited research and development investment by the government, the Council for Science, Technology and Innovation will classify measures of the relevant ministries and agencies into packages by goals and other items, and set indices to grasp the progress and verify the effect package by package.

The Cabinet Office will cooperate tightly with the relevant ministries and agencies as well as think tanks to ensure continuous implementation of investigation to grasp where the innovation drivers (universities, public research institutions, and private-sector companies) are with accuracy. Moreover, it will promote enrichment of the related database (researchmap and The Cross-ministerial R&D Management System (e-Rad)) in addition to the investigation results, and by utilizing such databases, conduct progress analysis and international comparison of 1) to 3) listed below, announce its findings, and make requests of improvement to the relevant ministries and agencies as necessary. It will also implement analysis and assessment on obstacles to focused initiatives, progress of innovation creation etc., and nationwide progress in the development of an innovation-friendly environment. The results will then be summarized to make annual reports by reflecting successful cases in private-sector companies and opinions from relevant institutions and private-sector companies. The reports will be utilized, along with other investigation results and statistics, in future policy operation. In future, review will be carried out with regard to enhancement of the goals and indices for research and development corporations and other institutions, paying attention to progress of research and development corporation reform.

(1) Nurturing the sprouts of innovations

○ Universities and public research institutions where diverse human resources including young, female, and foreign researchers learn from each other for further improvement become international hubs for creation of innovations

that consecutively generate innovation seeds one after another.

- Increase the rate of employment of female researchers in universities and public research institutions in the fields of natural science as a whole to 30%[21] by 2016.
- Increase the rate of foreign researchers to 20% by 2020, and 30% by 2030[22][23][24] at such research centers as universities and research and development corporations with sufficient potential to compete with the world's top-level universities and other institutions.

(2) Activating the innovation system

○ Radical strengthening of a virtuous cycle of concatenated generation of innovations, including enhancement of the industry-academia-government cooperation and cross-ministerial cooperation.

- Double the number of large-scale joint research projects with research value of 10 million yen or more at universities by 2030.
- Double the number of long-term joint research projects with research period of three years or longer at universities by 2030.
- Double the number of foreign patent applications by universities by 2030.

(3) Fructifying innovations

○ Increase the number of acceptances to become a secretariat country in relation to standards development at international standardization institutions to 95 by the end of 2015, which will rank Japan 3rd in the world.

○ Increase technology export volume to approx. 3 trillion yen by 2020.

The primary object of evaluation of these goals is to know if the innovation creating environment in Japan has been improved or not, therefore, achievement of the numerical goals is considered to be just one of the items to be checked in the evaluation. The Council for Science, Technology and

[21] 24.2% at universities as of FY2011 (Ministry of Education, Culture, Sports, Science and Technology), and 21.2% at research and development corporations as of FY2010 (Cabinet Office.) The 3rd Science and Technology Basic Plan states that the target rates of female researcher employment at universities and public research institutions are 25% in natural science fields as a whole (20% in science, 15% in engineering, 30% in agriculture, and 30% in health science.) The 4th Science and Technology Basic Plan urges that these rates must be achieved at the earliest possible date, and aims to achieve 30% by promoting related initiatives. It emphasizes that the targets of 20% in science, 15% in engineering, and 30% in agriculture must be achieved as soon as possible and states that achievement of 30% in medical, dental, and pharmaceutical together must be strived for.

[22] Natures of research areas and other perspectives must be given due consideration in monitoring the numerical targets.

[23] Due consideration must be given to the perspective of prevention of technology leakage.

[24] In FY2010, average in universities and 34 research and development corporations was 3.9%.

Innovation will conduct practical and formative evaluations taking into consideration the actual situation in which the efforts are made.

Chapter 4 Fulfilling the Headquarter Functions of the Council for Science, Technology and Innovation

1. Basic understanding

In order to transform Japan into “the world’s most innovation-friendly country,” science and technology promotion and innovation policies must be advanced in an integrated fashion. Taking a panoramic view of the entire efforts being made by a diverse range of bodies including private-sector companies, universities, and public research institutions, as well as the relevant ministries and agencies, and using a cross-cutting approach are indispensable to ensure effective and efficient implementation of the specific policies described in Chapters 2 and 3. The Council for Science, Technology and Innovation, which function as a headquarter, will strive to embody the measures to radically strengthen its function so as to be able to exert its momentum more powerfully than ever in budgeting and have more authority.

Meanwhile, the government has strived for the realization of programs such as the “Science and Technology Budgeting Strategy Committee,” the “Cross-Ministerial Strategic Innovation Promotion Program (SIP),” and the “Impulsing Paradigm Change through Disruptive Technologies (ImPACT) program.” The Council for Science, Technology and Innovation will, while utilizing these programs, reinforce its budget reconciliation function, and perform a Inter-ministerial policy guidance along the timeline with foresight and impetus.

Moreover, the Council for Science, Technology and Innovation will engage itself in efforts such as eliminating silos of ministries and agencies, strengthening industry-academia-government collaboration, and bridging between basic research and commercialization for a faster realization of social application, in a more direct fashion to ensure integration of science/technology and innovations. In doing so, it will reinforce its cooperation with other headquarters (the Headquarters for Japan’s Economic Revitalization, the Council for Regulatory Reform, etc.) and the headquarters in charge of science, technology and innovation (the IT Strategic Headquarters, the Intellectual Property Strategy Headquarters, the Headquarters for Ocean Policy, the Space Development Strategy Headquarters, the Office for Healthcare and Medical Strategy, etc.)

In addition to the abovementioned measures, the Council for Science,

Technology and Innovation will also actively achieve its commitment toward realization of “the world’s most innovation-friendly country” by enhancing its efforts covering basic research and commercialization and measures taken in each phase to increase innovations nationwide.

In order for the Council for Science, Technology and Innovation to exert the analytical and planning capabilities as expected, it is important to strengthen its secretariat function through qualitative and quantitative enhancement of the structure of its secretariat division that serves as a foundation of the Council as well as through improvement of its investigative and analytical function to collect related data and evidence from Japan and abroad and conduct analysis. Because the Council for Science, Technology and Innovation must be operated through active utilization of capabilities of industry to accelerate innovation generation, staff and policy investigators with expertise will be deployed in the Cabinet Office, which is in charge of the secretariat division of the Council, under the cooperation of relevant ministries and agencies, industry, universities, etc. The science and technology policy fellow system, which has been launched in FY2014, will be introduced to allow researchers to participate in policy-making processes. At the same time, dissemination of the system to research and development sites as well as reflection of the system in researchers’ career building will be strived for.

Installation of the Science and Technology Advisers (tentative name), who make proposals regarding science, technology and innovation to the Prime Minister so that the office of the Prime Minister can exert its leadership, is yet to be discussed, in addition to strengthening the headquarter function of the Council for Science, Technology and Innovation.

2. Strengthening the headquarter function of the Council for Science, Technology and Innovation

The Council for Science, Technology and Innovation has to be able to take powerful actions that are substantially different from what had been taken by government bodies before, and has actually executed measures such as the ones relating to budgeting and law revision. Now the Council has reached the point where it utilizes all it has done so far to conduct research and development with participation from every single body of the government. It also must continue its efforts toward creation of new values and tackle generation of sustainable innovations and creation of an optimal research environment by

breaking away from the past models of success so as to be able to make a major contribution to economic revitalization, one of Japan's most pressing tasks.

It is inevitable that the Council continues to evolve to ensure that its efforts are brought to fruition.

(1) Leading the Science and Technology Budget Formation

The "Science and Technology Budgeting Strategy Committee" (hereinafter "Budgeting Strategy Committee") was launched and its first meeting was held in Jun 2013 to introduce processes to lead initiatives of the relevant ministries and agencies. This enables the Council for Science, Technology and Innovation to exert its "headquarter" function in government-wide science and technology budgeting and ensure the PDCA cycle of policies based on the Comprehensive Strategy on Science, Technology and Innovation. The Budgeting Strategy Committee consists of officials from the relevant ministries and agencies, with the Minister in charge of the science and technology policy as chairman.

Policies such as the "Policy for Allocation of Budgets and Other Resources Relating to Science and Technology for FY2014" (hereinafter "Resource Allocation Policy") were established to enable the Council for Science, Technology and Innovation to implement, by utilizing the Budgeting Strategy Committee, budget allocation focused on the principal cross-ministerial policies in FY2014 budgeting. By promoting a problem-addressing approach and other types of efforts based on the Resource Allocation Policy, the Council for Science, Technology and Innovation has played a proactive and leading role in science and technology budgeting. In this problem-addressing approach, the Cabinet Office's budget allocation function under the "Cross-Ministerial Strategic Innovation Promotion Program (SIP)," which was newly established, and the policy guidance function of the relevant ministries and agencies under the "Action Plan for Principal Science and Technology Measures" are integrated.

The 4th Science and Technology Basic Plan states that allowance necessary for promotion of measures listed in the Basic Plan must be secured, paying attention to consistency between the worsening financial crisis of Japan and restoration of fiscal health, while aiming to achieve increase of the government's R&D investment volume to 1% of GDP (approx. 25 trillion yen[25] in total during the period of the 4th Science and Technology Basic Plan) during the pertinent period of the 4th Basic Plan.

In light of these facts, the Council for Science, Technology and Innovation will

[25] Based on an assumption that nominal growth rate of GDP in the period is 2.8% average.

guide the relevant ministries and agencies with the measures listed below to ensure focused allocation of limited resources to important fields of research and highly effective measures as well as to realize effective utilization of the resources in FY2015 budgeting by taking a panoramic view of the policies being deployed.

○ The Council for Science, Technology and Innovation will establish a policy for resource allocation upon discussion on issues, including how to proceed with budget prioritization in light of the comprehensive strategy described here, by holding a Budgeting Strategy Committee meeting prior to making a budget appropriation request.
○ The Council for Science, Technology and Innovation will decide the target measures (group of measures) of prioritization based on the policy for resource allocation after grasping the activities of relevant ministries. The Cabinet Office will collaborate with the fiscal authorities and other relevant bodies to ensure that the policy for resource allocation is reflected with effect in the government budget.
○ The Council for Science, Technology and Innovation will establish an effective PDCA cycle for each of the target measures (group of measures) of prioritization based on the policy for resource allocation, and strive for further utilization of policy resources with effect and efficiency, based on the PDCA cycle.

(2) Inducing the Development of Innovation Environment

The Council for Science, Technology and Innovation launched the “Cross-Ministerial Strategic Innovation Promotion Program (SIP)” to exert its “headquarter” function based on the Japan Revitalization Strategy and the Comprehensive Strategy for Science and Technology, and reported the allocation of the “Expenses for Promotion of Science, Technology and Innovation Creation” as a reserve fund in the budget to the Cabinet Office in FY2014.

The target areas of SIP are energy, next-generation infrastructure, regional resources, and healthy longevity. The Council for Science, Technology and Innovation has identified 10 tasks in relation to the three areas excluding healthy longevity, and selected a program director (PD) for each task among human resources representative of industry and academia.

Each PD is assigned to the Cabinet Office, and together with the relevant ministries and agencies, establishes and promotes research and development

plans, which are coordinated with regulatory and system reforms and other elements with the whole process of innovation, from basic research to exit (To be implemented/commercialization) in focus. The governing board, which consists of expert Diet members from the Council for Science, Technology and Innovation, will evaluate and give advice for each task as needed, and the Council for Science, Technology and Innovation will allocate budget for each task with impetus. The Cabinet Office will prepare a secretariat structure to support the PDs, install a promotion committee consisting of the relevant ministries/agencies, experts, etc. inside the Cabinet Office, and make necessary coordination with the committee.

SIP is a program to generate values that contribute to global society based on visions of the next generation. Transcending the conventional mechanism of value generation, it integrates all elements into a system while taking a look at the whole picture. In this program, the Council for Science, Technology and Innovation, industry, academia, and the government will play their own roles to pursue an innovation-oriented management scheme that generates value in a whole new way. Through improvement of research propulsion and by applying a core innovation model, which will be achieved in the course of implementation of the program, SIP will contribute to economic revitalization of Japan by facilitating solution to the social issues, creating new markets and employment, and strengthening the industrial competitiveness of Japan, while paying attention to international standardization and handling of intellectual properties.

Also, measures to support and foster excellent talent who will forge the future of Japan, aiming to become “the world’s most innovation-friendly country,” will be actively deployed and implemented. These will include measures to equip researchers with an innovation- and social application-oriented mind-set and management ability.

With regard to issue addressing, the policy challenges described in Chapter 2 must be solved with an approach that is different from any of the conventional ways. Thus far, specific measures in action plans were managed by the Cabinet Office as measures under collaboration of ministries and agencies. The procedure here was; first, each of the ministries and agencies proposes its own measure from its own standpoint, then the Cabinet Office makes some adjustment to these measures. From now on, the Council for Science, Technology and Innovation must take the lead in this procedure, position SIP measures, which will be executed by the Council itself, as a navigator in addressing policy challenges, and deploy all measures proposed by ministries

and agencies to enhance SIP measures. In doing this, it is important to follow the PDCA cycle directly linked with the budget together with the policy chiefs from the relevant ministries and agencies while continuing to reflect advice from experts from industry, academia, and government.

(3) Investing in Cross-cutting Innovative Research for the Future

The Council for Science, Technology and Innovation has launched the "Impulsing Paradigm Change through Disruptive Technologies (ImPACT) program," aiming at generating nonsequential innovations that may not have a high level of feasibility (i.e., high-risk) but will have a significant impact on society and industries if they work out (i.e., high-impact).

ImPACT will facilitate active fusion of flexible ideas, different domains, and different fields, cultivate challenge-oriented human resources willing to take risks, and expand the environment where such human resources can fully demonstrate their potential. Introduction of program managers (PM) enables operations to get the overall picture of research and development and foster human resources that play a role in planning and management, and manage the program in a way that will contribute to developing the career paths of the pertinent human resources. In bringing results of research and development into use through ImPACT, effective policies will be examined, such as regulatory reform, government procurement, and policy-based finance. From such a perspective, necessary measures will be taken, for example, approaching the relevant ministries, agencies, and institutions for promotion of innovations in the meetings of the Council for Innovative Research and Development Promotion, which had been installed under the Council for Science, Technology and Innovation.

Through implementation of ImPACT, a change of mind-set is strongly to be urged to take up the challenge for measures with risk, and accelerate the attainment of "the most innovation-friendly country" as advance measures for the reform of the nation's innovation systems.

(4) Realizing an Innovation Cycle through the World's Highest-level New Research and Development Corporation System

With regard to research and development-type agencies, the amendment bill for the Act on General Rules for Independent Administrative Agency and the enhancement bill for the same Act (the Cabinet decision dated April 15, 2014) were submitted to the Diet. The purpose was to categorize such agencies

differently from the ones that manage targets on a single-year basis or in the medium term in accordance with the Act on General Rules for Independent Administrative Agency as well as the “Basic Policy to Reform Independent Administrative Institutions” to achieve the goal of maximizing research and development outcomes, the primary goal of such corporations.

The amendment bill proposes that such research and development-type agencies should be given the name of special national research and development corporations to clarify that they deal with tasks universities or private-sector companies cannot. It also states, from the perspective of maximization of research and development outcomes, that:

○ Periods for medium-term goals will be extended from maximum five years to maximum seven years to make them medium- and long-term goals.
○ Contents of the draft guidelines written by the Council for Science, Technology and Innovation must be reflected in the guidelines established by the Minister of Internal Affairs and Communications in relation to goal setting for the medium- and long-term plans as well as reviews performed when such goals are achieved, both of which are conducted by the competent minister.
○ Councils pertinent to research and development (which may include foreign members) must give advice that is compliant with international standards and scientific knowledge to the competent minister at the time of goal setting for the medium- and long-term plans, as well as during reviews performed upon achievement of such goals.

For promotion of the corporations that are expected to generate, based on the national strategy, the world’s top-level results that serve as the foundation of science, technology and innovation in international competition, the Council for Science, Technology and Innovation, the competent minister, and corporations must unite their efforts in science, technology and innovation policies, in light of the “Basic Policy to Reform Independent Administrative Institutions,” and by paying sufficient attention to prevention of research misconduct. From such a perspective, corporations that perform creative activities to attain the world’s top-level results that serve as the foundation of science, technology and innovation policies will be positioned as special national research and development corporations, and given a function as network hubs for various fields and sectors. In this way, the Council for Science, Technology and

Innovation will drive the nation's research and development sites for science, technology and innovation while performing a headquarter function, expecting these corporations to become the core in efforts toward launch of a system that enables sequential generation of innovations in Japan at each site. By utilizing this function of the corporations, nationwide maximization of research and development outcomes must be realized throughout the process of an innovation, from basic research to practical application. It is also important to cultivate national power to win the international competition through creation of an innovation system that Japan can be proud of, while building an affluent people-oriented society.

In order to realize the abovementioned goals, a new system must be launched under the collaboration of the Cabinet Office and the Ministry of Internal Affairs and Communications at the earliest possible date. Based on the "Concepts of a Special National Research and Development Corporation (tentative name)," the new system will mandate a high level of involvement from the Council for Science, Technology and Innovation and the competent minister, and stipulate special measures needed in business operation.

Items listed below will be incorporated in this new system from the perspective of enhancement of the integrated efforts and governance, aiming to produce the world's highest level research and development outcomes:

○ A basic policy relating to research and development promotion by special national research and development corporations and development of the supportive structure must be established.
○ Setting medium- and long-term goals and reviews upon achievement of such goals must involve the Council for Science, Technology and Innovation.
○ The competent minister must involve him/herself in the system by providing accurate directions responding to dismissal of a corporate chief or other changes.
○ Medium- and long-term goals must include clear description of items related to operational improvement.

In addition, the following matters will be included in the system from the perspective of expanding discretion of corporations with due consideration of the nature of their R&D or other activities:

○ Measures must be taken to secure internationally competent talent for

operations that especially require the world's highest level expertise and experience.

○ Consideration of the nature of each research and development or other activities must be legislated to ensure promotion of the world's highest-level research and development etc. in international competition.

Reviews must be conducted to explore the best possible way this new system can be delivered, including the scope of the special national research and development corporations. Such reviews must be performed taking into account the enforcement status, and necessary measures must be taken based on the review results.