

Japan's Science and Technology Basic Policy Report

Council for Science and Technology Policy
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I. Basic understanding

1. A changing world and crisis in Japan

The world, including Japan, is undergoing drastic changes in politics, society, and economics. In order to address such changes promptly, many countries are using all possible policy instruments. Under such circumstances, roles expected for policies concerning science and technology ("S&T") are also changing considerably. Major changes in the recent situation of S&T are as follows.

<Changes around the world>

Global-scale issues to be addressed in cooperation with many countries, including environmental problems, are becoming increasingly more serious. Meanwhile, international competition to acquire resources, energy, foods, etc. is expected to intensify, which could lead to distortions in the world's economic growth on a mid- and long-term basis, as well as instability in the world economy and politics. In addition, with the economic rise of newly emerging countries that have great market potential, including China and India, the distribution of wealth and force is rapidly changing on global and local levels.

Moreover, as a result of further progress in economic globalization, intensifying competition in emerging markets, and diversification of consumer needs, accelerated realization of innovation is becoming more important, innovation systems are greatly shifting to more open, global, and flat platforms, and the commercialization of research and development ("R&D") of S&T is also progressing. Also, as brain circulation is becoming prevalent around the world, international competition to acquire excellent human resources who play key functions in S&T and innovation ("STI") is increasingly more fierce.

<Crisis in Japan>

In addition to the foregoing drastic changes around the world, Japan is also facing issues that might lead to a decline in socio-economic vitality, such as the issue of an aging and decreasing population with a declining birthrate. Japan's gross domestic product (GDP) has mostly leveled off in recent years, and its per capita GDP has also fallen in international ranking. Given the issue of aging and decreasing population with a declining birthrate, a fall in the labor force and shrinkage of the domestic market cannot be avoided in the long run.

Meanwhile, despite the fact that S&T and human resources are important resources for Japan, which is poor in natural resources, a trend is increasing among students to avoid S&T departments at colleges / universities, while many excellent researchers and engineers in Japan are reaching the retirement age. Accordingly, there is concern that the presence of Japan in S&T fields may also decline. In addition, the response of Japanese enterprises to changes in innovation systems is still on the way, which is contributing to the continuation of the long-term slowdown in Japan's industrial competitiveness.

2. Position of Science and Technology Basic Plan

In accordance with the Science and Technology Basic Law established in 1995, the Science and Technology Basic Plan ("Basic Plan"), consisting of 3 5-year terms (15 years total), was formulated to ensure steady promotion of S&T in Japan. However, it cannot be denied that the S&T policies have been implemented mainly to promote S&T independently, not in organic coordination with essential policies on industry, economy, diplomacy, etc. On the other hand, many foreign countries position S&T policy as a basis of national strategies and develop S&T policy actively in organic / integrated coordination with other policies on industry, economy, diplomacy, etc. In view of what other countries are doing, as seen in the first acknowledgement of "Creation of innovation" by law, i.e., the

2008 Research and Development Enhancement Law¹, there is increasing need in Japan for the government to make an all-out effort to strongly and strategically promote S&T policies by integrating innovation policies, and tying S&T policies closely to other key policies on industry, economy, education, diplomacy, etc.

In light of these circumstances, the 4th Basic Plan aims to provide basic policies for comprehensive and systematic promotion of Japan's S&T policies by widely recognizing the "New Growth Strategy -- Blueprint for Revitalizing Japan," formulated in June 2010 as a 5-year national strategy on S&T with an eye to the coming decade, deepening and embodying the policies provided by this Policy, and ensuring further coordination with other important policies.

3. Results and issues of the 3rd Science and Technology Basic Plan

In Japan, many research findings and results have been reported since the 1st Basic Plan as the result of an increase in governmental spending in R&D, development of R&D infrastructure, reform of S&T systems, etc. On the other hand, some issues remain unsolved, including the contribution of S&T to solutions to various issues, human resource development, and development of research environments. The following describes the main results and issues of the 3rd Basic Plan.

<R&D investment and strategic priority setting>

Under the 3rd Basic Plan, area-focused R&D was promoted in the eight areas² designated in the four primary priority areas and four secondary priority areas, leading to the creation of many innovative technologies. However, since it has been indicated that individual achievements did not necessarily lead to the solution of social issues, the government should identify essential issues to address, and then formulate responsive strategies and facilitate effective R&D.

In the field of basic research, performance has been steadily achieved, as seen by a researcher whose research paper has the world's top class citation, while the total share of Japanese research papers is slightly declining and the country's citation index is low compared to other advanced countries. In order to build infrastructure for the development of Japan's S&T, basic research should be dramatically strengthened to generate originality and diversity that can lead to the creation of new concepts and knowledge assets for mankind.

In addition, due in part to the severe financial situation throughout the 3rd Basic Plan, governmental R&D investment has almost leveled off with only a slight increase and is anticipated to fall short of the targeted amount of 25 trillion yen. If such situation lingers on, the level of S&T in Japan might decline, so R&D investment should be further strengthened.

<Reforming the S&T system>

The 3rd Basic Plan, specifying "from 'hard' to 'soft' such as human resources" as one of the basic concepts, focused on investment in human resources, improvement in the mobility of personnel, and reform to promote competition. However, while graduate school students have rapidly increased due to the effect of the policy's focus on graduate schools, researchers tend to be late in establishing their career path. Accordingly, it has been pointed out in recent years that many young researchers have difficulty in planning their careers and tend to avoid working abroad. Since human resources play the leading role in STI, it is necessary to actively develop and secure human resources including women and foreigners, facilitate their activities, dispatch and invite them, and further promote the development of their environment.

In Japan, many excellent technologies were born from breakthrough ideas that were produced through

¹ Law on Enhancement of Research and Development Capacity and Efficient Promotion, etc. of Research and Development, etc. by Advancement of Research and Development System Reform (Act No. 63 of 2008)

² "Four primary priority areas": Life science, information and telecommunications, environmental sciences, and nanotechnology/materials; "Four secondary priority areas": Energy, manufacturing technology, infrastructure, and frontier

basic and fundamental researches. Meanwhile, industrial systems are changing sharply and open innovation has become a mainstream, e.g., a key to innovation is networking "knowledge" even in the phase of basic research through collaboration between researcher communities and outsiders. Hence, construction of a new and open STI system is urgently required.

Also, universities (including Inter-University Research Institute Corporation; hereinafter the same), R&D corporations, and the private sector, are playing very significant roles in promoting Japan's S&T. However, the recent decrease in operating expense subsidies granted to such institutions is causing problems in their research activities, educational activities, maintenance and operation of their facilities and equipment, etc.

<S&T to be supported by the public>

The people greatly expect S&T to play a significant role in improving the global competitiveness of Japan and solving social issues. On the other hand, there is an indication that the people do not necessarily acknowledge the idea that investment in S&T is "investment in the future." Needless to say, R&D activities should steadily achieve results in order to further respond to public expectations. However, in addition to this, it is necessary to develop activities to grasp social needs accurately and promote efforts for S&T communication activities so as to foment public understanding and support for S&T.

4. Principles of the 4th Science and Technology Basic Plan

(1) Visions of the country

S&T not only serves as a means for exploiting knowledge frontiers and helping to solve issues facing humankind but also constitutes a basis for Japan's wealth and power. In this sense, S&T policies should not aim to promote only S&T but should aim at organic coordination with key policies on economy, education, diplomacy, security, etc. as one of major policies for society and the public, which is expected to realize a vision or identity that Japan should aim for, i.e., how Japan should coexist with other countries or how Japan should exist.

From such a viewpoint and in order to respond to public expectations and demands for S&T, Japan should provide a clear vision for which it should aim through S&T policies on a mid- and long-term basis. To this end, the 4th Basic Plan provides the following five visions for a future Japan as major goals Japan should aim for on a mid- and long-term basis in promoting its policies.

(i) A country that achieves sustainable growth for years to come

Such problems as restricted use of resources / energy and aging are expected to become serious and material global issues in the mid- to long-term. To avoid this, Japan aims to overcome these issues ahead of other countries so that new industries and employment may be created, and thereby achieve sustainable growth for years to come.

(ii) A country that realizes an affluent high-quality life for the people

As social structures are rapidly changing, Japan aims to realize a safe, affluent, and high-quality life that the people can be proud of for years to come.

(iii) A country that possesses S&T as the foundation for national survival

Japan aims to possess core S&T that enables the nation to exist, ensures national security, and develops unknown / unexploited knowledge frontiers.

(iv) A country that takes the initiative in solving global issues

Japan aims to take the initiative in solving serious and material global issues including climate change

via its unique knowledge assets, creativity and international cooperation.

(v) A country that continues to create "knowledge" assets and fosters S&T as a culture

Japan aims to become a country that continues to create various, unique and advanced "knowledge" assets, and fosters S&T as a culture that encompasses research activities to that end, concerned persons and research institutions, research infrastructure and environments, etc.

(2) Basic concepts of future S&T policies

In order to realize the five visions of the country mentioned in (1) above, it is necessary to consistently produce excellent intellectual assets of the world's highest level and to drive S&T policies comprehensively and systematically in directions that promote innovation by clearly identifying the issues for Japan to address. Also, to steadily promote such policies, the roles of excellent human resources cannot be overemphasized. Moreover, to realize "policies for society and the public," involvement of the people in crafting those policies should be further deepened.

Given these viewpoints and considering the results and issues of the 3rd Basic Plan, the 4th Basic Plan adopts the following three points as basic concepts for future S&T policies.

(i) Integrated development of "STI policies"

The importance of innovation was also described in the 3rd Basic Plan. However, the undertaking to relate results of S&T to new value creation through innovation is still on the way. Japan should, therefore, in order to create new values, identify issues facing the country and the world, utilize S&T strategically to solve the identified issues, further promote the return of results of such activities to society, and thereby promote S&T steadily so that it may serve as a source of innovation.

For that purpose, it is essential to have viewpoints of not only natural science but also human and social sciences, include widely related innovation policies in addition to S&T policies, and ultimately promote them in an integrated manner. Accordingly, such policy is positioned as "STI Policy"³ in the 4th Basic Plan in order to develop it with particular focus.

There are two approaches to promoting STI policy; one is to identify issues for Japan to address in advance and promote related S&T comprehensively to solve such issues, and the other is to produce creative research findings and develop them for new value creation. In response, the 4th Basic Plan describes, for the former approach, actions for environment / energy and medical / nursing care and health as urgent issues for the country to address in Chapter II and various critical issues facing Japan in Chapter III, and, for the latter approach, strengthening of basic research in Chapter IV, including specific undertakings.

(ii) Further focus on the "roles of human resources and the organizations"

In order for Japan, where natural resources are limited and a continuous decrease in population is expected, to drive STI policies powerfully, it is indispensable to constantly foster and secure the human resources for supporting such policies. Activities concerning such human resources should be particularly and cross-sectionally undertaken by the government. To this end, with further focus on the "roles of human resources and the organizations," activities should be strengthened so that personnel who bear the future of Japan may actively enter the world of STI with dreams and hopes, by constructively developing efforts to foster and secure human resources who are able to demonstrate their capabilities at home and abroad, who can lead the world in their specialties, and who bear the

³ "Science, Technology and innovation (STI)" is defined as the "creation of intellectual / cultural values based on new knowledge obtained from scientific discovery, invention, etc., and the innovation to develop such knowledge into economic, social, or public value."

next generation, as well as by improving their career paths. Additionally, in order for such human resources to be able to demonstrate their capabilities sufficiently, organizational support that can assist them should be improved and networks among researchers, organizations, etc. should be strengthened at universities, public research institutions, etc.,

(iii) Realization of a "Policy to be created and promoted together with society"

Since the "Declaration on Science and the Use of Scientific Knowledge" was adopted at the World Conference on Science held in Budapest, Hungary, in July 1999, and the concept of "Science in society, science for society" was proposed there more than 10 years ago, the relationship between S&T and society has become increasingly closer, and public expectations and demands for STI have also been rising. Under such circumstances, it is becoming increasingly important for the government to grasp such public expectations and social demands accurately so as to utilize them in planning and promoting policies and to show results and effects of policies widely to the people and return those results and effects to society. Accordingly, the government will advance activities to deepen the relationship between society and STI in order to realize a "policy to be created and promoted together with society," and will strive to gain an understanding and trust in the people by clarifying responsible organizations, performance goals, results, etc. concerning S&T policies, and further promoting dialogue and information services for the people.

II. Promotion of the two major innovations as a pillar of growth

1. Basic concept

In order for Japan to continue growing and developing in ways that will secure a pivotal position in the world and realize affluent people's lives, the most important thing is to become "(i) A country that achieves sustainable growth for years to come" as stated in the five visions of Japan mentioned in Chapter I. This is because that the realization of this goal is prerequisite to achieving the other four goals and solving issues to that end will lead to the establishment of foundations for new growth and consequently improve the quality of people's lives.

The urgent important issues Japan should undertake to achieve this goal include response to climate changes, realization of a low-carbon society, and response to the issue of aging. Particularly, the realization of a low-carbon society is expected not only to contribute to reduced emissions of greenhouse gas but also to lead to the emergence of new markets on a global scale as a result of a prevalence / increase in recyclable energy etc., development of social infrastructure, etc., which would consequently solve the issue of the restricted use of resources and energy and create new industries and employment in Japan. In addition, the increase in senior citizens and the decrease in overall population will cause a sharp rise in social welfare costs and lead to a reduced work force, and could seriously interrupt the growth of Japan in the future. On the other hand, however, a progressively advancing aged society is expected to expand demand for medical care, nursing care, and health services, and activities to eliminate such factors of social interruption can also serve as a driving force for spurring new growth in the mid- to long-term.

From such viewpoints, the 4th Basic Plan positions "Green Innovation" for environment and energy and "Life Innovation" for medical care / nursing care / health as two major pillars of growth, and aims to develop STI policies in those regards strategically. In addition to the issues mentioned in this Chapter, Japan is faced with many serious and diverse issues, and Chapter III provides specific policies for activities to address such issues.

Moreover, in line with the sophistication and complication of S&T and the urgent globalization of its market, the government should establish an innovation system having strong linkage among industry, academia and government and strong cooperation with society. Hence, in order to promote S&T-based innovation with full respect for the diversity, originality, etc. of each entity of industry, academia and government, system reforms including the establishment of new systems will be undertaken.

2. Promotion of Green Innovation

(1) Growth vision of the country

The government will promote Green Innovation with particular focus, with the aim to solve the climate change issues facing Japan and the world, which should be addressed urgently, and realize the world's most advanced low-carbon society by identifying trends in de-fossil fuel that many countries are developing competitively as a key to future growth. Such promotion is expected to facilitate further innovation of environmental / energy technologies, in which Japan has strengths, and promote the reform of social systems and institutions. With such prevalence and development of Green Innovation at home and abroad, Japan will achieve sustainable growth. Also, through such efforts, the government will aim to realize a country leading the world in advanced environment / energy technologies, and achieve a sustainable recycling society that exists in harmony with nature, and bring affluent people's lives.

(2) Promotion of measures for achieving essential issues

As specific measures for achieving the goals of Green Innovation described in section (1), the

following essential issues are to be determined. The government will promote relevant measures with particular focus, including R&D responding to these issues, in cooperation with universities, public research institutions, and industrial sectors.

(i) Low carbon energy supply

The government will strategically promote R&D of renewable energy technologies, such as solar power, biomass utilization, wind power, small scale hydropower, geothermal power, tidal power, and wave power, and facilitate the utilization of such technologies. In so doing, the aim is to disseminate and develop such technologies according to their characteristics and the features of local communities by utilizing the potential of such technologies for reducing greenhouse gas emissions to the maximum extent. For solar power generation and biomass utilization, efforts will be promoted to develop innovative technologies that can serve as a new breakthrough, as well as achieve remarkable improvement in existing technologies.

R&D will also be promoted for hydrogen supply systems including storage batteries, fuel cells, recharging infrastructure, superconducting power transmission, manufacturing, transport and storage with the aim to innovate distributed energy supply systems and, furthermore, R&D for energy management, including smart grids that comprehensively provide optimal control of supply systems for both basic and distributed energies, as well as energy demand systems, and then promote overseas development of results of such R&D activities.

Moreover, efforts will be promoted for extended use of nuclear power generation with the prerequisite of ensuring safety, with the aim of ensuring higher efficiency and low-carbon generation in basic energy supply sources, including R&D for the realization of a zero-emission thermal power generation system where an integrated gasification combined cycle and collection and storage of carbon dioxide are combined, in addition to high efficiency thermal power generation and petroleum refining, and R&D for the commercialization of the next-generation of light water reactors.

(ii) Highly efficient and smart use of energy

In order to ensure more efficient use of fossil resources in manufacturing sectors, R&D will be promoted to innovate manufacturing process in steel production, functionally improve the materials used there, and, furthermore, develop green sustainable chemistry and bio-refineries.

With the aim to ensure lower carbon generation in consumer sectors (household and commercial) and transport sectors, which collectively account for about a half of the final energy consumption of Japan, efforts will also be promoted for the development and dissemination of (i) energy-saving technologies, including higher grade insulation systems for houses and buildings, stationary fuel cells, more efficient lighting, power semiconductors, and (ii) power control via storage batteries, fuel cells, and power electronics used for next-generation automobiles. Moreover, R&D will be advanced into highly efficient transport equipment (trains, ships and airplanes).

Furthermore, since information and telecommunication technologies are basic technologies in promoting energy supply, energy use, and low carbon generation from social infrastructure, R&D will be advanced with regard to next-generation information and telecommunication networks, further energy-savings for information and telecommunication equipment and system components, and technical development for optimized control of entire network systems.

(iii) Greening of social infrastructure

For the realization of environmentally advanced cities, the government will advance R&D for highly efficient traffic and transport systems. R&D will also be promoted into mega network systems where existing consumer networks are connected to all electric-powered equipment at home, each of which works as a communication entity, hence forming networks with social infrastructure including electric power, gas, water, traffic services, etc. In addition, the government will drive R&D for simulations

for constructing a comprehensive water resource management system built with advanced water processing technologies. At the same time, the government will promote overseas development of those results as integrated systems, as part of efforts to disseminate and expand R&D results.

The government will also promote efforts for innovating resource recycling technologies, creating alternate materials for rare metals, etc.

Furthermore, since information obtained from earth observation, forecasts, and integration analysis is significant social / public asset for driving Green Innovation, the government will markedly enhance technologies related to that and promote the utilization of such information obtained from earth observations, etc. in various fields. Besides these efforts, the government will promote efforts to develop cities and local communities for climate changes, conserve the natural environment and biodiversity, maintain the natural cycle of forests, reduce natural disasters, realize sustainable recycling-based food production systems, etc.

(3) System reform for promoting Green Innovation

In promoting Green Innovation, it is necessary, in addition to the promotion of actions for achieving the essential issues mentioned in (2), to promote efforts that promote innovation in ways that promptly and effectively lead to the creation of industries and jobs, and consequently to the sustainable growth of Japan and solutions to global issues. From such viewpoints, the government will actively advance system reforms, including regulatory and institutional reforms for accelerating innovation, and promoting the development of innovation results including technologies to overseas countries.

<Promotion measures>

- In order to promote the R&D and other activities of businesses that aim at innovation, the government will consider how to establish new regulations and systems based on technical / economic reasonableness taking into account international competitiveness, such as the setting of sustainability criteria, including criteria for reducing greenhouse gas emissions by using biofuels, and revision of standards for automotive fuel consumption.
- In order to promote the commercialization / dissemination of next-generation vehicles, supply infrastructure facilities such as hydrogen stations, recyclable energy equipment, etc., the government will promote the review and reform of relevant laws that may interfere with such efforts.
- In collaboration with local governments, universities, public research institutions, and industrial sectors, the government will support efforts for integrated R&D and technical demonstration, dissemination, and development meant to achieve a new social system based on local characteristics, such as smart grids.
- In relation to the development of social infrastructure, such as energy, water, traffic, and transport systems, the government will promote the overseas development of advanced technologies, management / operation know-how, and human resource development systems possessed by the government and private sectors by packaging them as an integrated system.
- In order to promote support for developing countries via the utilization of Japan's excellent technologies, the government will promote technology transfers and system reforms for measures against climate changes comprehensively in connection with policies on poverty programs, development of agriculture / water resources, disaster prevention, etc., and strengthen the independent capabilities of such countries to address such issues.

3. Promotion of Life Innovation

(1) Growth vision of the country

In Japan, aging is progressing at the fastest pace in the world, and it is an urgent matter to find solutions to the issues of medical and nursing care, which are expected to become increasingly serious

in the future, while showing respect for personal views of life and death. Under such circumstances, the government will powerfully promote Life Innovation in order to realize a society where people are healthy in body and mind and can feel happily. With these efforts, the government will create and revitalize industries such as medical care, nursing care, and health services and thereby aim to achieve the sustainable growth of the country. In addition, the government will aim to internationally contribute to measures for aging societies, which many advanced countries will face in the near future, and diseases prevalent in developing countries through the development of pharmaceuticals and medical devices.

(2) Promotion of measures for achieving essential issues

As specific measures for achieving the goals on Life Innovation described in section (1), the following essential issues are to be determined. The government will aggressively promote relevant measures, including R&D responding to these issues, in cooperation with universities, public research institutions, and industrial sectors.

(i) Development of innovative preventive care

Preventive care based on objective grounds (evidence) will be developed by identifying the mechanisms that govern the onset and development of lifestyle-related diseases, etc. through research into the effects of lifestyles and living environments, including foods, based on long-term follow-up of the health condition of people and through the promotion of cohort studies, such as analysis of clinical data, metabolome, and gene sequences.

Also, in order to promote large-scale epidemiological research, improvement of infrastructure for electronization, standardization, database creation, etc. of medical data will be facilitated, and effective use of such information will be accelerated while carefully protecting personal data.

R&D into vaccines of high preventive effect will be promoted with focus on infectious diseases that may seriously affect society, and dissemination and development of such vaccinations will be facilitated at home and abroad.

In addition, in view of serious social / economic losses and burdens caused by dementia or other diseases, R&D will be promoted into technologies for preventing the onset, enabling early detection, and delaying the development of dementia and other diseases by encouraging active intervention studies.

(ii) Development of new early diagnostic methods

Since the development of diagnostic approaches that lead to the early detection of a disease is important towards maintaining public health, development of high precision early diagnosis technologies will be promoted, including development of new detection methods and equipment that contribute to early diagnosis, such as technologies for identifying trace substances, and searching for and identifying new markers.

In addition, microscopic technologies / equipment, such as smaller, less invasive high-performance endoscopes and new imaging technologies that contribute to early diagnosis, such as three-dimensional imaging, will be developed.

Furthermore, the development of new technologies for early diagnosis will be promoted via the organic integration of such technologies and equipment.

(iii) Realization of safe and highly effective treatment

In the development of new medicine, new drug targets need to be searched for by analyzing disease mechanisms and treatment using animal disease models, diseased cells by iPS cell generation, etc. To this end, basic studies in the life sciences will be promoted.

Furthermore, R&D aiming at the establishment of innovative treatments, such as nucleic acid

medicines and drug delivery systems, will be promoted. To improve the quality, safety, and effectiveness of treatment, the development of new drugs based on the stratification and hierarchization of diseases will be promoted, and the development of drug dosing methods that minimize side-effects will be advanced based on the genetic background of people.

Development will also be promoted into new medical devices, such as radiotherapy equipment and robotic surgical instruments; drugs and devices that integrate diagnosis and treatment, such as a combination of endoscope and medicine; telediagnosis / telemedicine technologies; and image processing technologies that support telediagnosis etc.

For what regards regenerative medicine as a precursor to disease treatment, alternatives to lost function, regeneration, technologies for the proliferation / differentiation of iPS cells, ES cells, somatic stem cells, etc. inside and outside the body will be developed, and efforts will be made to standardize such technologies, develop application techniques, and promote R&D into safety assessment techniques for them. In addition, scientific studies of bio-dynamic systems will be promoted.

(iv) Improvement of quality of life (QOL) of elderly / disabled persons and patients

In order to improve the QOL of elderly / disabled people and reduce the burden of care providers, R&D will be promoted, including the establishment of safety assessment approaches with regard to technologies that compensate for the decreased functions of elderly / disabled persons, such as life support robots, brain machine interface (BMI) equipment, and personal mobility for the elderly, technologies for supporting self-sufficient living / livelihoods, technologies for advanced communication support, and technologies for supporting care providers.

In addition, research into palliative medicine for relieving the mental and physical pains of cancer patients or elderly persons in the terminal state will be promoted.

(3) System reform for promoting Life Innovation

In promoting Life Innovation, as in promoting the measures mentioned in section (2) for achieving essential issues, a system for promptly commercializing results of such promotion as pharmaceutical products or medical devices should be developed. The process of applying the results of researches into pharmaceuticals etc. to clinical studies, clinical trials, and commercialization takes too much time in Japan compared with international levels. Therefore, from the viewpoints of solving this issue and promoting Life Innovation, regulatory and institutional reforms related to examinations for approval and development R&D environments will be promoted.

<Promotional measures>

- The government will improve and strengthen "regulatory science"⁴, e.g., the formulation of assessment guidelines and criteria based on scientific principles and social validity for the safety, effectiveness and quality assessment of pharmaceutical products and medical devices, and thereby develop consistent guidelines that cover clinical studies and trials as well.
- In order to ensure prompt and efficient examination for approval of pharmaceutical products and medical devices, the government will considerably improve and strengthen the organization of the examination body, and promote improvement of the research function of regulatory science in the relevant examination body, and foster and secure human resources familiar with these areas.
- In order to produce seeds that lead to the development of new drugs and medical devices and accelerate the commercialization thereof in cooperation with universities, public research institutions, and industrial sectors, the government will promote the improvement of infrastructure that supports new drug / medical technology development by the joint efforts of the government and private sector. In particular, the government will improve and strengthen research centers

⁴ Science for coordinating results of S&T with the most desirable form for harmony between people and society by conducting accurate forecasts, assessments, and decisions based on evidence for the purpose of using the results of S&T for the people and society.

that serve as a "bridge" and establish open medical institution networks in universities, businesses, etc. by inviting research proposals from the public.

- With regard to integrated systems for clinical studies and trials for pharmaceutical products and medical devices, the government will consider the introduction of such a system through surveys and studies of similar systems abroad, e.g. Investigational New Drug (IND) and Investigational Device Exemption (IDE) in the U.S., and request universities, etc. to implement clinical studies in accordance with international standards.
- In order to ensure smooth and efficient development of new drugs and medical devices based on results of clinical studies, the government will develop a system that enables research institutions, etc. to receive the consultation and advice of regulatory authorities from the early stage of R&D, and improve and strengthen service centers for consultation and notification and the systems of examination for approval and safety measures so that a series of actions, including clinical studies, clinical trials, applications for approval, and post-marketing safety measures to be taken after approval may be performed in an integrated manner.
- With the aim to create new seeds that lead to the development of innovative pharmaceuticals and medical devices, the government will promote efforts for supporting bio-venture businesses from a long-term viewpoint.

4. System reform for promoting STI

(1) Strengthening of the strategic promotion system for STI

(i) Foundation of "STI Strategy Council (tentative name)"

In order to drive STI in a direction that responds to key issues facing the country, including Green Innovation and Life Innovation, the government should establish a collaboration system that enables the proactive participation of various persons concerned in a wide range of areas, including industry, university and government, and the sharing of future visions among them and concerted efforts involving them. With the establishment of such a system, each participating entity will be able to recognize their individual roles in retrospect of an overall picture and promote activities in close cooperation with each other. From such viewpoints, the government will build a platform that supports the full process of crafting strategies for essential issues, including examination and promotion.

<Promotional measures>

- The government will establish the "STI Strategy Council (tentative name)" ("Strategy Council") in coordination with the Council for Science and Technology Policy (or reorganizing of the same Council as the "STI Strategy Headquarters (tentative name).") A Strategy Council will be created for each essential issue in order to ensure integrated promotion of STI, and provide opportunities of close cooperation through participation of various persons concerned from a wide range of areas, including relevant ministries and agencies, fund distribution organizations, universities, public research institutions, and industrial sectors, and NPOs.
- The government will encourage the proactive participation of persons and organizations concerned in a wide range of areas, and improve the support system, e.g., by appointing a "Strategy Manager (tentative name)" who takes charge of cooperation among related organizations, etc.
- In order to specify a future vision of essential issues and contribute to strategy formulation for realizing that vision, the Strategy Council will consider from various viewpoints the desirable approaches to specific R&D, regulatory / institutional reforms, performance targets, promotion systems, and fund distribution to be promoted in each of the phases of basic research, application, development, industrialization, and commercialization. The Council for Science and Technology Policy will formulate strategies to achieve the essential issues based on the examinations made by

the Strategy Council.

- The Strategy Council will be responsible for all management aspects of strategic promotion efforts in order to ensure the effectiveness of such strategies. Participating organizations, such as universities, public research organizations, fund distribution organizations, and industrial sectors, and persons concerned will promote activities in cooperation with each other with the "Strategy Manager (tentative name)" coordinating everything.

(ii) Strengthening "knowledge" networks among industry, university and government

Alongside the growing sophistication of S&T, scaling up of R&D activities, and globalization of socio-economic, issues underlying the existing vertically integrated R&D models have been surfacing, while activities aiming at open innovation are rapidly increasing in response to such surfacing. In such situations, it is becoming increasingly necessary to establish a system for producing quality research findings at universities and public research organizations promptly and effectively. However, the current status of industry-university cooperation at home and abroad indicates a low percentage of joint studies between universities and foreign companies and a declining trend in the number of technology transfer projects involving the Technology Licensing Organization (TLO). For these reasons, the government will implement efforts to further advance cooperation between industry, university and government in order to strengthen "knowledge" networks for promoting innovation via S&T.

<Promotional measures>

- The government will promote networking amongst industry, academia and government, including the enhancement of cooperation between universities and coordination with financial institutions and other related organizations.
- The government will request universities and public research institutions to strengthen their functions for enabling smooth cooperation with industrial sectors, which includes them providing quality research findings and developing systems to promptly coordinate the rights related to provided findings. The government will also expect universities to optimize their functions for industry-university-government cooperation including organization of the TLO with broad-based functions, and strengthening of integration / cooperation of the headquarters of industry-university-government cooperation with the TLO.
- The government will strengthen support for universities in their efforts to acquire patents at home and abroad, and also provide support for important technologies in specific fields if infringement of their patents occurs abroad and may damage national interests. The government will also request universities and public research institutions to improve their research management systems in order to increase joint or contracted research with overseas universities and businesses, which includes having them review cooperation rules for intellectual property protection, etc. and developing / securing specialized human resources.
- The government will expect universities and public research institutions to clarify their policies on the management and utilization of acquired patents and their handling of intellectual properties and confidentiality principles when doctoral course students, etc. participate in research, and to develop a flexible system of industry-university-government cooperation, such as to establish a university laboratory in a facility of a business or a company's laboratory on a university campus.
- The government will strengthen ongoing support to universities and public research institutions for a wide range of work from finding promising seeds to commercialization. In so doing, the government will promote the utilization of private sector funds, such as matching funds, in cooperation with related investment institutions. In addition, since public research institutions are expected to introduce seeds of universities to society, the government will improve and strengthen the functions concerning industry-university-government cooperation.
- In order to verify results of industry-university-government cooperation comprehensively, the

government will promote quantitative assessments, such as the number of patent licenses and related income, and qualitative assessments, such as the contribution to markets, dissemination of research findings, and job security. The government will also develop systems necessary for such assessments.

(iii) Establishment of "places" for industry-university-government collaboration

In order to advance S&T-based innovation promptly and efficiently, it is necessary to concentrate various knowledge assets and R&D capabilities of industries, universities and governments, and establish a chain of "places" for systematically conducting strategic R&D. In Japan, international R&D centers, including Tsukuba Science City, have been developed; for further development of such concentrated research locations, it is important to enhance their functions. In foreign countries, the roles of such systems and organizations that demonstrate the comprehensive power of industry, academia and government are increasingly valued. Given the situation, in order to promote innovation, core R&D centers will be established by concentrating various R&D capabilities of industry, academia and government.

<Promotional measures>

- The government will establish open innovation centers that promote R&D via "competition" and "cooperation" by concentrating various R&D organizations from industry, academia, and government in the stages of basic research, application, and development, and by placing focus on R&D of common basic technologies in non- competitive / pre-competitive areas. Particularly, in order to demonstrate a synergetic effect and promote innovation at centers where universities and public research institutions are concentrated, the government will encourage the use of facilities and equipment across institutional lines and integrated sharing and release of research findings.
- While maintaining close dialogue between industry and academia in research fields determined between them, the government will promote the establishment of a virtual core center ("place for joint creation") where collaborative R&D and human resource development are carried out across organizations.
- The government will promote the formation of "advanced interdisciplinary innovation creation centers" as places of innovation via industry-university collaboration.

(2) Construction of new systems for STI

(i) Environmental improvement for strengthening commercialization support

Revitalization of business start-up activities by effectively using results of advanced S&T is very important for the creation of industries and jobs, and economic revitalization. However, the environment for starting up in business has been becoming increasingly severe in recent years, as seen in the drastic decrease in the number of ventures initiated by universities due in part to the difficulty in securing personnel and/or funds. In view of the situation, the government will improve the environment in order to strengthen support for venture start-ups based on advanced S&T, by ensuring the provision of consistent support from the initial stage of R&T to commercialization.

<Promotional measures>

- The government will improve the infrastructure for comprehensive activities, including fostering of entrepreneurship, human resource development with training for business start-up simulation, and establishment of a network of professionals who provide support in legal affairs, intellectual properties, and capital strategies. In addition, the government will provide support to ventures initiated by universities and, in that process, will pay particular attention to management strategies - whether a comprehensive business strategy has been established or not and whether a management team has been formed and human resources engaged in such a team developed or not -- marketing, capital strategies, and intellectual property strategies.

- The government will promote the introduction of a multi-stage selection method in "Small Business Innovation Research (SBIR)" as a system for taking results of advanced S&T to commercialization. Accordingly, for the introduction of the multi-stage selection method, the government will consider setting targets of a certain ratio or amount of the R&D budgets of the governmental ministries and agencies.
- In order to ensure revitalization of venture activities, the government will strengthen the system that provides risk money more effectively, and consider a system that enables those who produced research findings to contribute intangible assets, such as human capital or intellectual property, as capital. In addition, new measures for supporting ventures will be examined including improvement of "angel investment."
- In order to promote innovation in the public sector, which has a limited market, the government will establish a cooperation system between technology users and technology holders, i.e., R&D institutions.

(ii) Utilization of regulations / institutions for promoting innovation

Regulations on R&D activities and institutions that monitor and govern those R&D activities were originally provided for the purpose of smooth promotion, ensuring safety, etc. in R&D activities, but they interfere with innovation in many cases because they are too strict. Yet, taking advantage of these regulations / institutions may have the effect of accelerating innovation. Hence, the government will promote efforts to improve and encourage utilization of regulations and institutions with the aim to facilitate innovation, including a special zone system for implementing exceptions to regulations and support measures in tax / financial / monetary systems.

<Promotional measures>

- The government will identify regulations and institutions considered to be a bottleneck in S&T-based innovation, and develop a solution system by discussing improvement measures among relevant ministries and agencies.
- In order to accelerate the efforts of businesses that aim their R&D at innovation, the government will, taking global competitiveness into consideration, examine how new regulations / institutions based on economic / technical reasonableness should be. For example, consideration should be shown for the establishment of sustainability criteria, such as, in regards to biofuel, criteria for reducing greenhouse gas emissions, and revisions to vehicle fuel consumption criteria.
- In order to strengthen advanced R&D, the government will consider establishing advanced research centers under the special zone system that limitedly relax regulations that interfere with the smooth progress of R&D after taking complementary measures. To be specific, such centers will be carefully selected and designated from among existing research organizations at universities and public research institutions, and their institutional feasibility will be verified.

(iii) Establishment of regional innovation systems

In order to encourage local activities to solve various issues, develop them countrywide and even worldwide, and use them towards the sustainable growth of Japan, it is necessary to actively utilize the diversity, originality, and creativity of individual local communities. Since efforts to promote S&T may not be firmly established in local communities due to severe financial situations, the government will build a system that enables local communities to independently develop STI activities that capitalize on their strengths and characteristics.

<Promotional measures>

- The government will build a support system that fully uses the measures of relevant ministries and agencies so that local governments, universities, public research institutions, and industrial sectors may, in cooperation with each other, develop quality schemes formulated independently by local communities to successively progress from research to commercialization.

- In order for local clusters that have achieved good performance to further play key roles as centers of autonomous growth in their communities, the government will provide focused support in networking, fostering and securing of human resources, intellectual property activities concerning R&D, as well as promotion of R&D.
- The government will support local communities in fostering and securing human resources who coordinate R&D, management, industry-university-government cooperation, and intellectual property activities. The government will also support the activities of universities and public research institutions to strengthen their abilities to contribute to their local communities in human resource development, industry-university-government cooperation, and intellectual property activities.

(iv) Promotion of intellectual property strategies and international standardization strategies

As many activities for open innovation are developed around the world, and research and economic activities are becoming globalized, in order for Japan's universities, public research institutions, and industrial sectors to address such changes appropriately, intellectual property strategies including international standardization strategies should be integrally promoted with R&D and other strategies. Hence, the government will formulate and implement an international standardization strategy in response to global changes in the environment of innovation, and review existing systems for intellectual property rights and improve systems concerning intellectual property activities.

<Promotional measures>

- The government will formulate competitiveness enhancement strategies in close cooperation with the private sector, with regards to specific strategic fields subjected to international standardization and for which growth on a global scale is expected and Japan has superior technologies. In addition, the government will promote international joint-research development programs that contribute to the acquisition of international attestations, and strengthen the functions of R&D institutions involved in international standardization and/or the formulation of standards for performance assessments and safety. Moreover, the government will advance cooperation with organizations that conduct product testing or certification, particularly in Asia.
- With industry-university-government cooperation, the government will actively provide proposals concerning international standards to standardization organizations such as the International Organization for Standardization (ISO), International Telecommunication Union (ITU), and International and Electrotechnical Commission (IEC), and comprehensively support international standardization activities including forum standards that contribute to the enhancement of industrial competitiveness. The government will also provide support in the development of training programs and participation in international standardization activities in order to develop and secure human resources who can appropriately respond to international standardization activities.
- Aiming at the substantial mutual international recognition of patent examination results, the government will improve the quality and increase the quantity of patent examination work-sharing by establishing a system for sharing examination results of each patent office in Japan, the U.S. Europe, South Korea, and China, expanding targets of the Patent Examination Highway, and simplifying relevant procedures. Also, in view of participation in the Patent Law Treaty, the government will advance institutional improvements so as to increase the convenience for applicants.
- The government will review the patent system so that it may promote the use thereof by universities and public research institutions, including the adoption of free application formats, an increase in exceptions to loss of novelty, and improvement of the academic discount system.
- The government will establish a system that enables free use of patents only for the purpose of

research in cooperation with participating organizations including universities. The government will also develop a system for collecting and publicizing S&T information related patents and a framework for utilizing intellectual property. Moreover, the government will promote improvements to the infrastructure and networking concerning information related to intellectual properties, such as by creating a system that combines and analyzes patents and various references.

III. Response to the essential issues facing Japan

1. Basic concept

In order for Japan to produce good results in S&T and return them to society, the government should promote R&D more effectively and efficiently. From such a viewpoint, the 2nd and 3rd Basic Plans, as a particular focus, designated the four primary priority areas and four secondary priority areas as R&D fields to preferentially allot resources and ensure the prioritization of R&D. However, it was pointed out that this approach had problems as such an unclear relationship with the visions of the Basic Plan or policy goals, a mixture of viewpoints on addressing social issues and creating and developing seeds in setting target fields, and insufficient establishment of the task-achieving type of comprehensive R&D due to a division of fields into a top-to-bottom structure.

In view of these indications, the government should identify issues to address in R&D activities that should be aggressively promoted by the country, and prioritize resource allotment to R&D activities that contribute to their promotion. Green Innovation and Life Innovation, which are positioned as two major pillars of growth in Chapter II, are activities for overcoming the restrictions afflicting Japan and achieving essential progress that is leading to economic growth. However, Japan is faced with a number of serious issues other than those in the fields of environment, energy, medical care, nursing care, and health. In order to overcome such issues, the government should promote R&D and other activities comprehensively and systematically with the participation of various organizations in industry, academia and government through a cross-sectional approach and by coordinating activities developed by each of these organizations, including basic research, application, development, industrialization, and commercialization, so that such efforts lead to new value creation.

In view of such circumstances, this Chapter identifies essential issues to be addressed by the country and provides a basic direction of relevant policies, including the R&D to be aggressively promoted in order to achieve success in those issues, to the same extent as discussed in Chapter II for the environment, energy, medical care, nursing care, and health, in response to the five visions of Japan mentioned in Chapter I. Accordingly, the 4th Basic Plan has greatly changed the policy to the prioritization of measures for achieving success in essential issues from the prioritization of R&D based on the four primary priority areas and four secondary priority areas. Additionally, in identifying specific R&D issues under this new policy, the performance and findings of R&D so far produced based on field-specific prioritization will be appropriately utilized. Moreover, promotion of measures for achieving success in essential issues requires comprehensive development of STI policies including a reform of social systems, so that the government promotes efforts for this in an integrated manner.

In addition, the essential issues facing Japan, including global and other issues, are expected to become common global issues the mid- to long-run. Also, given the emergence of Asia as a global growth center and the trend of aging with a declining birthrate in Japan, it will be important to combine the international development of S&T activities with the vitality of the world in order to maintain and strengthen Japan's global competitiveness in STI. By actively using the Japan's world-leading S&T and promoting multitiered cooperation with many advanced and developing countries, the government will proactively address the essential issues facing Japan, the improvement of S&T levels, and the utilization for diplomatic activities.

2. Promotion of measures for achieving success in essential issues

(1) Realizing an affluent and high-quality life for the public

In order for the public to continue to live a safe, affluent, and quality life in the future, the government should ensure a stable supply of food, water, resources, and other items indispensable to daily life and protect their lives and property from disasters, etc. It is also important to promote efforts to realize true affluence including an improvement in convenience and comfort, in addition to public safety.

To these ends, by setting the following essential issues to be addressed, the government will aggressively promote relevant measures, including R&D responding to these issues, in cooperation with universities, public research organizations, and industrial sectors.

(i) Ensuring a stable supply of food, water, resources, and energy

To improve the food self-sufficiency rate, enhance food safety, and ensure a stable supply of water, the government will promote R&D concerning the production, distribution, and consumption of safe and quality food materials and products, and R&D concerning stable supplies of food and water, which will include the utilization of advanced technologies such as genetically modified organisms (GMO) and the adoption of industrial viewpoints.

In addition, from the viewpoint of resources and energy security, the government will facilitate investigations and technical development for the acquisition and efficient and cyclic use of new resources and energies, and R&D concerning the control, proper management, and reuse of waste, and promote the dissemination and development of findings.

(ii) Ensuring safety and improving convenience in public life

With the aim to ensure the safety of people from natural disasters, etc., the government will promote the study, observation, and forecasting of earthquakes, volcanoes, tsunamis, high waves / tide, wind / flood damage, landslides, etc., R&D concerning disaster prevention and reduction, R&D concerning measures against fires, serious accidents, and crimes, and promote efforts of the central and local governments, etc. to implement their measures, etc.

In addition, for the protection of human health and ecosystems, R&D will be promoted into assessing hazards and risks of environmental pollutants in the air, water, and soil, as well as control and countermeasures concerning them.

Furthermore, to ensure safety and establish both convenience and comfort, R&D will be promoted into the advancement of traffic / transport systems and safety assessments thereof, and advancement / life extension of residence / social capital as measures against aging.

(iii) Increasing the wealth of public life

In order to realize true wealth in the lives of people, the government will promote activities that contribute to S&T-based improvement in the quality and wealth of public life, including improvements / increases in public and private-sector services (e.g., education, welfare, medical / nursing care, administration, tourism, etc.) and improvement / deepening of relations among people by utilizing S&T, such as advanced information and telecommunications technologies.

Furthermore, in order to improve human sensibility and wealth of the mind, R&D that leads to the creation of new culture and improvement in the potential and content of design, which Japan is proud of, will be conducted from the viewpoint of merging humanity and the social and natural sciences. Also, efforts will be made to return the results of such R&D to public life and apply them to overseas development.

(2) Strengthening the industrial competitiveness of Japan

In order for Japan to achieve sustainable growth in the future, given the increasing presence of newly

emerging countries in Asia and other regions, it is necessary to strengthen the global competitiveness of industries that support the economic growth of Japan and to create / reinforce the fields capable of acquiring added-value. Hence, in order to create new industrial infrastructure and further strengthen manufacturing in Japan, it is necessary, in addition to new market creation through Green Innovation and Life Innovation, to promote R&D at the world's top level in basic fields that have a high ripple effect in many industries, and further strengthen industrial competitiveness.

To these ends, by setting the following essential issues, the government will aggressively promote relevant measures, including R&D responding to these issues, in cooperation with universities, public research institutions, and industrial sectors.

(i) Strengthening common infrastructure for the enhancement of industrial competitiveness

R&D will be promoted into innovative common basic technologies, including basic technologies required for the development and utilization of advanced materials and components of high added-value, large market share or future growth potential. Japan has many technologies of high global competitiveness, and many basic technologies that support the utilization of high-performance electronic devices, information and telecommunications. Therefore, a strategy for appropriately opening up those technologies will be promoted.

Furthermore, in order to respond to various market needs, common infrastructure for new manufacturing technologies will be established by promoting R&D into the advancement of measurement / analysis techniques, high precision processing technologies, and built-in system development techniques, integration of elemental technologies, establishment of performance / safety assessment methods, and hardware (materials, components, and units) coordination with software.

(ii) Creation of new industrial infrastructure utilizing the strengths of Japan

To create new added-value in end products such as machines, vehicles, and electrical machines in an environment of intensifying global competition, R&D will be promoted in line with demonstration experiments and international standardization, with the aim of establishing integrated systems, such as next-generation transportation systems and smart grids. Also, efforts will be made to promote integrated services, including maintenance and operation, and overseas development of results of such R&D.

In addition, in order to enhance the productivity of the service industries in Japan, R&D and other activities for utilizing S&T effectively will be promoted. Furthermore, to enhance the efficiency of the financial world in general and create new industries, R&D will be promoted into information and telecommunications technologies for establishing next generation information and telecommunication networks and realizing reliable cloud computing systems. And, the broad utilization of results from that R&D will be promoted.

(3) Contribution to the solution of global issues

Japan maintains a high level of S&T thanks to the various promotional measures so far taken. In the future, Japan should, as a mature country, not only aim at further development of S&T of its own but also actively contribute to the solution of various issues arising on a global scale in cooperation with foreign countries and by actively using their S&T.

Accordingly, by setting the following essential issues, the government will aggressively promote relevant measures, including R&D responding to these issues, in cooperation with universities, public research institutions, industrial sectors, foreign countries and international organizations.

(i) Promotion of a response to global issues

With regard to large-scale climate change, etc., the government will promote observation, forecasting, and impact assessment on a global scale via international cooperation, and R&D into measures against catastrophic natural disasters that may be caused by climate change. For the conservation of biodiversity, the government will promote surveys and observations of ecosystems, impact assessments, and R&D into the conservation and restoration of ecosystems.

The government will also promote R&D into new resources / energies and cyclic use, and alternative resources in order to ensure a stable supply of resources and energy.

Furthermore, the government will promote R&D into identifying pathogens, prevention, diagnosis, and treatment related to emerging / re-emerging infections.

In accordance with the promotion of such R&D, the government will also promote the dissemination and development of R&D findings at home and abroad, while taking the initiative in building consensus of the international community on addressing relevant issues.

(4) Maintaining the basis of national existence

In order for Japan to maintain international superiority and ensure the safety of public life, some R&D issues will require the government to take a long-term viewpoint and promote R&D and accumulate findings consistently and widely over the long-run. The government will aggressively address such R&D issues considering the R&D to be related to the basis of national existence. In promoting such R&D, the government will consider the basis of national existence in a broad sense, including, in addition to national security, the promotion of R&D for establishing the independent basis of S&T aiming to develop new areas of S&T.

Accordingly, to be specific, the government will promote R&D into the following, while ensuring consistency with on other plans such as the Space Basic Plan, Basic Plan on Ocean Policy, and Basic Energy Plan, and Framework for Nuclear Energy Policy.

(i) Strengthening national security and critical technologies

The government will promote R&D into technologies for ocean exploration and development aiming to develop and secure useful natural resources, technologies for space transportation and satellite development and utilization that help to ensure national security, public safety, etc., including information collection, technologies for new energies with the aim of securing independent energy sources, technologies for nuclear energy including fast-breeder reactor cycles and nuclear fusion; high-performance computing technology of the world's top level, technologies for geospatial information, and technologies concerning active and dependable information security.

(ii) Establishment of S&T infrastructure for new frontier development

The government will promote R&D including theoretical research, experimental studies, surveys / observations, analyses, etc. in order to build S&T infrastructure for developing the frontier of new knowledge, such as integrated understanding and analysis of substances, life, oceans, earth, and space.

(5) Improvement and reinforcement of common infrastructure for S&T

In order to promote R&D concerning S&T effectively and efficiently and thereby address various issues facing Japan and the world, it is necessary to promote R&D into S&T that is cross-sectionally available in multiple areas. It is also important to ensure further improvement and reinforcement of common and basic facilities and equipment that are extensively used for various R&D activities.

Accordingly, to be specific, the government will promote relevant measures including R&D into the following.

(i) Enhancement of cross-sectional S&T

The government will promote R&D into nanotechnology and optical / quantum technologies that will lead to the development of advanced techniques for measurement, analysis, etc., advanced information & communication technologies such as simulation and e-science, S&T that is cross-sectionally available in multiple areas such as mathematical science and system science technologies, and S&T for integrated areas.

(ii) Advancement of common and basic facilities and equipment

The government will promote the effective use and application of common and basic facilities and equipment used in extensive R&D areas concerning S&T and various research institutions at industries, universities and government facilities, and facilitate R&D aimed at accelerating technical advancement of such facilities, etc.

3. System reform to achieve success with essential issues

(1) System reform for promoting task-achieving type of R&D

In order to promote the task-achieving type of R&D effectively and efficiently, it is necessary to implement R&D activities systematically and comprehensively, with the extensive participation, cooperation of industries, universities and government offices. Accordingly, in order to achieve success with the essential issues described in section 2, the government will actively advance efforts based on the promotion policy described in II-4 "System reform for promoting STI."

<Promotional measures>

- In cooperation with universities, public research institutions, industrial sectors, etc., the government will implement efforts, under the promotion policy described in II-4, to found strategy councils and promote industry-university-government cooperation in each essential issue, enhance support for commercialization, effectuate regulatory / institutional reforms, promote S&T in local communities and promote intellectual property strategies and an international standardization strategy.

(2) Establishment of promotion system for R&D requiring governmental initiative

In promoting R&D of critical technologies for national security and basic facilities and equipment used commonly across multiple areas or organizations, since such R&D should be undertaken consistently on a long-term basis, the government should take the initiative to build a system for conducting such R&D using all available resources of relevant research institutions owned by industry, academia and government. Accordingly, the government will launch a new project to advance such R&D effectively and efficiently.

<Promotional measures>

- With regard to R&D into basic technologies centering on national security and critical technologies, the government will establish a project (titled, e.g., "National Security / Critical Technology Project [tentative name]") for the government to take the initiative in implementing R&D into specific technical issues in consideration of related plans, etc. In so doing, the results of "National Critical Technologies" adopted in the 3rd Basic Plan will be utilized to the fullest extent.
- In promoting this project, the government will appoint a project manager who oversees and effectively controls the entire project, without limiting to individual R&D activities, and will formulate a mid- to long-term strategy, which will include the formulation of action plans, protection of intellectual properties, and development of human resources in cooperation with relevant organizations. In so doing, the project should be examined in consideration of the assessment results for the issues selected as "national critical technologies" in the 3rd Basic Plan.

4. Strategic development of globally integrated activities

(1) Promotion of R&D for solving common issues in Asia

In order for Japan to play a leading role in solving global issues and maintain a firm position in the world, it should strategically promote STI policies from the viewpoints of international cooperation. Particularly in Asia, Japan's S&T could be utilized to solve issues in many areas, such as the environment, energy, food, water, disaster prevention, and infectious diseases. Japan should, therefore, play an active role in solving such common issues in Asia and build relationships of mutual trust and interest in this region. For this reason, the government will promote new efforts to enhance S&T cooperation with Asian nations.

<Promotional measures>

- As part of the East Asian Community, the government will promote the "East Asia Science & Innovation Area." Specific activities considered under this initiative include the establishment of reciprocal relationships among participating countries in a manner open to non-participating countries, joint implementation of R&D activities that contribute to solving common issues, and human resource development and exchange. In so doing, while Japan will lead R&D areas in which Japan has strengths, other areas that should be promoted by taking advantage of characteristics of other Asian countries will be promoted by such countries.
- As part of this initiative, the government will consider the establishment of an international research fund and the implementation of a large-scale joint project with the aim to enhance the S&T level and promote innovation within the participating countries.

(2) New development of S&T diplomacy

(i) Development of international activities taking advantage of the strengths of Japan

Japan is promoting activities that lead the world on various issues including the environment and energy, and its S&T are also at a high level. In the future, in order as well to achieve sustainable growth and create new demand, Japan should "export task-achieving type prescriptions" (system export) based on such high-level S&T with a particular focus on rapidly-growing Asia. Hence, the

government will promote the development of systems that lead to social reform in Asia by taking advantage of the strengths of Japan.

<Promotional measures>

- The government will support, in cooperation with Asian countries, activities for advancing the international standardization of technologies, regulations, criteria, and standards in the areas where Japan has a technical advantage.
- For the development of social infrastructure (e.g., energy, water, and transportation systems) in newly emerging countries, the government will promote efforts for overseas development of integrated systems where advanced technologies of governments and the private sector are packaged with management and operation know-how, human resource development, etc.
- The government will consider the creation of a "Council for Promoting Cooperation Based on S&T Diplomacy (tentative name)" as a place for consistent exchange of information among relevant ministries and agencies, industrial sectors, academic circles, etc.

(ii) Promotion of international activities concerning advanced S&T

In order to ensure further development of Japan's S&T and enhance the synergetic effect of S&T and diplomacy, it is necessary for Japan to promote R&D activities concerning advanced S&T in cooperation with developed countries and international organizations, and then actively utilize such activities for diplomatic activities. For this reason, the government will aggressively promote international activities concerning advanced S&T, and advance activities for improving international research networks.

<Promotional measures>

- The government will improve international research networks in various areas with countries whose S&T levels are high, and promote international cooperation concerning advanced S&T utilizing quality research resources from overseas.
- The government will promote cooperation in large-scale international projects and R&D requiring comprehensive database preparation, taking into account opinions from researcher communities. In so doing, in consideration of Japan's international position in each research area, the government will provide support so that Japan may demonstrate leadership in the areas where it has strengths and is strongly interested.
- Japan will support universities and public research institutions with the world's top level R&D capabilities so that they may develop research activities at overseas research centers in combination with the vitality of the world. In so doing, it is expected for such universities and public research institutions to incorporate overseas resources, such as by employing capable local researchers, utilizing the characteristics of overseas areas in research, and effectively using overseas research fund systems.
- In promoting S&T, the government will promote the utilization of international frameworks such as the G8, APEC, ASEAN+3, and East Asia Summit (EAS), international organizations such as the United Nations and OECD, and research institutions such as the Economic Research Institute for ASEAN and East Asia (ERIA). The government will also play a leading role in creating new frameworks by taking advantage of Japan's S&T in meetings that have a great influence on policy decisions of member countries. Furthermore, the government will seek international trust concerning the peaceful use of nuclear energy, and play a leading role in international cooperation on technical development and human resource development concerning nuclear nonproliferation and security.

(iii) Promotion of the cooperation on global issues with developing countries

Japan is greatly expected to actively promote international cooperation with developing countries in Asia, Africa, Latin America, etc. and contribute to the development of S&T, human resource

development, etc. in such countries. Such expectations are, in other words, responsibilities imposed on Japan by the international community. From that viewpoint, the government will promote multifaceted international cooperation with developing countries concerning S&T.

<Promotional measures>

- In cooperation with international organizations and NPOs developing activities in various areas, the government will promote activities in combination with international joint research using Japan's advanced S&T and technical cooperation through the Official Development Assistance (ODA) in order to solve issues in developing countries.
- The government will promote multifaceted cooperation in human resource development, including support of young researchers of counterpart countries involved in international joint research in their acquisition of academic degrees in Japan, as well as continued support even after they return to their home countries.

(iv) Enhancing the infrastructure for developing international activities for S&T

In order to progress strategically with bilateral / multi-lateral international cooperation activities concerning S&T, it is necessary to further increase the dialogue between the Japanese government and the governments of foreign countries, and to consistently collect and utilize information concerning the trends of overseas S&T. For this reason, the government will strengthen the basis for developing international activities for S&T.

<Promotional measures>

- The government will strengthen policy dialogues by leaders and cabinet members with foreign countries concerning S&T by holding ministerial conferences, etc. In addition, under inter-government and inter-organization coordination established through bilateral and multilateral cooperation, the government will promote cooperation based on government dialogues and agreements more effectively.
- In cooperation with universities and public research institutions, the government will establish systems for information exchange and cooperation between their overseas centers and Japanese diplomatic missions / researchers abroad. The government will also support policy dialogues concerning S&T with the private sector from a viewpoint of expanding the range of Japan's international activities.
- The government will establish a system for collecting, accumulating, analyzing, and using overseas information cross-sectionally, consistently, and systematically in order to utilize such information for policy decisions, and foster human resources who engage in such promotion.

IV. Enhancement of basic research and human resource development

1. Basic concept

The promotion of basic research serves as a key for creating new knowledge assets and solving various global common issues. Basic research also constitutes the basis for maintaining and developing Japan's high-level of S&T as a source of national strength, creating new industries by way of innovation, and realizing a safe and affluent public life. Furthermore, the main players who engage in such activities explore the frontier of knowledge via such basic research and promote efforts for achieving relevant issues are those.

From such viewpoints, as well as in response to essential issues to be addressed by the country described in Chapters II and III, the promotion of basic research with a long range perspective and development of human resources who lead S&T should be further strengthened as the "two main wheels of a car."

The significance and importance of basic research deriving from free ideas of researchers have increased in recent years as basic research plants the seeds for producing innovation (seedbed for diversity), extensively creates new intellectual / cultural values and makes direct / indirect contribution to social development. In order to firmly establish the basis of STI in Japan, it is essential for Japan to focus on creative diversified basic research and aggressively promote those projects, therefore the government will implement efforts to drastically enhance basic research.

It is also necessary for Japan to strategically foster and support various human resources who lead the promotion of STI from a mid- to long-term viewpoint. In particular, as various activities have been developed globally in recent years, international competition to acquire human resources is further intensifying. Accordingly, the government will strengthen efforts for the development and securing of quality human resources from a viewpoint of actively promoting STI as a national commitment.

Moreover, in order for Japan to attract the world's top class human resources at home and abroad, and promote R&D in combination with the vitality of the world, it is necessary to advance the development of quality research facilities, equipment, and other environments. As such, the government will further promote the establishment of research environments and infrastructure based on international standards.

2. Drastic enhancement of basic research

(1) Enhancement of creative and diverse basic research

Basic research should be rooted in the intellectual curiosity and the spirit of inquiry of researchers and conducted based on their initiative and creativity. Findings of such research will lead to the creation of intellectual assets common to mankind and the accumulation of profound knowledge, and will further serve as a source of wealth and strength for Japan. The government will, therefore, strengthen efforts to promote such creative diversified research extensively and consistently.

<Promotional measures>

- The government will support basic research based on the free ideas of researchers, and increase basic expenses for university operation (operating subsidies and facility improvement subsidies for national university corporations, and aid to private schools) in order to enable academic diversity and consistency, and ensure seedbeds for intellectual activities.
- The government will further expand Grants-in-Aid for Scientific Research in order to ensure a 30% new adoption rate and 30% indirect costs. The government will also develop a system to secure sufficient research funds for Principal Investigators (PI) by simplifying relevant existing systems.
- In order to develop seeds produced from the aforementioned research to achieve goals, etc., the government will develop and improve various research fund systems and enhance coordination with Grants-in-aid for Scientific Research. In particular, the government will further increase

research funds for supporting basic / fundamental researches strategically and aggressively.

- The government will improve the system of examination and assessment including peer reviews, e.g., flexible determination of research themes and research assessment based on various indicators such as international standards, in view of the nature of the basic research and in consideration of the researcher's creativity and development potential of the research.
- The government expects researchers of universities and public research institutions to disseminate information to gain a broad understanding from the people of the significance of research and expected findings. The government will support such activities.

(2) Enhancement of globally top-level basic research

In order to further enhance research that is highly evaluated around the world as well as to attract quality researchers at home and abroad, and promote globally-advanced R&D, it is necessary to build research centers that can work as a hub of international research networks. To these ends, in order to build centers for conducting the world's top level research / education activities, the government will improve the environment for promoting the acquisition and acceptance of quality foreign researchers and students, as well as promote efforts to strengthen and accelerate the reform of university operations.

<Promotional measures>

- The government will aggressively support relevant activities in order to form a group of research-focused universities that conduct research / education activities at an internationally high level.
- The government will support, via various approaches, efforts for the promotion of research at an internationally high level, development / securing of human resources, expansion of opportunities for international dissemination of information, etc. In so doing, the government will individually assess universities and public research institutions according to each research area, and examine a system for reflecting assessment results in funds distribution.
- The government will promote the establishment of the world's top level research centers with quality research environments by concentrating the world's top researchers, making prompt decisions, independent personnel affairs and pay system, using English in each function, and developing new interdisciplinary research areas.
- The government will advance the establishment of research centers provided with advanced large-scale R&D infrastructure as core centers of international brain circulation.
- By also referring to overseas cases, the government will build a system that enables international comparisons according to each research area, and identify the international and domestic positions of each university for each research area. Also, based on the results of such activities, the government will promote efforts to provide focused funding support and encourage strategic personnel management and administration for universities that can serve as an international hub in each research area.
- Through the aforementioned efforts, the government will aim to establish more than 100 research / education centers with researchers whose research papers are ranked within the top fifty in the world's citation ranking in their individual research areas, and considerably increase researchers whose research papers are ranked within the top one percentile in the world's citation ranking in their individual research areas.
- In order to promote the acceptance of quality foreign researchers and students at universities and public research institutions, the government will strengthen support systems including fellowships (grants for encouragement of research) and scholarships, ensure the execution of employment agreements with a term of at least 3 years and reappointment provision, examine the measures taken under the present immigration control system, and support environmental improvements for the internationalization of related local governments and local communities including the living

environment of relevant families. In addition, under the 300,000 International Students Action Plan, the government will promote comprehensive efforts for strategic acquisition of quality exchange students.

- The government will promote efforts for re-invitation and research expense support in order to maintain / enhance relationships with researchers and exchange students who did research in Japan. In addition, the government will develop a database of Japanese researchers working actively abroad to utilize it for employment and establishment of international networks.
- In order for universities and public research institutions to increase the appointment of quality foreign researchers, the government will promote the enhancement of systems, such as by improving research environments and treatment including salaries and deploying personnel with expertise, and encouraging them to work on various efforts according to the characteristics of universities etc., such as setting the percentage of foreign researchers to 10%. The government will support such efforts.

3. Development of human resources to lead S&T

(1) Development of human resources capable of working actively in diverse scenes

(i) Drastic enhancement of graduate school education

In fostering human resources of high expertise required internationally and extensive ability to work actively in various areas of society, the role of graduate school education is very significant. In order to make graduate schools more attractive and improve career path environments, it is necessary to respond to various social expectations and promote efforts for improving the quality of university education and research in reference to the results and issues of the 3rd Basic Plan. For this reason, the government will promote drastic reform and enhancement of graduate school education aiming for the development of quality human resources who can work actively in a knowledge-based society.

<Promotional measures>

- The government will promote the establishment of "Leading Graduate Schools," which provide doctoral courses in international networks and cooperation with industrial sectors with the aim to develop leaders who can lead the world in new fields of growth.
- The government will establish a "Human Resource Development Council (tentative name)" as a function for dialogue between industrial sectors and universities in order to foment a common understanding of human resource development. In addition, industrial sectors are required to clarify what is required for graduate school graduates through this function and cooperate with universities upon request in preparation of curriculums, etc. for quality improvement and career path diversification for graduate school graduates.
- The government will formulate new "Guidelines for Graduate School Education Promotion Policy," which specify the direction of graduate schools reform, purpose of graduate school education, and systematic and intensive efforts for achieving the purpose in reference to the opinions of the Central Council for Education, and then develop relevant policies based on the Guideline.
- The government will upgrade assessments of universities and establish multifaceted assessment standards and indicators that are comparable domestically and internationally in order to promote function- and field-specific assessments of universities. In addition, the government will examine and promote measures for applying such assessments to resource allocation in education research support projects, etc.
- In order to promote systematic assessments of graduate courses and credits for majors at universities, the government will request universities to set a purpose for human resource development and goals for achieving that purpose, clarify the contents and methods of education,

improve coursework, develop and utilize teaching materials, etc. The government will support such efforts and build a system for collecting and listing information concerning graduate school education.

- In order for universities to ensure the quality of their graduate school education, the government will request them to consider the review of the admission capacity of doctoral courses and adopt a selection system for admission that is fair and open to domestic and foreign students and pertinent to the purpose of human resource development.
- The government will expect universities to evaluate the educational performance of faculty members from multiple viewpoints with visualized data, and enhance their awareness through efforts to reflect evaluation results in personnel affairs and treatment, improved faculty development (FD), increased opportunities for self-study, etc.
- The government will encourage universities to promote international educational cooperation with overseas universities and research institutions, such as credit transfers and double degree programs between Japanese and overseas universities. The government will also support such efforts.

(ii) Support for entry into doctoral courses and diversification of career paths

In order to encourage quality students to proceed to a graduate school's doctoral course, it is necessary to ensure various types of career paths so that students may use their expertise not only at their universities but also in industrial sectors or local communities after graduating from their school, in addition to economic support while studying at their graduate school. For this reason, the government will substantially strengthen economic support for doctoral course students, support for career development for students, graduates, etc., and other support.

<Promotional measures>

- The government will increase grant-type economic support, such as fellowships, Teaching Assistants (TA) and Research Assistants (RA), so that quality students may feel secure about proceeding to a graduate school. With this effort, the government will strive to achieve the goal set by the 3rd Basic Plan, i.e., "enabling 20 percent of doctorate course students to receive an amount equivalent to their living expenses." The government will also take measures to reduce the burden of students according to their family budget, such as by tuition reductions, scholarships and loans, and encourage universities to help themselves, such as the use of donations from the private sector.
- The government will request universities to ensure in cooperation with industrial sectors that doctoral course students may develop management abilities and basic skills for multiple fields of expertise as required in industrial sectors. Industrial sectors are also expected to evaluate the capabilities of doctoral course graduates and post doctors to promote their appointment to positions other than those for academic research.
- The central and local governments, universities, public research institutions, and industrial sectors, in cooperation with each other, will further support the career development of doctoral course students, graduates, and post doctors according to their aptitudes, hopes, and areas of expertise, such as by increasing opportunities of long-term internship in businesses, etc.

(iii) Engineer training and skill development

In promotion of STI, industrial sectors and engineers supporting them play a core role. In addition, in accordance with the advancement and integration of technologies, qualities and skills required of engineers are becoming increasingly sophisticated and diversified. For this reason, the government will strengthen efforts for the training of engineers, skill development, etc. in response to such changes.

<Promotional measures>

- The government, universities, technical colleges, and industrial sectors will, in cooperation with

each other, formulate field-specific targets for fostering practical engineers, preparation of teaching materials, internships, bilateral exchanges of human resources between industry and academia. In addition, the government will expect universities to consider the formulation of double linear and diversified curriculums and the establishment of an organized and systematic education system for graduate school students who aspire to be practical engineers.

- The government will promote the dissemination, expansion, and further utilization of engineer certification systems, such as for professional engineers, and review the existing systems in response to the demands of the times. Industrial sectors are also expected to actively evaluate professional engineers and promote their activities.

(2) Training for creative quality researchers

(i) Establishment of fair and highly transparent assessment systems

In order to train creative quality researchers, it is necessary to provide young researchers with opportunities for independence and activities, and increase posts for them so that they may establish a career path. At present, the ratio of young teachers is declining at universities, while teachers on the whole are entering the stage of significant generational change. Taking advantage of the situation, the government will promote efforts so that universities may increase posts for young researchers and establish a fair and transparent ability-based personnel system in adopting them.

<Promotional measures>

- The government will request universities and public research institutions to focus on qualitative assessments in evaluating the performance of researchers, and conduct fair, flexible, and transparent ability-based assessments from various viewpoints, such as efforts for developing R&D results to commercialization or international assessment of research papers. It is also expected to reflect results of such assessment appropriately in the treatment of relevant researchers.
- The government will expect universities, in accordance with their purpose and characteristics, to review treatment so as to reflect the performance and duties of researchers appropriately, and promote the increase of posts for young researchers and appointment of quality researchers, e.g., through a review of researchers who reached a certain age or their shift to another pay system.
- The government will expect universities and public research institutions, in accordance with their purpose and characteristics, to select quality human resources at home and abroad through international solicitation. The government will also expect them, in accordance with their purpose and characteristics, to step by step promote employment based on an annual salary system.

(ii) Improvement of career paths for researchers

In order to train quality researchers, it is necessary to improve career paths for young researchers as well as to secure posts for them. In so doing, it is significant to increase the mobility of researchers in order for researchers to accumulate experiences in various research environments and broaden their human networks and views as a researcher. On the other hand, it is pointed out that efforts to improve the mobility in some cases discourage young researchers from working on research, so the government will develop career paths that both provide stability to researchers and ensure a certain level of mobility.

<Promotional measures>

- The government will increase support to universities that promote the dissemination and establishment of the tenure track system.⁵ In so doing, the government will ensure that each university will introduce the tenure track system according to its purpose and characteristics.

⁵ A system that enables young researchers employed through a fair and transparent system to accumulate experiences as an independent researcher in the form of employment with a fixed term of service before gaining a more stable position through review process.

Consequently, the percentage of teachers belonging to the same system will rise to about 30% of the total number of newly hired young natural science teachers of all universities.

- The government will substantially increase support, such as fellowships and research funds, in order to build an environment where quality young researchers selected through competition can concentrate on research independently at a place where they desire to work.
- The government will expect universities and businesses, in collaboration with each other, to enhance the mobility of human resources by promoting a personnel exchange system that enables quality researchers to step up between the university and business or otherwise. The government will also expect universities, in accordance with their purpose and characteristics, to establish a personnel system that highly evaluates experiences and performance in a quality university other than their alma mater or public research institution, at home and abroad.
- The government will strengthen support for overseas sabbatical and study so that young researchers and students with excellent qualities and abilities may actively work on studies in foreign countries. The government will also expect universities and public research institutions to establish a personnel system to appropriately evaluate the experience of studying abroad in employing young researchers.

(iii) Promoting the activities of female researchers

Japan is promoting the appointment and activities of female researchers by setting numeric targets for the adoption of female researchers under the 3rd Basic Plan. As a result, their number is increasing year by year, but is still at a low level as compared with those in foreign countries. The appointment of female researchers is very significant for not only the enhancement of gender equality but also to demonstrate organizational creativity by adopting various viewpoints and ideas and stimulating research activities. For this reason, the government will improve the environment for further appointment of female researchers and promotion of their activities.

<Promotional measures>

- Considering as well the present percentage of women researchers in doctoral courses, the government will promote relevant activities so as to achieve the numerical target for recruitment of female researchers under the 3rd Basic Plan, i.e., 25% for natural science as a whole, and further raise the percentage to 30%. In particular, the government will aim at early achievement of the targets of 20% for physical science, 15% for engineering, and 30% for agriculture, and achievement the target of 30% for the total of medicine, dentistry, and pharmacy.
- The government will support universities and public research institutions that improve their research support system, etc. so that female researchers may cope with childbirth, childcare and research. The government will expect universities and public research institutions to work on the establishment of flexible employment, personnel and assessment systems, telecommuting and short-time working systems, improvement of research support system, etc.
- The government will expect universities and public research institutions, in order to achieve the foregoing targets, to promote active appointments by formulating specific plans concerning efforts for stimulating activities of female researchers and the numeric targets set for female researchers, and to release to the public the percentage of enrolled women researchers according to job classification and department. The government will also expect them to promote efforts to increase female researchers in a leading position, female students of natural science, and quality women aiming to be a professional researcher.

(3) Development of human resources who can lead the next generation

In order for Japan to lead the world with S&T in the future, it is necessary to consistently and systematically nurture talented children to lead the next generation. In Japan, the percentage of junior and senior high school students who have interest in learning science and enjoy learning science

and mathematics is low as compared with foreign countries. The government will, therefore, develop consistent activities to enhance the interest of children in science and mathematics at elementary and secondary education so as to increase the population of children interested in such subjects, and to identify talented children and develop their abilities.

<Promotional measures>

- The government will expect each board of education and university, in cooperation with one other, to promote activities concerning graduates from science / engineering departments or graduate schools, by utilizing the special course and special part-time instructor systems.
- The government will request each board of education and university, in cooperation with one other, to increase opportunities to come in contact with S&T and practice observation and experiment through training for active faculty members and teacher training courses.
- The government and each board of education, in cooperation with universities and industrial sectors, will increase opportunities for practical and easy-to-understand learning, such as study tours to laboratories and plants, experiments and classes on demand, and utilization of digital teaching materials. The government and each board of education will also review / improve observation and experiment instruments, etc. in schools.
- The government and each board of education will increase opportunities for further activities of outside personnel as observation / experiment supporting staff, including researchers and engineers of universities or industrial sectors and students of science / engineering departments or graduate schools who aspire to become teachers.
- The government will further strengthen support for the Super Science High School (SSH), which aims at the development of S&T-related human resources who are expected to lead the next generation, and promote efforts to spread the results of such activities widely to other schools.
- The government will strengthen efforts to increase children who participate in international S&T competitions, develop the talents of such children, and increase efforts to raise the students' interest in S&T, e.g., by holding a "Science Koshien" or "Science Inter-Collegiate Game."
- The government will support efforts to evaluate results of international S&T competitions, SSH, etc. in entrance examinations for universities, and promote efforts for smooth high-school-university cooperation, such as completion of university natural science or major subjects while in high school.
- From a viewpoint of developing talents for S&T, the government will consider policies for high school students to learn more advanced contents, improve issues concerning the way university entrance examinations should be, etc.

4. Establishment of international-level research environment and infrastructure

(1) Improvement of R&D environments at universities and public research institutions

(i) Development of facilities and equipment at universities

Universities should develop high-quality facilities and equipment with satisfactory functions in order to cope with more advanced and diversified education and research activities, attract quality human resources and enhance global competitiveness, and promote industry-university cooperation, local contributions, and internationalization. Development of facilities and equipment at universities is steadily progressing, but some of them have difficulties with systematic improvements or maintenance due to the severe financial circumstances, so the government will promote efforts for developing / advancing such facilities and equipment, and ensuring stable operation.

<Promotional measures>

- The government will formulate a plan for aggressively developing facilities at all national university corporations (including the Inter-University Research Institute Corporation and

technical colleges), strengthening support and ensuring stable and consistent development.

- The government will request national university corporations to formulate a campus development plan based on a long-term perspective, and further promote facility management. The government will also expect them to utilize various revenue sources, such as donations, self-income, long-term loans, and Private Finance Initiatives (PFI), for facility development. The government will promote efforts to support tax benefits including consideration of the way it should be. The government will also increase support for the improvement of facilities and equipment at private universities.
- The government will increase support to national university corporations via systematic development / renewal and stable maintenance of their research equipment and the development of large / advanced research equipment available for joint use / research. The government will also support their efforts to secure engineers who engage in the maintenance, operation, and development of research equipment.
- For research facilities and equipment possessed by universities, in order to ensure the effective use of limited resources, the government will develop a system for effective mutual use and reuse via inter-university cooperation.
- The government will formulate a promotion plan, including operation stage, for large scientific research projects going on under the leadership of universities in reference to discussions made by the community of researchers, and will provide stable and consistent support based on this plan after implementing objective and transparent assessments. In so doing, for projects to be advanced under international cooperation, the government will carefully examine whether to join such projects, extent of involvement, etc. considering appropriately the international position, domestic utilization, etc. concerning Japan's R&D capabilities. In addition, the government will ensure the optimization of resource allocation through constant reviews even after commencement of the project, such as to focus resources on high-priority projects.

(ii) Promoting the development and shared use of advanced research facilities and equipment

Public research institutions have so far played a leading role in the development and operation of advanced research facilities and equipment, which require high costs and are appropriate for joint use in extensive areas of S&T. Such advanced research facilities and equipment are very important for producing quality R&D findings and personnel training, but how to maintain and manage such facilities is becoming a matter of concern since financial support for public research institutions has been falling. For this reason, the government will promote efforts to ensure that public research institutions can sufficiently develop, operate, and promote extensive joint use of such facilities and equipment.

<Promotional measures>

- In addition to the promotion of world-leading R&D, the government will steadily advance development and renewal of advanced research facilities and equipment expected to be used for extensive areas centering on public research institutions, and provide support for steady operation of such facilities and joint use of the world's most advanced research facilities and equipment, including facilities under the "Joint Use Law"⁶.
- In order to promote joint use of their facilities and equipment and enhance convenience for researchers and organizations that use them, public research institutions will improve and strengthen the user support system, such as appropriate arrangement of technical support engineers after ensuring stable operation and grasping user needs. In addition, in order to create quality research findings, public research institutions will take measures, in joint use, for strategically

⁶ Law concerning the Promotion of Shared Use of Specific Advanced Large Research Facilities (Law No. 78 of 1994)

conducting R&D that is expected to produce quality results, including public solicitation for research themes and methods for selecting themes.

- In order to promote the fusion of different fields and innovation, the government and public research institutions will promote the development of research facilities and equipment that leads to the advancement of basic technologies that are expected to bring drastic innovation and are available commonly for a broad range of R&D issues, and strengthen networks among them.

(2) Development of intellectual infrastructure

In order to promote R&D activities effectively and efficiently, it is necessary to systematize intellectual assets, such as research findings and research materials, and thereby develop intellectual infrastructure⁷ so that they may be available for use by many researchers. Since development of research materials, measurement standards, measurement / assessment methods, etc. is favorably progressing, development of intellectual infrastructure will be promoted in the future also from the viewpoint of quality improvement in order to respond to various needs of users.

<Promotional measures>

- The government, in view of the progress made with the "Intellectual Infrastructure Development Plan," will formulate a new development plan to promote the development, use, and application of intellectual infrastructure, centering on universities and public research institutions as core organizations, in cooperation with related organizations.
- The government will promote the accumulation of results based on user needs, development and integration of databases, use and application of such database, and effective use of devices and equipment that have already been developed, and thereby improve and advance intellectual infrastructure. The government will also promote participation in international activities for development, implementation of joint research with foreign countries, mutual use, and standardization with regard to intellectual infrastructure.
- The government will proceed with the development of advanced measurement / analysis technologies and equipment under a cooperation system with entities of commercialization and users, and promote the dissemination and use of developed technologies and equipment in R&D organizations including universities and business enterprises, and the marketplace.
- In order to proceed with the stable and consistent development of intellectual infrastructure, the government will promote efforts to train and secure personnel engaging in development and granting incentives to development institutions.

(3) Development of research information infrastructure

Research information infrastructure is the basic information infrastructure that supports Japan's R&D activities, and steady promotion has so far been implemented, including development and operation of research information networks and retention and dissemination of research findings. Meanwhile, development of research information infrastructure is becoming difficult for individual organizations due to financial, administrative, and technical issues. Considering such circumstances, the government will promote efforts to enhance research information infrastructure and ensure information dissemination of research findings and further improvement of distribution systems.

<Promotional measures>

- The government will encourage universities and public research institutions to establish institutional repositories⁸ so that they may promote systematic collection, retention, and open access of education and research results, such as research papers, observations and experiment data,

⁷ Research materials, measurement standards, measurement / analysis / test / assessment methods, and advanced equipment, related databases, etc. concerning them.

⁸ An electronic archive system for the retention and public release of research papers and other data according to each organization.

by digitalizing them. The government will also promote electronic issuance of research paper journals published by academic societies and associations, and electronization and open access to literature and materials possessed by the National Diet Library and university libraries, including those on humanity and social science.

- The government will advance networking of digital information resources, standardization of data, development of basic information on the location of contents, and enhancement of the function to associate information, and then promote cross-disciplinary integrated search, structuralization, and automatic knowledge extraction. The government will also build a system for "knowledge infrastructure," which enables integrated searching of and data extraction from all research information.
- The government will expect universities and public research institutions to consider effective measures for the efficient and stable subscription of electronic journals. The government will also support such efforts.

V. Development of policies to be created and promoted together with society

1. Basic concept

In recent years, political, economic, and social environments concerning STI policies have been greatly changing in Japan, and it is necessary to proceed with steady improvements and reforms in accordance with such changes. Particularly, it is becoming increasingly important to obtain the understanding, support, and trust of the people in formulating and promoting STI policies.

With such viewpoints, the 4th Basic Plan positions STI policies as part of "Policies for society and the public," and promotes the public involvement in these policies and S&T communication activities in order to deepen the relationship between society and STI. In addition, the government will strengthen accountability by identifying the entity of promotion, objectives, and goals for each stage of strategy planning and promotion, and promote efforts for the establishment of a PDCA cycle.

To reform systems for researching and developing S&T, various efforts have been made by the government, universities, and public research institutions, including the development of R&D infrastructure and improvement of research environments. Meanwhile, as further efficiency is pursued in all policy fields, issues are pointed out in terms of policy promotion systems, allocation of research funds, R&D systems, etc. In addition, the Research and Development Enhancement Law was established in 2008, providing for a review of the same Law within 3 years (by October 2011). Accordingly, in view of the status and issues concerning R&D, the government will greatly enhance the effectiveness of STI policies by aggressively pushing R&D system reform forward.

Moreover, in order to implement STI policies steadily in order to achieve the goals of the 4th Basic Plan, it is essential to secure sufficient investment in R&D. As foreign countries are further increasing investments in S&T, the government, in order to enhance the competitiveness in STI, which could be considered Japan's single resource, and maintain the present international position, will further strengthen investment in R&D with the extensive understanding, support, and trust of the public.

2. Deepening the relations between society and STI

(1) Promotion of STI policies from the public viewpoint

(i) Further involvement of the public with policy planning and promotion

In order for STI policies to lead to economic / social value in Japan, the government is required to correctly grasp the public expectations of issues and social needs in planning and promoting such policies, and appropriately reflect such expectations in the policies. It is also necessary to disseminate such policies widely to all levels of the people and to strive to enhance accountability. Accordingly, the government will promote efforts for taking public comments and obtaining the wide public involvement in planning and promoting policies.

<Promotional measures>

- The government will develop new systems, such as by creating opportunities for a wide range of the people to join discussions of issues and social needs to be addressed with STI policies, measures for returning results to society, etc.
- The government will promote efforts to collect opinions from a wide range of the people in planning and promoting policies, measures, and large R&D projects. The government will also expect universities and public research institutions to actively promote similar efforts.
- From the viewpoint of enhancing the people involvement in government policies, the government will support, e.g., S&T activities by NPOs, etc., and efforts for the investigation and analysis of social issues.
- In order to strengthen cooperation between those engaged in S&T policy planning and those leading R&D, the government will promote the creation of opportunities for dialogue between

parliamentary members / policy makers and researchers.

- The government will promote efforts to clarify to the extent possible policies, objectives of measures, performance targets, time limits, entities of implementation, budgets, etc., release the progress of such policies, etc. widely to the people, and reflect opinions obtained from the people in reviewing the relevant policies, etc.

(ii) Response to ethical / legal / social issues

As the contents of S&T become more sophisticated and diverse in accordance with progress, involvement of the people in S&T is becoming increasingly close in legal, ethical, and social terms, such as the issue of bioethics and concern over genetically modified organisms (GMO). For this reason, the government will further strengthen efforts concerning social impact and risk assessments of S&T.

<Promotional measures>

- The government will formulate guidelines for those who lead S&T to understand ethical / legal / social issues correctly in their activities in consideration as well of international trends. In so doing, the government expect academic societies, etc. to proceed with activities taking independently into account the formulation of such guidelines, etc.
- In order to promote activities to solve ethical / legal / social issues, the government will promote the allocation of a portion of research funds to such activities according to the purpose and characteristics of the research fund system.
- The government will improve the regulatory science so as to formulate examination guidelines and criteria based on grounds concerning scientific reasonableness and social validity.
- The government will consider the way technology assessment⁹ should be and promote efforts to ensure broad consensus-building based on technology assessments, etc. in making decisions on policies, etc.

(iii) Training and securing human resources who connect society with STI policies

In order to make activities concerning STI policies effective, the role of human resources engaging in such activities is significant. For this reason, the government will promote efforts for training and securing personnel who act as a bridge between society and STI, and promote activities of such personnel in various opportunities of STI.

<Promotional measures>

- The government will train and secure personnel who engage in the management of R&D, etc. concerning STI considering requests, etc. from society and the public, such as "Strategy Managers (tentative name)" who head up strategy councils and Program Directors (PD) and Program Officers (PO) in relevant ministries and agencies and fund distribution organizations.
- The government will train and secure specialists for research administration (Research Administrator) who manage overall R&D activities using their expertise, specialists for research techniques (Science Technician) who engage in technical affairs and development of intellectual infrastructure concerning research, specialists for intellectual property, etc.
- The government will train and secure personnel who have expertise in the relationship between society and STI, including technology assessments.
- The government will train and secure S&T communicators who act as a bridge between the public, policy makers, and researchers to communicate findings, etc. from research activities to the public in an easy-to-understand manner.

⁹ Activities to investigate, analyze, and assess the effect of S&T on society and the public according to the development stages of R&D.

(2) Promotion of S&T communication activities

In order to implement STI policies with the public understanding, support, and trust, activities for interactive communication between the people and the government, research institutions, and researchers is necessary with regard to R&D activities and expected results. For this reason, the government will promote more actively S&T communication activities by researchers, various activities concerning S&T in science museums, etc. With such activities, the government will also aim to improve the public literacy in S&T so that people may adequately grasp and flexibly use knowledge concerning S&T.

<Promotional measures>

- In order to increase opportunities for the people to come into contact with S&T, the government will actively develop activities for interactive dialogues and opinion exchange by holding S&T events jointly with local communities, opening to the public of research facilities during Science & Technology Week, implementing Science Cafe, etc.
- The government will support experimental lectures, experience-based activities, and other events to be implemented by science and other museums of local communities. The government will also support groups, etc. that develop various activities concerning S&T.
- The government will support organizational efforts for S&T communication activities at universities and public research institutions. The government will also request researchers who received more than a certain amount of government research funding to hold dialogues with the people concerning the contents and findings of their research activities.
- The government will expect universities and public research institutions to accumulate know-how cultivated through individual activities, and promote the training and securing of expert personnel who engage in such activities, in order to disseminate and firmly establish S&T communication activities. The government will also expect them to promote the participation of researchers in S&T communication activities and reflect results of such activities in performance appraisals.
- The government will expect that academic societies and associations, recognizing their important functions to provide opportunities for the presentation of research findings by researchers, assessment of findings, and cooperation between researchers or relevant organizations at home and abroad, to strengthen such functions and disseminate research findings and results widely to society.

3. Promotion of effective STI policies

(1) Enhancement of policy planning, making and promotional functions

In Japan, the Council for Science and Technology Policy was installed as an organization that promotes S&T policies across governmental ministries and agencies under the prime minister's leadership, and has been playing its roles in the formulation of the basic policy and other strategies and resource allocation policies, assessments of large-scale R&D projects, etc. However, for integrated promotion of STI policies, it is necessary to strengthen functions to promote policies systematically and comprehensively from a broader viewpoint. For this reason, from a viewpoint of positioning STI policies as a national strategy and promoting them much more intensively, the government will establish a "STI Strategic Headquarters (tentative name)" by reorganizing the Council for Science and Technology Policy, in order to strengthen the functions of policy planning and promotion.

<Promotional measures>

- Positioning STI policies as significant policies in national strategies, the government will aggressively promote efforts to formulate specific strategies under the 4th Basic Plan and secure budget and resource allocations for S&T under the leadership of the "STI Strategic Headquarters (tentative name)."
- The government will establish strategy councils for each essential issue designated by the

government with extensive participation from industry, academia, and government, and formulate strategies according to each essential issue in reference to results of discussions in each council. In addition, the strategy councils will promote activities to be developed under such strategies.

- The government, in cooperation with relevant ministries and agencies, will strengthen activities concerning the "Action Plan for the Implementation of Important Science and Technology Policy Measures" ("Action Plan"), which comprehensively promotes measures concerning essential issues, and advance the reform of the budgeting process by utilizing activities concerning the Action Plan and resource allocation. In formulating the Action Plan, the results of discussions on specific strategies in the strategy councils will be fully utilized.
- The government will classify the functions of R&D systems in Japan into four stages: "policy decisions", "measures formulation", "fund distribution", and "R&D implementation," and then specify roles, functions, entities, etc. required in each stage.
- The government will promote a "Science for STI Policy" in order to plan policies based on objective grounds (evidence) and reflect results of policy evaluation and verifications in policies. In so doing, the government will ensure the involvement of a wide range of researchers from the humanities and social sciences as well as the natural sciences, and promote the training of personnel engaging in policy formation through such activities.
- From the viewpoint of promoting S&T-based innovation, the government will identify regulations and institutions considered to be bottlenecks in such promotion, and develop a system for discussing measures to improve such regulations, etc. among relevant ministries and agencies.

(2) Enhancement of the assessment and allocation functions in the research fund systems

(i) Systemic reform for effective and efficient assessment / allocation of research funds

In operating a research fund system, it is necessary to identify the entities that examine and allocate research funds so that funds may be appropriately used by researchers and research organizations, and improve the system in order to facilitate the effective use of research funds. At present, allocation of research funds, etc. is implemented by relevant government ministries / agencies and fund distribution organizations according to the fund system. In addition, the issue of low convenience in using research funds is being improved, while it is also pointed out that there are still limitations on the purpose of use, etc. In view of these issues, the government will advance reform to establish a more effective and efficient research fund system.

<Promotional measures>

- The government will ensure that the functions of reviewing and distributing research funds are performed by relevant government ministries and agencies for R&D projects directly related to administrative demands or by independent fund distribution organizations for other R&D projects. For the research fund systems that qualify for operation by fund distribution organizations, the government will promote the transfer of the function from relevant government ministries and agencies to such organizations from the viewpoint of ensuring expertise in efficient and flexible operation and management of research funds according to their purposes and characteristics.
- The government will consolidate the research fund systems that have a similar purpose or subject of R&D within or across government ministries and agencies. In addition, the government will further promote efforts to integrate, simplify, and streamline rules, etc. for using research fund systems and to utilize the approved carry-over system, and consider systemic reform that enables execution over two or more fiscal years.
- In order to ensure the effective use of equipment purchased with research funds, the government will strive to mitigate the conditions of research fund systems so that joint use of equipment by researcher other than those to whom the fund was granted may be widely accepted.

- The government will promote the "Funding Program for the World-Leading Innovative R&D on Science and Technology" that was established as a fund in fiscal 2009, and evaluate this Program from the viewpoint of flexible management of research costs. In addition, the government will consider systemic reform for other research fund systems according to their purposes and characteristics.

(ii) Improvement and enhancement of the competitive fund system

The competitive fund system is an essential research fund system for the establishment of a competitive research environment and the consistent and developmental commitment by researchers to various and creative R&D activities. It is classified into various systems according to the purposes and characteristics of research projects. As R&D activities are becoming increasingly advanced and sophisticated, efforts to further improve this competitive fund system will be promoted by ensuring the diversity of the system.

<Promotional measures>

- The government will further increase competitive funds with the aim to enhance the rate of new adoption and ensure sufficient research costs per project. In so doing, the government will strive to implement action for securing 30% of the budget for indirect costs, while securing direct costs with regard to all competitive fund systems. The government will also request universities, public research institution, etc. to use indirect costs effectively.
- The government, looking over all the competitive fund systems in Japan, will identify the objectives and positions of each system and promote efforts to ensure the continuity between systems while ensuring the diversity of fund distribution organizations.
- Aiming for fair, transparent, and high quality examination and assessment, the government and fund distribution organizations will ensure diversity in age, gender, organization, etc. of examiners, eliminate stakeholders, develop an examiner evaluation system, specify methods and criteria for examination and adoption, and disclose examination results.
- The government and fund distribution organizations will increase and secure Program Directors (PD) and Program Officers (PO) after identifying their authorities and roles. In addition, the government expect universities and public research institutions to evaluate the job experience of PDs and POs so that they may be positioned as part of the career paths of researchers.
- The government and fund distribution organizations will request universities and public research institutions to properly manage researchers in order to avoid illogical overlaps and excessive concentration of fund allocations, and manage competitive funds appropriately and efficiently by operating the "Cross-ministerial R&D Management System (e-Rad)."
- The government and fund distribution organizations will promote efforts to prevent unauthorized use of research funds. In addition, the government will request universities and public research institutions to establish a system for appropriate management and auditing of research funds.

(3) Enhancement of R&D implementation systems

(i) Reform of the R&D Corporation

The R&D Corporation is an institution performing R&D activities that are difficult for private sectors or universities, such as R&D of a long-term perspective, high public nature, or high risk at present. The R&D Corporation was established as an independent administrative agency, but should be improved to a corporation in full consideration of the peculiarity of its R&D activities, etc. From such viewpoints, the Research and Development Enhancement Law and the additional resolution that necessary actions should be taken for the way the R&D Corporation should be. Considering such circumstances, the government will promote efforts to strengthen the functions of the R&D Corporation.

<Promotional measures>

- In reference to the "Basic Policy on Review of Administrative Systems / Projects of Independent Administrative Agencies," the government will establish a new system concerning national R&D institutions to achieve reform, etc. in organizational governance or management, considering the characteristics of R&D (long-term nature, uncertainty, unpredictability, and expertise). In addition, the government will promptly consider reviewing institutions that can be improved in operation under the current system.
- The government will take budgetary measures necessary for the R&D Corporation, and promote the joint use of the Corporation's facilities and equipment, and the introduction of outside funds through acceptance of joint / contract researches, etc.

(ii) Development of a system for promoting research activities effectively

In order for universities and public research institutions to promote research activities effectively and efficiently, it is necessary to develop, in addition to researchers, a system enabling active working for various personnel specialized in management of overall research activities, management / operation of intellectual properties, maintenance / management of facilities and equipment, etc. It is, however, pointed out that each research institution is insufficient in securing specialized personnel and that researchers do not have enough time for their research, so the government will strengthen efforts to improve such conditions.

<Promotional measures>

- The government will encourage universities to promote efforts to ensure that doctoral course students / graduates and post doctors can acquire expertise as Research Administrators, Science Technicians, intellectual property experts, etc. The government will also support such efforts.
- The government will support universities and public research institutions in their effort to secure various human resources, such as Research Administrators, Science Technicians, and intellectual property experts. In addition, the government will expect universities and public research institutions to evaluate such personnel properly and reflect evaluation results in personnel treatment and establishing career paths for them.
- The government will request universities to promote the training and securing of personnel engaging in the promotion of research activities under systematic SD (Staff Development), and strengthen the executive office system. In addition, the government will expect them to evaluate appropriately the performance of such personnel and reflect evaluation results in personnel treatment.

(4) Establishment of PDCA cycle in STI policy

(i) Ensuring the effectiveness of PDCA cycle

In order to promote an STI policy effectively and efficiently, after setting clear performance targets, such as policies, measures, implementation systems, etc., it is necessary towards promotion to conduct follow-up timely and appropriately and to ensure progress by establishing the PDCA (Plan-Do-Check-Action) cycle reflected in the review of policies etc. and the planning of new policies etc. For this reason, the government will promote efforts for ensuring the effectiveness of the PDCA cycle.

<Promotional measures>

- The government will specify, to the extent possible, objectives, performance targets, time limits, entities of implementation, etc. according to each level of the hierarchy of R&D systems, i.e., policies, measures, programs or systems, and individual R&D issues. Then, the government will ensure the implementation of assessments based on them, and appropriately reflect assessment results in reviews of policies, etc., planning of new policies, etc., prioritization of resource allocation, efficiency increase, etc.
- In the strategy councils, the government will ensure pliable and flexible promotion of strategies, including the review of R&D, promotion system, fund distribution, etc. in view of the progress of the entire strategy according to each essential issue, and reflect results of such review in strategies timely and appropriately.
- The government will follow up Action Plan with regard to their reflection in budgets, progress of measures, etc. and reflect follow-up results in the improvement of Action Plan. In so doing, the government will fully utilize results of discussion made in the strategy councils.
- The government will follow up the progress made with the 4th Basic Plan timely and appropriately, and will utilize results of the follow-up in reviewing the Basic Plan and new policy planning.

(ii) Improvement and enhancement of R&D evaluation systems

Evaluation of R&D in the execution phase has an important role in enhancing the quality of R&D, and establishing a PDCA cycle. Meanwhile, viewpoints required for evaluation are becoming diversified in accordance with the advancement and sophistication of R&D, and due in part to such diversification, the issues of overlap in evaluations and excessive load have been pointed out. Hence, the government will further improve and enhance R&D evaluation systems in accordance with the "National Guidelines for Evaluating Government Funded R&D," and thereby promote the utilization of evaluation results for the advancement of quality R&D activities, human resource training, effective and efficient fund distribution, enhancement of accountability, etc.

<Promotional measures>

- From the viewpoint of promoting STI, including the establishment of R&D evaluation systems based on each level of R&D (policy, measures, programs or systems, R&D issues), the government will extensively examine the way R&D evaluation systems should be, and review, as needed, the "National Guidelines for Evaluating Government Funded R&D."
- The government and fund distribution organizations will establish diversified evaluation criteria and items so that high-risk researches and researches on new / integrated areas may be positively evaluated. In the evaluation of R&D issues, the government will promote setting personnel training, S&T communication activities, etc. in evaluation criteria or items in addition to R&D activities. In addition, if considered effective, application of global benchmarks and appointment of researchers working actively abroad as assessors will be promoted.
- The government and fund distribution organizations will promote efforts to implement evaluations at an appropriate time before R&D is completed in order to carry quality R&D results to the next stage without interruption.

- The government and fund distribution organizations will promote streamlining and efficiency increases in R&D evaluations through the utilization of results of other evaluations in order to avoid overlaps of evaluations and excessive load.
- The government will promote the training and securing of personnel with expertise and experience in R&D evaluations. The government will expect universities and public research institutions to develop administrative systems to conduct evaluations effectively and efficiently, such as the utilization of an operation-specific information system for R&D evaluations, and promote training of personnel engaging in such activities and the securing of career paths for them.

4. Expansion of R&D investment

Since Japan has the issues of limited natural resources and an aging and decreasing population with a declining birthrate, S&T and S&T-based innovation could be the sole source of competitiveness in the future. In that sense, S&T could be referred to as the lifeline of Japan. Based on this viewpoint, the government is united in strengthening S&T by setting target amounts to increase R&D investments in Basic Plans. As a result of such efforts, as compared with other general expenditures, S&T expenditures increased, although they were still short of the targeted amounts set by the 2nd and 3rd Basic Plans. Such increase in the expenditure is highly evaluated given the recent slow growth in GDP and severe financial situation.

In recent years, however, in addition to developed countries, newly emerging countries, including China, are considerably increasing investment in S&T as a national effort for S&T development. A future decline in the position of Japan even in S&T is, therefore, a serious concern. Hence, in order to maintain the position of a developed country in S&T with steady implementation of the policies provided by the 4th Basic Plan, and contribute to the world via STI, such as solutions for global issues in cooperation with other countries, it is essential to increase investment by setting clear targets for R&D investment that support such efforts.

The government has recently established the target¹⁰ of increasing S&T investment by the government and private sectors up to fiscal 2020. Meanwhile, to increase targets, the government must determine specific targets for S&T investment by the government in the 4th Basic Plan, comprehensively considering that the percentage of the Japanese government's burden of research costs is lower than foreign countries, that the government's investments are expected to produce the synergetic effect of promoting private-sector investment, which is in the bad situation, and that many foreign countries are increasing S&T investment by setting targets.

Accordingly, the target of R&D investment is set to 4% or more of the GDP in the total of the government and private sectors, and set to 1% of the GDP in the government sectors.

To this end, the total amount of the government's R&D investment during the period of the 4th Basic Plan needs to be about 25 trillion yen (calculated on a trial basis assuming that the government's investment in R&D totals 1% of the GDP and the nominal growth rate of GDP is 2.8% on average).

Accordingly, although the financial situation of Japan is expected to become worse and critical, the government will aim to secure the expense budget necessary for promoting the measures of the Basic Plan so as to ensure consistency with the Fiscal Consolidation Targets, decided by the Cabinet in June 2010, and the Fiscal Management Strategy including the Medium-term Financial Framework.

In parallel, in order to induce R&D investment by private sectors, the government is also required to consider a reasonable review of regulations and institutions, preferential tax treatments for R&D investment by private sectors, etc..

¹⁰ The New Growth Strategy states to "increase investments by the government and private sectors to a total of 4% or more of the GDP by fiscal 2020."