Chapter 2 Transition and Achievements of the Science and Technology Basic Plan

Chapter 2 outlines the Science and Technology Basic Law (Law No. 130, 1995) ("Basic Law") and the Science and Technology Basic Plan ("Basic Plan"), addresses the policies taken in 20 years since enactment of the Basic Law, their achievements and issues in future and clarifies the entire image of science, technology and innovation(STI) policies in Japan.

"Science, technology and innovation" is defined in the 4th Basic Plan as "Create intellectual and cultural value based in new knowledge derived from scientific discoveries and invention, etc., and, through the development of that knowledge, bring about reforms that lead to the creation of financial, social, and public value."

Section 1 Science and Technology Basic Law and the Science and Technology Basic Plan

In order to solve domestic and international issues and maintain the sustainable development of Japan and the world, it is important to lead reforms of society by creating STI. Thus, it is essential to promote STI policy for this purpose. This section explains the procedure and main points for providing the Basic Law that stipulates the basic items in science, technology and innovation policies in Japan and the Basic Plan determined by the government according to the Basic Law.

1 Science and Technology Basic Law

The Diet, considering the promotion of science and technology one of the most important issues, proposed legislation on this matter and the Basic Law which was proposed by House members, came into effect in 1995, with unanimous consent by legislation, to actively promote science and technology and realize "becoming an advanced science and technology oriented nation." The outline and main provisions of this law are discussed below.

(1) Background of the Science and Technology Basic Law

1) Situations at the time of enactment

Post-war, Japan strove to catch up to industry in the U.S. and European nations and develop manufacturing and application technologies to increase productivity and produce cutting-edge products based on leading countries' technologies. Time passed and as the mass production of cheap, quality and sophisticated products became possible in Japan, exports soared, due partly to the fixed exchange rate, Japan achieved high economic growth and finally caught up with the U.S. and European nations.

After the late 1980s, however, under the effects of intellectual rights were rapidly reinforced, etc. and the growth strategy of Japan for importing technologies and follow-up and improving them by applications no longer worked. In addition, after the bubble economy bust, Japan suffered a recession of unprecedented length and the Japanese economy ran out of steam to create new industries and empower new growth. The nation also faced a social issue of a super aged society and was threatened by the decline in national power.

As a world leader, Japan was required to change its policy to explore Japan's future, make it one capable of challenging unexploited areas of science and technology and demonstrate its creativity. For this purpose, investment in basic research which underpins ingenious achievements was essential in Japan. However, due to Japan's track following type economic growth and the fact that investment in basic research does not always spawn direct outcomes, Japan's investment in basic research was scarce at that time. Moreover, Japanese competitiveness in basic research largely fell behind the U.S. and Europe. Government funds to environment that support basic research were also lacking and aging and obsolescence of facilities and equipment and shortages of research assistants were serious problems in universities and public research institutions. Awareness of the need for inter-organizational R&D also increased in the academic community, which used to be reluctant to join industry-academia-government collaborative R&D.

Japan, as one of the world leaders, must also play a role in solving problems faced by humans, including the global environment, food, energy and infectious diseases.

Not mere a nation based on technology, now and in future, as a developed nation, Japan needed to set goal of "becoming an advanced science and technology oriented nation" and for this purpose, reveal specific policies which target areas to reinforce and execute them to contribute advancement of world's science and technologies, social development and achieve progressive socioeconomic growth to support truly affluent lifestyles.

2) Significance of the Science and Technology Basic Law

The Basic Law clearly stipulates the responsibilities of the national and local governments to promote science and technology and indicates the basic policies of Japan to achieve "becoming an advanced science and technology oriented nation". The law must be categorized as the "basic law" to define the promotion of science and technology as one of the most important issues in Japan and gain national consensus on the same.

Moreover, the Basic Law obligates the government to make the "Science and Technology Basic Plan" and to ensure funding required for promoting the Basic Plan, regarding the circumstances that national R&D investment has been small compared with the U.S. and Europe at that time. This contributed significantly to increasing the science, technology and innovation capability of Japan.

(2) Main provisions of the Science and Technology Basic Law

1) Objective of the Basic Law

The Basic Law sets out fundamental policy provisions to promote science and technology, targeting efforts to boost the national level of science and technology, and this contribute to national socioeconomic growth, national welfare, global scientific and technological progress and sustainable social development.

2) Guidelines of promotion of science and technology

The Basic Law states that science and technology provides the basis for the future development of Japan and human society and that the accumulation of knowledge on science and technology is the intellectual asset common for all mankind. In this context, it stipulates that science and technology shall be actively promoted with the recognition that the creativity of researchers and technicians can fully developed. In this regard, the following should be considered;

・The creativity of researchers and technicians can fully developed.

- Harmonization with human life, society and nature.
- Improvement of balanced ability of research and development in various fields
- Harmonized development among basic research, applied research and development
- Organic cooperation of national research institutes, universities (including graduate schools in this law.) and private sector
- Balanced development of natural science and the humanities

Furthermore, the Basic Law stipulates that the national and local governments should consider the importance of their roles in basic research and the characteristics of research in universities and research institutions in promotion of national and municipal policies.

3) Implementation of the Science and Technology Basic Plan

The Basic Law stipulates that the government shall establish a basic plan for the promotion of S&T in order to comprehensively and systematically implement policies with regard to the promotion of S&T. The plan should specify the comprehensive plans for the promotion of R&D and policies to develop the research environment comprehensively and systematically, including facilities and equipment. The Basic Law also stipulates shall take the necessary measures for the smooth implementation of the Basic Plan such as including the necessary fund in the budget within the limits of national financial status..

4) Annual report (white paper on science and technology)

The Basic Law stipulates the preparation of an annual report on policies by the government to promote science and technology for submission to the Diet. This white paper is created based on the provisions of the Basic Law.

5) Government policies

The Basic Law stipulates the following major government policies:

- Balanced promotion of various levels of R&D in comprehensive fields
- Improve education and research in graduate schools, to secure and train Researchers and to improve their quality
- Improvement of facilities and promotion of Information Intensive R&D
- Making public the results of R&D and promotion of information disclosure and international exchange
- Promotion of scientific and technological education, enlighten the people in S&T and to disseminate knowledge on S&T

2 Science and Technology Basic Plan

The Basic Plan is determined every five years with a decade-long vista to promote government policies in order to comprehensively and systematically implement policies with regard to the promotion of S&T. The features and main points of the Basic Plans implemented to date are discussed below.

(1) Features

Prior to the Basic Law, science and technology policies in Japan were based on the “General Guidelines for Science and Technology Policy" approved by the Cabinet and then by the Basic Law, once it came into effect, S&T policies were based on the Basic Plan. While the "General Guidelines for Science and Technology Policy" used to indicate the basic direction of national policies, the Basic Plan requires to indicate policies and scales, including government R&D investment as much detail as possible and their time schedules. In particular, the target government R&D investment for the period of the plan has been presented since the 1st Basic Plan, indicating attitude of government in active promotion of science and technology. The Basic Plan can be modified as required during the period of the plan.

(2) Main points of the preceding Science and Technology Basic Plans

1) The First S&T Basic Plan (approved by the Cabinet on July 2, 1996)

The 1st Basic Plan set "Program to support 10,000 postdoctorals" to achieve a new R&D system by the year 2000 and clearly stated the introduction of a contractual employment system into the public research institutions to promote exchanges among researchers. It also focused on promoting industry-academia-government collaboration, significantly increasing competitive funds and R&D evaluation. Approximately 17 trillion yen of government R&D investment was targeted to the science and technology-related costs, aiming to increase the expense to GDP ratio to the level of major Western nations at the start of the 21st century in terms of the GDP ratio.

2) The 2nd S&T Basic Plan (Approved by the Cabinet on March 30, 2001)

The 2nd Basic Plan included strategic priority setting in S&T in four priority fields: life science, information and communication, environment and nanotechnology /materials as well as basic research, based on the results and issues of the 1st Basic Plan and allocated resources to these areas preferentially. It also encouraged introduction of scheme for IP management by institutions and planned the duplation of competitive funds, introduction of 30% indirect costs in competitive funds and extension of the contractual assignment period (from 3 to 5 years). The government R&D investment target during plan period was set at around 24 trillion yen in total.

3) The 3rd S&T Basic Plan (Approved by the Cabinet on March 28, 2006)

The 3rd Basic Plan focused on priority setting in S&T for policy-oriented subjects and determined four priority fields to be promoted and four fields to be promoted. It also selected "strategically prioritized S&T" for focused investment during the plan and designed large national projects as "Key Technologies of National Importance." It also set a target number of female researchers for employment, enhancement of university competitiveness and the introduction of 30% indirect costs to all competitive funds. The target government R&D investment was set at approximately 25 trillion yen in total.

4) The 4th Science and Technology Basic Plan (Approved by the Cabinet, August 19, 2011)

The 4th Basic Plan set out the promotion of science, technology and innovation as basic policy for recovery and reconstruction after the Great East Japan Earthquake on March 11, 2011 and for the sustainable growth and social development of the country. Based on this policy, the Basic Plan was transformed to an issue-oriented prioritization containing three pillars, including disaster restoration. At the same time, the Basic Plan stipulated that the policy was deployed as science, technology and innovation policy, including wide-ranging related innovation policies and development of policies to be created and promoted together with society. In addition, a reinforcement of policy planning and implementation capability and innovation of R&D institutes were included. The government R&D investment target was set at an unchanged amount from the preceding term, approximately 25 trillion yen in total.

■ Figure 1-2-1 / Notable features of 1st to 4th S&T Basic Plans

	1st Basic Plan (FY 1996 - 2000)	2nd Basic Plan (FY 2001-2006)	3rd Basic Plan (FY 2007 - 2010)	4th Basic Plan (FY 2011 - 2015)
Feature	•Introduction of contractual employment system •Program to support 10,000 postdoctorals •Expansion of competitive research funds	•Strategic Priority Setting in S&T •Doubling of competitive fundings and introduction of indirect costs (30%)	•Strategic Priority Setting in S&T •Expansion of competitive fundings; mandated allocation of 30% indirect costs to competitive funds	•Promotion of R&D for issue-oriented prioritization •Comprehensive development of STI policies •S&T to be created and promoted together with society
Policies	•Introduction of the contractual employment system in national experiment and research institutions •Program to support 10,000 postdoctorals •Emvironmental improvements of environment for industry-academia-government collaboration; promotion of human exchange •Drastic expansion of competitive research funds and other research funds from various sources •Evaluation of R&D; Overall guidelines for evaluation	•Strategic Priority Setting in S&T →Classification of materials to 4 priority fields: Life science, information communication, environment, nanotechnology/materials field •Improvement of contractual employment for fostering young researchers (extension of period from 3 to 5 years in principle) •Development of various carrier paths; increase of opportunities for outstanding foreign researchers; improvement of research environment for female researchers •Promoting introduction of scheme for IP management by institutions •Doubling of competitive fundings and introduction of indirect costs (30%)	•Strategic Priority Setting in S&T →4 priority fields to be promoted (life science, information communication, environment, nanotechnology/materials) →4 fields to be promoted (energy, manufacturing, social infrastructure, frontier) →Selection of strategically prioritized S&T and key technologies of national importance • Support of the independence of young researchers; suppression of teachers in alma mater; 25% employment of female researchers •Formation of world class research centers (around 30) to improve competitiveness of universities •Mandated allocation of indirect costs (30%) to all competitive fundings	•Sustainable growth and development of society →Recovery and reconstruction from the Great East Japan Earthquake →Promotion of green innovation and life innovation •Response to important issues →Safe, affluent and quality lives of the people →Improvement of industrial competitiveness →Contribution to resolution of global issues →Maintenance of the basis for nation's existence →Enhancement and reinforcement of common base • Deployment of policies to be created and promoted together with society →Involvement of the public with policy planning and promotion →Reforms of R&D agencies (creating new systems) →Establishment of PDCA cycle; complete reformation with action plans, etc.
Investment	Total S&T budget approx. 17 trillion yen (as a result 17.6 trillion yen) (Raise the ratio to GDP to the level of major Western nations at the start of the 21st century)	Total national R&D investment (including local governments from 2nd plan) approx. 24 trillion yen (as a result 21.1 trillion yen) (given 1% to GDP, 3.5% nominal GDP growth rate during period of plan)	Total national R&D investment approx. 25 trillion yen (as a result 21.7 trillion yen) (given 1% to GDP, 3.1% nominal GDP growth rate during period of plan)	Total national R&D investment approx. 25 trillion yen (given 1% to GDP, 2.8% nominal GDP growth rate during period of plan)

Source: Created by MEXT

Column 1-9 Changes and Trends of Science, Technology and Innovation Policies in Other Countries

Major countries have continued to strengthen science, technology and innovation policies over 20 years as critical national policy.

	U.S.	U.K.	Germany	France	China	Korea
Background and features of S&T policies	S&T power has been strengthened through military demand.	Traditionally focused on S&T, but regretting the shattered state of research base, national R&D investment was maintained while the whole annual expenditure was on the decrease.	Authorities are not centralized, but distributed to research institutions. Private R&D is also active.	**Space, nuclear, aviation and railroad, etc. have been promoted mainly by public research institutions to be a nation independent of other nations under the Cold war.**	Rapid growth of S&T accompanied rapid growth of economy.	After the war, the government led introduction of technology was active in industries such as in textiles, shipbuilding, iron manufacture, and electronics.
In the 1990s	•The Clinton Administration (inaugurated in 1992) promoted enhancement of high-tech competitiveness, subsidies for private companies, and support of small business R&D (e.g. SBIR). •In 1999, a "cluster" concept that functions to accumulate industry as the source of innovation was invented.	•In the early 90s, policy was changed to the investment to basic research. •In the late 90s, innovation was promoted in light of reflection for the failure of commercializing R&D results.	•Priority was given to the reconstruction of format East Germany while focusing on basic research in the tight budget due to reunification (1990).	•Collaboration of companies, public research institutions and universities because common. •Needs for prioritized science policies and creation of innovation and employment in small and medium enterprises are recognized.	•A policy to build a nation based on science and education was announced (1995).	•"Long-term S&T development vision" was determined in 1999 to ensure world class S&T competitiveness •Especially, extensive investment to R&D and development of S&T human resources were emphasized.
In the 2000s	•Upon rise of emerging countries and rapid progress of information and communication technology, debate about strengthening of U.S. economic competitiveness gained force. •The Bush Administration (inaugurated in 2001) enacted the America COMPETES Act (2007) intended for improving basic research capability.	•A large increase in the investment to S&T was decided by "Science and Innovation Investment Framework 2004 - 2014" (2004).	•Policies were implemented based on "the High-Tech Strategy" (2006) for achieving future employment and quality of life through innovation. •After Merkel took office (2005), investment to S&T was increased.	•The Sarkozy Administration (2007) changed direction from public research institutions to universities.	•"Medium- to Long-term National S&T Development Plan" (2006) was announced as a 15-year program. •Improvement of voluntary innovation capability through increase of total R&D budget and strengthening of prioritized areas.	•Technology Basic Law (Law No. 130, effective on November 15, 1995) was enacted in 2001. 1st S&T Basic Plan was launched in 2002. •Drastic expansion of investment to S&T, especially IT field.
In the 2010s	•The Obama Administration (inaugurated in 2009) took over the America COMPETES Act, and promoted policies based on the "United States Innovation Strategy" (2011) aiming at investment to innovation infrastructure. •Total budget was decreasing but basic research budget maintained the status quo or was on the rise.	•"Innovation and Research Strategy for Growth" (2011) focused on the promotion of R&D in industry. •"Growth plan: Science and innovation (2014) presents the direction for the U.K. to be the most suitable nation for science and business.	•"The High-Tech Strategy 2020" (2010) was announced. Cross-sectional "Future-oriented Projects" were planned. •"Industrie4.0" was proposed as one of future-oriented projects to upgrade the manufacturing industry (2011).	•Basic strategy "France Europe 2020" (2013) was implemented, focusing on the social issues and technology transfer. •Drastic organizational change was made for the government S&T planning system.	•"The 12th 5-year plan: National economy and social development" (2011), indicating the national policies, suggested the creation of "Strategic new industries" as future industry.	•As the consequence of drastic ministerial reshuffle with the change of the president in 2013, "Ministry of Science, ICT and Future Planning" was newly created. •In 2013, "The 3rd S&T Basic Plan" seeking the improvement of five strategic areas ("High 5 Strategy") was implemented.

Source: Created by MEXT based on data from the Center for R&D Strategy (CRDS), JST

Section 2 Results of S&T Basic Plans in 20 Years

This section outlines the results of the Basic Plans within the 20 years since launching the first Basic Plan and gives an overall picture of the current national science, technology and innovation policy in Japan.

1 Promotion of R&D

(1) Academic and basic research

1) Placing in the S&T Basic Plan

Acknowledging the fact that basic research[1] achievements bring intellectual, cultural and socioeconomic changes to all of us, basic research has been successively and actively promoted from the 1st Basic Plan. During the 2nd and 3rd Basic Plans, a certain level of resources were provided for basic research and the

1 Research types can be classified in terms of the property of research (basic, application, development) and situation (academic, strategic, commissioned). "Basic research" is based on the property of research and "theoretical or experimental research to form a hypothesis or theory or obtain new knowledge on phenomenon and observable facts. Not for a direct purpose of individual or specific application or usage." "Academic research" is based on the research situation and "proceeded under the responsibility of researchers based on the internal motivation of such researchers in terms of seeking the truth, applying scientific knowledge, or identifying or solving the problem."

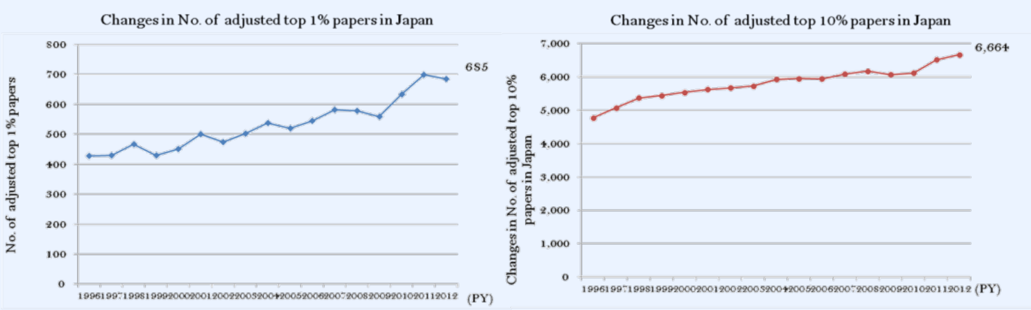
4th Basic Plan defined basic research as one of two wheels with important national issues.

2) Activities

Academic and basic research funds, such as the government subsidies for national university corporations and R&D agencies[1], KAKENHI (MEXT and the Japan Society for the Promotion of Science) and JST Strategic Basic Research Programs were provided to promote academic and basic research and innovative outcomes noted worldwide have been successively obtained.

Particularly after the turn of the century, many Japanese researchers won the Nobel Prize, including blue LEDs and iPS cells, the country is ranked No. 2 in terms of Nobel laureates for natural science worldwide and the number of highly qualified papers such as adjusted top 1% and 10% papers has also increased (Figure 1-2-2). Academic and basic research in Japan is highly evaluated worldwide.

■ Figure 1-2-2 / Number of highly cited (adjusted top 1% / 10%) papers



Note 1: Articles and reviews are subject to analysis using the integer count method. The year (PY) is the year of publication

Note 2: Note that numerical fluctuation is considerable depending on the database storage condition.

Note 3: The number of adjusted top 1% (10%) papers is the top 1% (10%) papers cited in each field in each year, corrected to represent the 1 / 100 (1 / 10) of the real number of papers. The citation index at the end of FY 2013 is used.

Note 4: Compiled by NISTEP based on Thomson Reuters "Web of Science."

Source: Compiled by MEXT based on "Science and Technology Indicators 2014 " NISTEP Research Material -229 (August 2014), National Institute of Science and Technology Policy

KAKENHI, having a long history since 1918, constitute the most fundamental competitive fund system that supports academic research in all fields. Its budget was doubled from the beginning of the 1st Basic Plan, reflecting a policy to expand competitive funds in the Basic Plan. Furthermore, it was improved as a more flexible system by establishing a foundation system and introducing adjustment money which enabled the use of funds over several fiscal years, while promoting innovation and reinforcement to ensure fair peer reviews and respond to modern demands and the social mandate to academic research.

JST Strategic Basic Research Programs, founded in 1981, also play a considerable role to promote basic research based on political strategy and requests. The programs are competitive fund systems to promote strategic basic research, targeting goals set by government and comprising multiple systems, including CREST, to promote research in the way that research representatives to form and use networks across

1 According to the "Act on Enhancement of Research and Development Capacity and Efficient Promotion, etc. of Research and Development, etc. by Advancement of Research and Development System Reform (R&D-Capacity Strengthening Act)" (Act No. 63 of 2008), the R&D agency is defined as an incorporated administrative agency which is engaged R&D, works that related to R&D, such as work relating to publicly-offered R&D, or to awareness-raising for science and technology and the dissemination of knowledge and separately specified. Specifically, there are 37 such corporations (as of April 1, 2015) including the National Institute of Information and Communications Technology (NICT), Japan Science and Technology Agency (JST), RIKEN Advanced Science Institute, Japan Aerospace Exploration Agency (JAXA), National Institute of Advanced Industrial Science and Technology (AIST), Electronic Navigation Research Institution (ENRI) and National Institute for Environmental Studies, etc. The national R&D institute is newly defined based on the national strategy in the "Act on General Rules of Incorporated Administrative Agency" (Act No. 103 of 1999) amended in June 2014, as an institute which engaged in R&D based on national strategies, which is difficult for universities and private corporations and there are currently 31 such corporations (as of April 1, 2015).

industry, academia and government and ERATO to help create science, technology and innovation under outstanding leadership. The programs have continuously improved the organization by, for example, setting research fields according to the fields of specialization, allowing fund allocation over several fiscal years, or combination with other research funds.

MEXT launched the "World Premier International Research Center Initiative" (WPI) in 2007 to provide comprehensive support to voluntary efforts by universities targeting the establishment of international research centers. Nine research centers backed by this initiative nationwide have produced outstanding scientific outcomes and become steadily internationalized, with foreign researchers accounting for about 40% on average.

As for large scientific research projects, "Super Kamiokande", as a succession machine of "Kamiokande" etc. , which contributed to the Nobel Prize in Physics in 2002 after confirming the mass of neutrinos for the first time worldwide, are installed at the Inter-University Research institution, outstanding scientific outcomes are achieved. From FY2010, MEXT has promoted the installation of large facilities according to the "Roadmap for Large Scientific Research Projects Roadmap for Large Scientific Research Projects" drafted based on "the master plan" provided by the Science Council of Japan, including the start of operating and testing the "Alma Telescope" to clarify the evolution of matters leading to the formation of galaxies, planets and life in space and improvement of the Large Hadron Collider "B Factory."

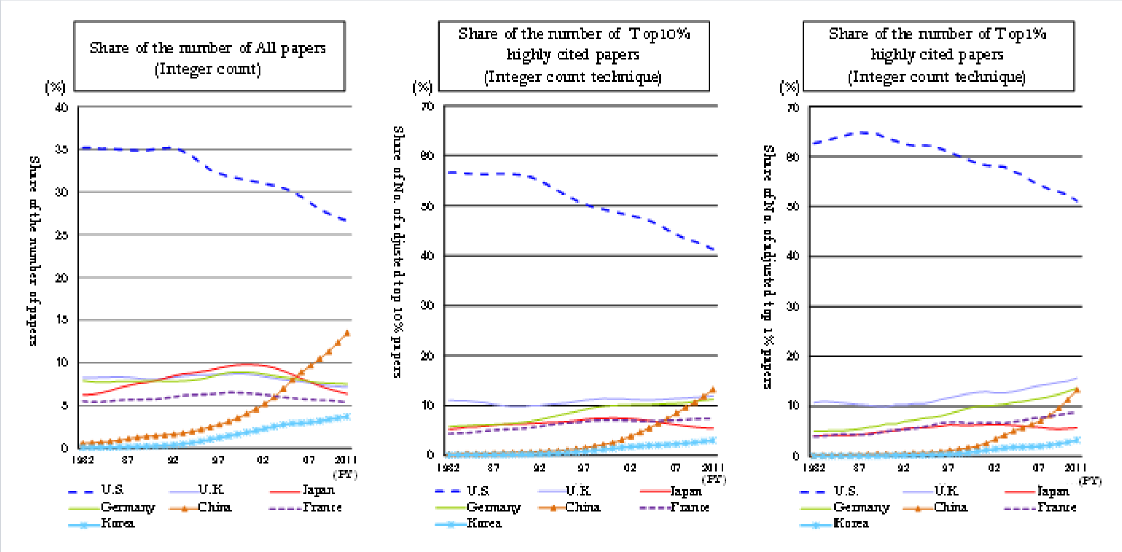
3) Issues

Recent basic research in Japan has revealed a tendency toward an increase in qualified papers such as those included in the adjusted Top 1% and 10% papers while the number of overall papers remains unchanged (Figure 1-2-2). In terms of the international share of the number of papers, however, all indexes have shown decline (Figure 1-2-3), which suggests declining competitiveness of Japan in basic research and gives cause for concern.

The potential causes include: in quantity terms, low increases in R&D funds mainly in universities compared with other major countries and in quality terms, in addition to these circumstances around R&D funding, fewer international joint papers compared with other major countries[1] and insufficient expansion of research fields and participation in multi-disciplinary and combined fields (Figure 1-2-4). Parties relating to industry-academic-government collaboration pointed out "decreases in the diversification of basic research" and "insufficiency of ingenious research" (Figure 1-2-5).

1 "Science and Technology Indicators 2014" search data -229 (August 2014), National Institute of Science and Technology Policy

■ Figure 1-2-3 / Changes in shares of papers and adjusted top 10% and 1% papers in major countries

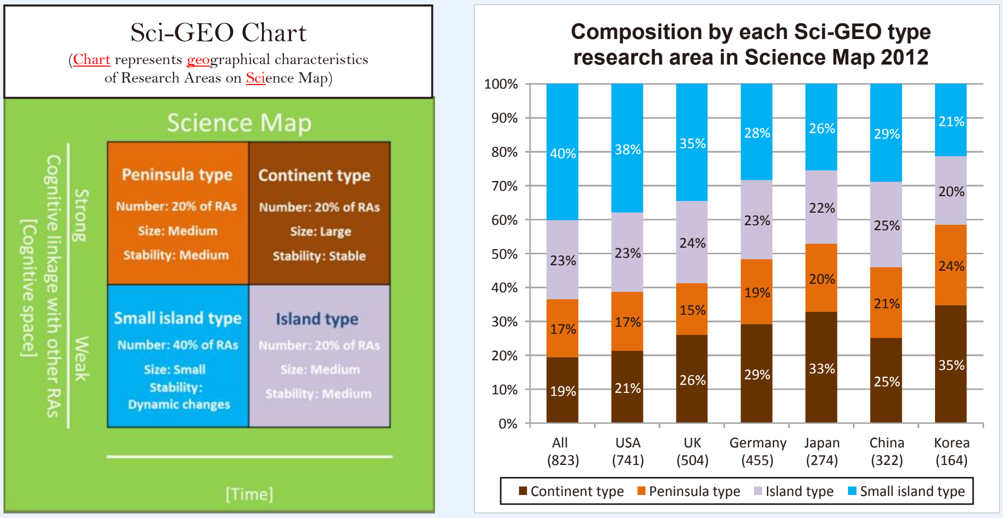


Note 1: Articles and reviews were subject to analysis. Annual data up to 2012 was analyzed by the publishing year (PY).

Note 2: Average of 3-year changes in the share of papers in all fields (e.g. average of PY 2010, PY 2011 and PY2012 for 2011) using the integer count technique. The number of citations at the end of FY 2013 was used.

Source: "Science and Technology Indicators 2014" NISTEP Research Material -229 (August 2014), National Institute of Science and Technology Policy

■ Figure 1-2-4 / Features of research field types in major countries

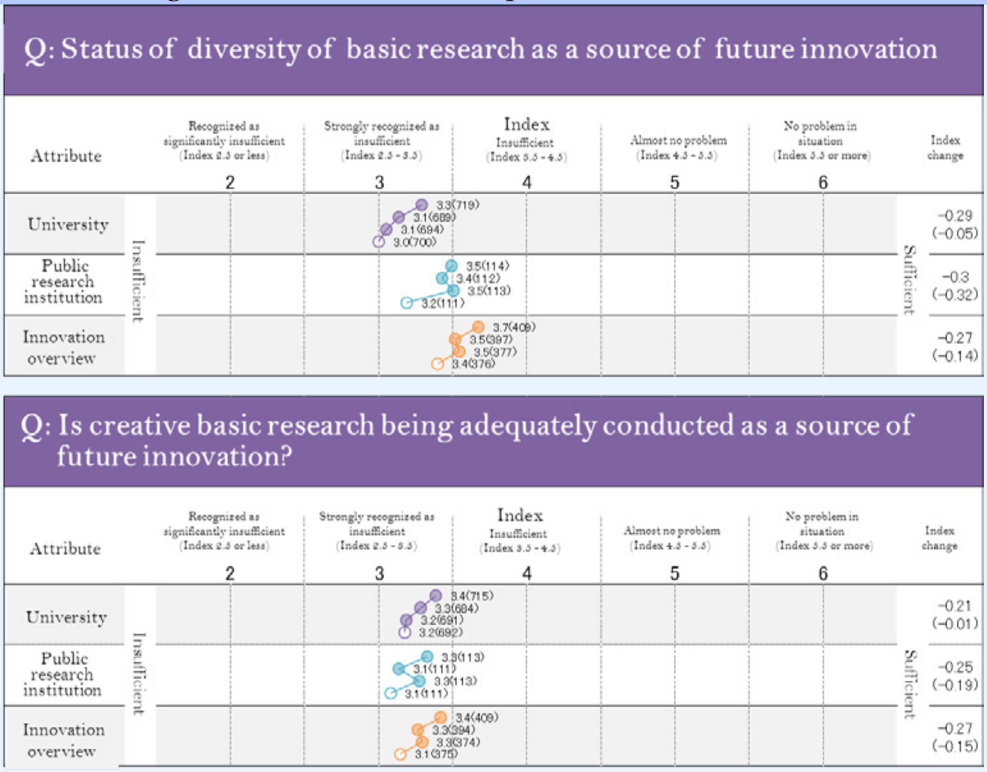


Note 1: The science map indicates the quantitative data of research fields of international attention obtained by analyzing papers, their relative positions and progress. The number at the side of the country name is that of participating fields and the vertical axis represents the proportion of research types. Participating means a relationship of at least one paper to the core paper (top 1% of papers) comprising research fields of the science map.

Note 2: Comparing the number of participating fields in Japan with totals in the U.K. and Germany, the difference is significant in fields stemming from interdisciplinary or combined fields and clinical medicine. Small-island type research, which comprises 40% of research fields of international attention, is insufficient in Japan.

Source: "Science Map 2010&2012 -Surveys on Trend of Noted Research Fields of Attention by Analysis of Scientific Paper Database (2005-2010, 2007-2012)", NISTEP REPORT No. 159 (July 2014), National Institute of Science and Technology Policy

■ **Figure 1-2-5 / Changes in the awareness of the parties concerned for basic research in Japan**



Note 1: NISTEP survey results in FY 2011 (top) to 2014 (bottom). White circles show the survey results in FY 2014. Figures in parentheses are total replies. The innovation overview group (overview) comprises key figures in industry, venture capital owners, PDs and POs of funding agencies, staff of industry-academy liaison offices and representatives of university ventures, etc.

Note 2: The value at the top indicates the result of FY 2011, while the bottom shows the result of FY 2013 in the Index Change column.

Source: "2014 Expert Survey on Japanese S&T System and S&T Activities by Fields" NISTEP REPORT No. 161 (March 2015), National Institute of Science and Technology Policy

(2) Priority Setting in S&T

1) Placing in the S&T Basic Plan

In the 1st Basic Plan, the government could not select science and technology areas to prioritize due to time constraints. In the 2nd Basic Plan, life science, information and communication, the environment and nanotechnology/materials were selected as four priority fields. Energy, manufacturing technology, social infrastructure and frontier were also selected as four priority fields to be promoted and fundamental and promoted at the view of being indispensable for the existence of a country.

During the 3rd Basic Plan, life science, information and communication, environment and nanotechnology/materials were chosen as four priority fields and energy, manufacturing technology, social infrastructure and frontier as four fields to be promoted. To determine priorities within individual S&T areas and strengthen the strategic features, a promotion strategy was created by the area and "strategically prioritized S&T" was selected for prioritized investment within the area during the planning period. Of the "strategically prioritized S&T," those requiring concentrated investment to maximize the socioeconomic effect, including a comprehensive guarantee of national security, were defined as "Key Technologies of National Importance."

In the 4th Basic Plan, following the suggestion that achievements from the prioritized fields in the 1st to

3rd Basic Plans had not been tied to solving social issues, the direction changed significantly, from prioritization by area to issue-oriented prioritization, and “recovery and reconstruction from the Great East Japan Earthquake,” “promotion of green innovation” and “promotion of life innovation” as selected national issues to be tacked. Areas including information and communication and nanotechnology/materials were included in those for cross-disciplinary S&T together with photo and quantum S&T and mathematical science etc.

2) Activities

(Prioritization of fund allocation)

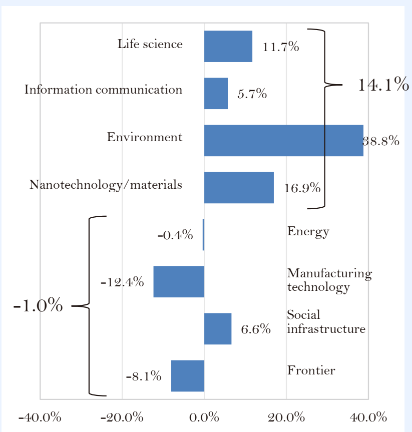
In the 2nd and 3rd Basic Plans, prioritization by area was further promoted (Figure 1-2-6). At the end of the 2nd Basic Plan, the science and technology budget allocated to the four priority fields to be promoted increased from 36.0% in FY 2001 to 39.4% in FY 2004 and the share of the four priority fields as a proportion of science and technology as a whole increased by about 14.1%, while that of other areas decreased by about 1.0% from FY 2001 to FR 2004.

After the 3rd Basic Plan, although the budget allocation to eight areas remained largely unchanged, strategic and prioritized resource allocation was promoted in strategically prioritized S&T. For example, the science and technology budget for eight areas comprised 16% in FY 2006 and 26% in FY 2010 (Figure 1-2-6).

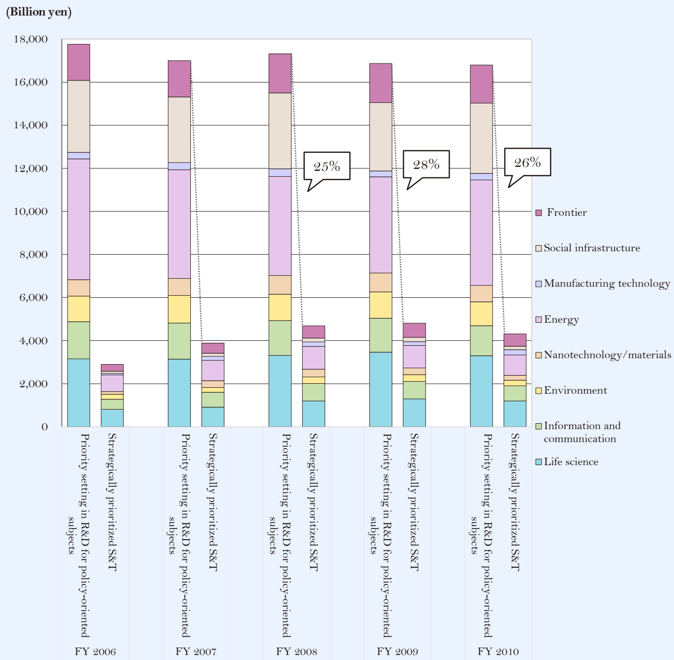
In the 4th Basic Plan, an action plan was designed for each of the major issues as well as a “Science, technology and innovation (STI) Strategy Councils”.

■ Figure 1-2-6 / Prioritization of the S&T budget in the 2nd and 3rd Basic Plans

● Prioritization of the S&T budget in the 2nd Basic Plan (budget increase and decrease by area from FY 2001 to FY2004)



● Prioritization of the S&T budget in the 3rd Basic Plan



Source: Created by the Cabinet Office

(Achievement by major national issues)

Activities in the "recovery and reconstruction from the Great East Japan Earthquake" prioritized in the 4th Basic Plan included the creation of advanced technologies and new industries and restoration of social infrastructure in afflicted regions. Actual examples include: "A Scheme to Revitalize Agriculture and Fisheries in Disaster Area through Deploying Highly Advanced Technology" (from FY 2011, MAFF) to make proposals for new agriculture and reconstruct fishing grounds, "R&D for the Reinforcement of Disaster Resistant Information Communication Network on the Recovery and Reconstruction from the Great East Japan Earthquake" (from FY 2011, MIC) to ensure mobile phone and other communication networks.

In the "Promotion of Green Innovation," streamlining of low carbon core energy supply sources and R&D for low carbon transportation and energy-saving technology in the private sector was conducted. This included the "Floating Offshore Wind Turbine Demonstration Project" (from FY 2010, MOE) to establish a means of assessing technology and environment for floating offshore wind turbine power generator systems, wind generator systems and "Polymer Electrolyte Fuel-Cell Commercialization Promotion R&D Project" (from FY 2010, METI) to reduce the costs of polymer electrolyte fuel cells used as home fuel cells and for fuel-cell vehicles.

In the "Promotion of Life Innovation," the development of new and early diagnosis methods, including innovative preventive methods using a large-scale cohort research and a health survey and imaging technology and equipment, acquiring ISO certification to ensure the safety of service robots and improve the quality of life (QOL) of the elderly, handicapped and patients. Actual examples include: "Tohoku Medical Mega-Bank Project" (from FY 2011, MEXT) to conduct large-scale genome cohort surveys in afflicted areas and the "Project for Practical Applications of Service Robots" (from FY 2009, METI) to support the development of service robots such as wearable models and the safety standard.

(Achievements by area)

Investment was focused on the field of life science from the 2nd Basic Plan. Japan has the highest competitiveness in basic research in this area; forming a triple pole with the U.S. and Europe. In particular, its high level of research in developmental and regeneration fields is highly evaluated worldwide. In 2012, Prof. Shinya Yamanaka of Kyoto University won the Nobel Prize in Physiology or Medicine for his achievement in establishing iPS cells.

In the environment area, an international cooperation system has been established, spawning globally leading work on climate change and predictability research in Japan through its contribution to the Global Earth Observation System of Systems 10-Year Implementation Plan (GEOSS), including research, development and operation of environmental observation satellites and the development of the "Earth Simulator" as a large-scale common research base.

In the field of information and communication, Japan has invested to enhance networks and advanced computing technology. Broadband Internet services have been widely rolled out with DSL[1] allowing the use of telephone lines for such services. Optical lines (FTTH[2]) enable faster and larger data transmission

1 Digital Subscriber Line
2 Fiber to the Home

online as well as easy access to video sharing websites and music, voice, image and various other contents through the Internet. In the area of development of supercomputers, "K computer" was developed and MEXT started developing a post "K" supercomputer in FY 2014 to address wide-ranging issues with its global top-level performance ("FLAGSHIP 2020 Project"). The post-K supercomputer will be completed by 2020.

In the field of nanotechnology/materials, prioritization resulted in many academic and industrial achievements, including the discovery of a new iron-based high-temperature superconductor and this area was considered one of the most competitive in Japan. Progress in basic and fundamental research saw the levels of manufacturing and science in universities coincided and paved the way for application. This could also be the result of prioritization. Recent projects have included "Strategy for Rare Elements Project" (from FY 2012, MEXT) to develop innovative alternatives for rare elements.

In the energy area, R&D has been promoted in the field of new energy technologies, including fuel cells, photovoltaic power generation and biomass, energy-saving technologies including residential houses, buildings, home information appliances and communication devices, and nuclear power and nuclear power safety technologies. Many of these achievements have already been commercialized.

In the area of manufacturing technologies, production technology and simulation software for more compact, power-saving and higher performance micro electric mechanical systems (MEMS) have been developed.

In the social infrastructure area, disaster prevention R&D, including the practical use of the Earthquake Early Warning System, implementation of an observation network for local heavy rain using the MP radar[1] and development of low-fuel and low-noise airplane engines have been completed.

In the frontier area, R&D covering space and sea has been promoted. During the 3rd Basic Plan, many scientific achievements were made, from the operation of the lunar explorer satellite KAGUYA (SELENE), deep sea drilling vessel "CHIKYU" and others. Recently, these projects have been promoted according to the "Basic Plan on Ocean Policy" (Approved by the Cabinet on April 26, 2013) and "Basic Plan on Space Policy" (Approved by Strategic Headquarters for Space Policy on January 9, 2015) based on the "Basic Act on Ocean Policy" (Act No. 33 of 2007) and "Space Basic Law" (Act No. 43 of 2008). The Basic Plan on Space Policy was amended in January 2015 to adjust to a new 10-year program for prediction for the coming 20 years and "Space Security," "Promotion of Space Utilization in Civil Sector" and "Promotion and Reinforcement of Space Industry and S&T Base" were defined as new space policy objectives. In addition, the Basic Space Plan clearly specifies activities such as satellite development as long-term development plan to improve "foreseeability" for industry investment and set out a total of 5 trillion yen over a decade to cover both public and private projects in the space equipment industry.

"Space transportation system," "next-generation supercomputer," "X-ray free electron laser," "Fast Breeder Reactor cycle technology" and "Marine Earth Observation System" were defined as five "Key Technologies of National Importance," achievements in these fields included 26 consecutive successful launches of H-IIA/B rockets (96.9% success rate)[2], start of drilling in the Nankai Trough by deep sea drilling vessel "CHIKYU" to clarify earthquake-generating mechanisms, operational launch of the

1 Multi parameter radar
2 As of March 31, 2015

Greenhouse Gases Observing Satellite "IBUKI" (GOSAT), successive first-place wins for the supercomputer “computer K”, global supercomputer performance ranking TOP 500 (June and November 2011) and the start of service (September 2012), start of the X-ray free electron laser facility (SACLA) (March 2012) and the development of a method to observe living cells at nanometer level as a world first (January 2014).

3) Issues

The issue-oriented approach taken in the 4th Basic Plan was evaluated with “although some surveys achieved certain significance, the short time from the presentation of direction in the 4th Basic Plan meant the effect of this approach on basic research must be checked continuously” in “the 4th Science and Technology Basic Plan Follow-up” (Council for Science, Technology and Innovation, October 2014). Decreased diversification and ingenuity in basic research must therefore be monitored in future.

When prioritizing science and technology, the Council for Science, Technology and Innovation should play a central role to maintain consistency with the programs in terms of relevant policies.

2 Science and Technology System Reformation

(1) Human resource system

1) Placing in the S&T Basic Plan

The 1st Basic Plan focused on establishing an attractive research environment to stimulate the creativity of researchers. From this perspective, it employed a contractual employment system at national universities and national experiment and research institutions and decided to attain “Program to support 10,000 postdoctorals[1]” by FY 2000 and researcher evaluation.

The 2nd Basic Plan targeted the extensive adoption of contractual employment, public invitation to research posts in national universities and public research institutions in principle, a 3- to 5-year extension of contractual employment and prioritized expansion of research funds for young researchers. Also promoted were recruitment of the finest foreign and female researchers and exploiting diversified career paths other than research work for postdoctoral fellows (postdocs) and proactive employment of postdocs and ex-postdocs in private companies.

The 3rd Basic Plan focused on human resource development and competitive environment according to the fundamental concept. Unclear career paths of postdocs were highlighted and the independence of young researchers was supported through a new tenure track system[2]. In addition, to improve flexibility, the “General One-transfer Rule for Young Researchers” and reduction in the ratio of teachers in their alma mater were recommended. In addition, the plan set objectives to increase the employment of female researchers to 25% as a proportion of the overall natural science sector and industrial and academic collaboration for the development of human resources was also promoted.

---

1 Postdocs are those who are employed in the fixed term after acquiring their PhD and engaged in research in 1) the research institution of a university without a teaching post such as professor, associate professor, assistant professor, or assistant, or 2) in the research institution such as an incorporated administrative institution, but not as a leader or senior researcher of the research group. Postdocs are at a stage prior to independent researchers and teachers, receive suitable guidance and training under relevant tutors, conduct original research, and acquire research skills and ethics, etc. required for independence.

2 A personnel system with public invitation and other fair and transparent selection procedures, employed with a fixed term and before completing the terms, fair and transparent tenure inspection was executed.

The 4h Basic Plan focused on the importance of human resources and the supporting role of organizations to improve organizational support and exploit researchers' full potential. Based on this concept, the plan sought the foundation of leading graduate schools, prepared a platform for dialog within industry, academia and government, fundamental reinforcement of graduate school education by evaluating teachers from various perspectives and introducing a double-degree program[1] with foreign universities, the phased employment of an annual salary system in universities and public research institutions and support for overseas study of young researchers and students. The employment target for female researchers as a proportion of the natural science sector was raised to 30%.

2) Activities

(Career path of young researchers, increasing flexibly mobility of human resources)

After contractual employment was introduced in 1997, employment of researchers by competitive funds, supported by relevant ministries, increased and a "Program to support 10,000 postdoctorals" was achieved in FY1999. Plans in national universities and public research institutions which explicitly indicate contractual employment and public invitation increased according to the "Basic Guidelines for Improvement of Researcher Mobility " (Council for Science and Technology Policy (CSTP), February 2001) and the number of researchers with contractual employment soared. Accordingly, contractual employment was widely used, particularly the flexible mobilization of young researchers. Of young researchers under 34 years old, around 53.6% in universities and around 44.8% in public research institutions were those of contractual employment in 2009[2].

In FY 2005, the "School Education Law" (Law No. 26 of 1947) was revised to add associate professor and assistant professor posts independent of professors to give young staff the opportunity to exercise their talents and ability to the full extent. In FY 2006, "Improvement of Research Environment for Young Researchers" was launched to support universities which introduced a system to give young researchers the chance for independence and for success in a competitive environment based on the tenure track system to provide an environment for young researchers to be independent and study and the project was taken over by the "Program to Disseminate Tenure Track System" from FY 2011. In addition, items supporting young researchers in KAKENHI were increased to promote the independence of young researchers.

Programs like "Young Researchers Training Program for Promoting Innovation" (from FY 2008, MEXT) to support career development, including long-term internships to diversify the career path of young researchers, were implemented to turn their career path toward industry. This program resulted in a total of 936 companies introducing internship posts (as of the end of FY 2013), including foreign companies. This shows how the program improved awareness among private corporations of postdocs and in the graduate schools where this program was conducted, the employment opportunities for doctoral students who joined the program at private institutes increased.

MIC launched "the grant for young researchers in the ICT R&D area" in 2002 as a research fund for young researchers in information and communication technology (ICT) area. The National Institute of Advanced Industrial Science and Technology (AIST) conducted "AIST School of Innovation" to develop

1 A program in which universities in Japan and overseas conclude a deal on compatible curricula and credits and award a degree

2 "A survey about mobility of researchers and diversity of research organizations" (March 2009), National Institute of Science and Technology Policy

human resources capable of being active in various areas through OJT[1] and accepted postdocs and doctoral students in its projects from FY 2008.

MEXT and METI published the "Basic Framework and Notes on Cross-Appointment System" in December 2014 under the control of the Cabinet Office to promote a cross-appointment system allowing researchers to be engaged in R&D according to the roles occupied in their institutes.

(Improvement of university and graduate education and development of next-generation human resources)

In an effort to improve university and graduate education, programs such as the "Global COE[2] Program" (from FY 2007, MEXT) were conducted to enhance the competitiveness of universities where world-beating human resources should be developed. MEXT launched the "Program for Leading Graduate Schools" from FY 2011 to foster leaders capable of being active in industry, academy and government and playing a leading role in growing industries worldwide. A total of 62 cases were employed to date, 20 in FY 2011, 24 in FY 2012 and 18 in FY 2013.

As for development of next-generation human resources, not only training of teachers, but also learning support in science and mathematics and with effect from FY 2002, MEXT and JST have jointly supported high schools engaging in advanced science and mathematics education as "Super Science High Schools (SSH)." A total of 204 schools were specified as SSHs as of FY 2014 and SSH graduates became researchers and gold medalists in the International Science Olympiads.

1 On the Job Training
2 Center Of Excellence

Column 1-10 Super Science High Schools (SSH)

From FY 2002, MEXT and JST jointly specified high schools engaging in advanced science and mathematics education to foster internationally renowned human resources in science and technology as Super Science High Schools (SSHs) to support experiential, problem-solving learning by developing and implementing curricula and the promotion, observation and experiments of specific subjects independent of the National Curriculum Standards. Comments on the SSH program of some graduates from high schools currently specified as SSH are introduced below.

Satomi Toda, Protection and utilization group, Center for Intellectual Property Strategies, JST
(Hyogo Prefectural Kakogawa Higashi High School, graduated in FY 2007)

I entered Hyogo prefectural Kakogawa Higashi high school, which had already been designated an SSH. The entrance exam was unique in that the test included an experiment and a short essay on science and technology.

I was impressed by the lecture of Nobel chemistry laureate, Dr. Hideki Shirakawa. He discussed the importance of serendipity. I clearly remember that he stated that we would miss the breakthrough of the century unless we kept a watchful eye on everything. I learned that accidental discovery was largely based on preparations on a routine basis. It was a valuable time to take part in a lecture by a person active on the front line. When I was engaged in research at university and graduate school, his words were always at the back of my mind.

I heard about school programs that I did not receive in my high school days, such as training at Massachusetts Institute of Technology and Harvard and a course to teach presentations in English. It seems the school has focused more on developing human resources as scientists and technicians active in the international community.

Nao Sakamoto, Food Research & Development Laboratory, R&D Dept., MC Food Specialties, Inc.
(Saitama Prefectural Urawa Daiichi Girls' High School, graduated in FY2006)

The Saitama Prefectural Urawa Daiichi Girls' High School (Urawa Ichijo) designated as the SSH participated in space experiments in the Space Shuttle, in which the students were engaged. I was a junior high-school student and got very excited to hear the news. I decided to attend this high school, because I wanted to keep in touch with such students, many of whom not only studied but tried to do various things. I thought I could have valuable school days and be inspired by numerous good things.

While in the high school, university teachers visited to give lectures with experiments as part of the SSH program. I was impressed by experiment indicating the CT scanning mechanism. Sectional images of vegetables taken by a digital camera were fed to the computer and regenerated on the same based on the principle of a CT scan. The lecture of the scientific presentation in English, commencing from the composition of the presentation, was one of the most impressive lectures.

Besides these special lectures, my chosen study theme was a plant’s internal clock. While receiving advice from science and English teachers, I studied how to select a theme, perform the study and give a presentation, as if in the middle of study at university. My personal study was finally consolidated into an abstract written in English as my graduation thesis. It was a variable study.

Koshiro Oda, The Laboratory of Plant Neutrition and Fertilizers, Department of Applied Biological Chemistry, Graduate School of Agricultural and Life Sciences, The University of Tokyo
(Hiroshima Prefectural Saijo Agricultural High School, graduated in FY 2005)

While in high school, I joined the natural science club as my extracurricular activity and the teacher who supervised the club taught us how to make a persuasive presentation. I remember it as a crucial lesson. I believe the importance of learning lies in the process of knowing what nobody knows and transferring what you know to others who are unaware of these things. To know this is very helpful. I was lucky to meet a good teacher.

After I graduated from high school, my alma mater was specified as the SSH and I was invited to give a lecture. The audience seemed to take what I said seriously. High-school students rarely have a chance to learn about university and research life and I think this was a valuable opportunity for them.

(Promoting activities of various human resources)

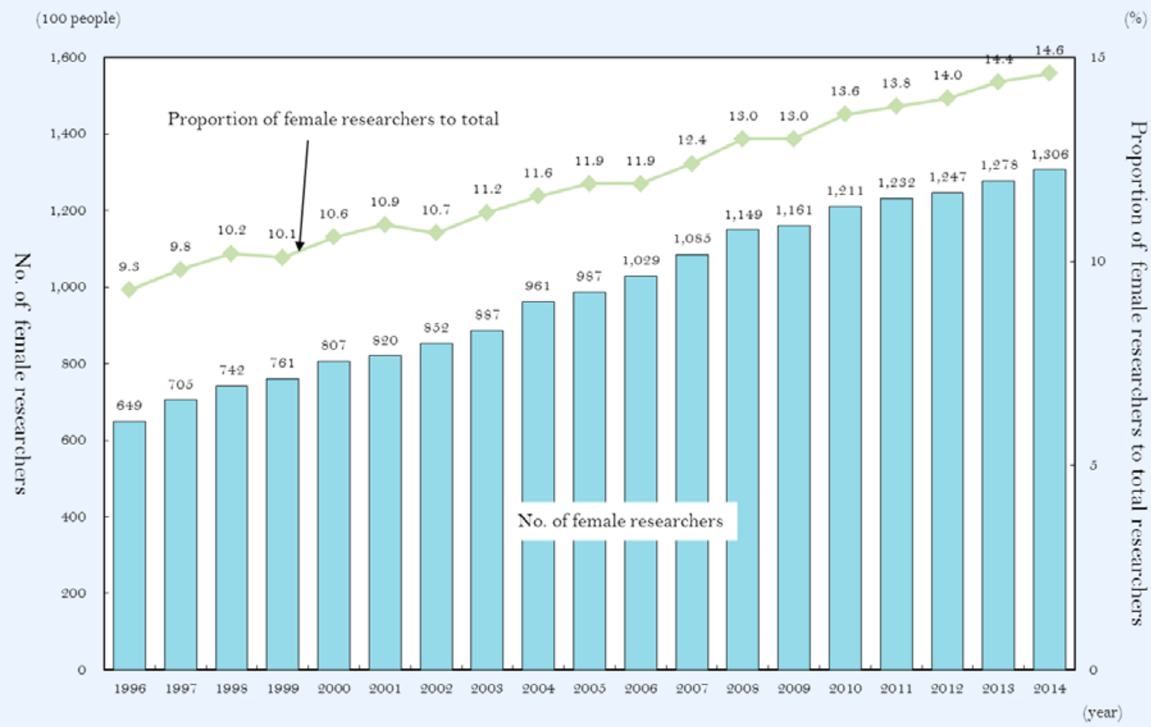
MEXT founded a “Supporting activities for female researchers” in FY 2006 to establish a model to promote activities of female researchers by supporting both life events such as childbirth and child rearing as well as research. The program was continued as a "Program to supporting research activities of female researchers" from FY 2011 and an "Initiative for Realizing Diversity in the Research Environment" project from FY 2015. MEXT launched a "Supporting positive activities for female researchers" in FY 2009 to build a female researcher employment and fostering system in universities. MEXT presented system models to promote the activities of female researchers through these projects.

WPI is provided to establish an international research center to attract outstanding foreign research from all over the world. In addition, the Japan Society to promote Science conducts "Postdoctoral Fellowship for Foreign Researchers" to encourage young foreign researchers to come to Japan.

These programs increased the number of female researchers as a proportion of the total number of researchers in Japan from 9.3% when the 1st Basic Plan was launched in 1996 to 14.6% in 2014 (Figure 1-2-7). The total number of foreign researchers in domestic research institutions also increased from around 17,000 in 1996 to 36,000 in FY 2013[1] and the total ratio of foreign researchers in universities and research and development institutes has also gradually increased[2].

The number of researchers in Japan has increased to the required level through human resource development and securing programs in the Basic Plans (Figure 1-2-8).

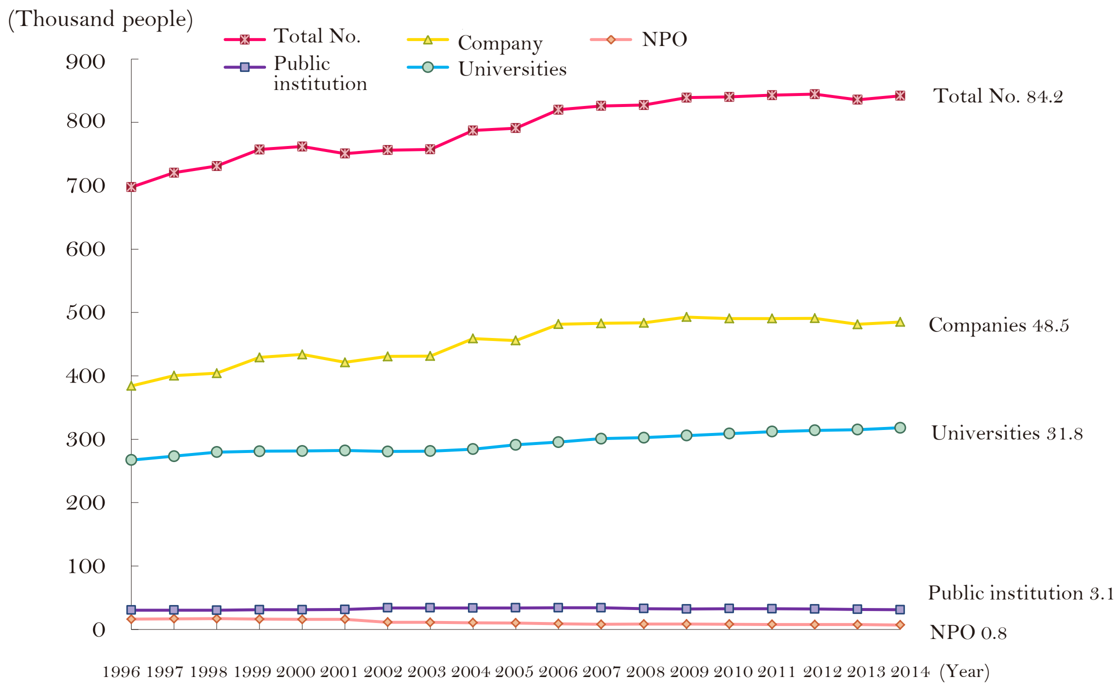
■ Figure 1-2-7 / Number of female researchers and proportion of female researchers to all researchers



Source: Compiled by MEXT based on the "Report on the Survey of Research and Development ," Statistics Bureau, MIC

1 "2013 Survey on International Research Exchanges," MEXT
2 "2014 White Paper on Science and Technology" Figures 1-1-43 and 1-1-44

■ **Figure 1-2-8 / Number of researchers by sector in Japan**



2012 -	2002 - 2011	- 2001
Company	Company	Company
NPO	NPO	Private research institution
Public institution	Public institution	Research institution other than private
Universities	Universities	Universities

Note 1: Number of researchers, including cultural and social sciences, as of March 31 each fiscal year (number of full-time researchers in companies, NPOs and public institutes and the real number of researchers, including those with other posts in universities) (values till FY 2001 are as of April 1).

Note 2: Survey categories were changed in 2002 and 2012. The above table shows the association of categories before and after the change.

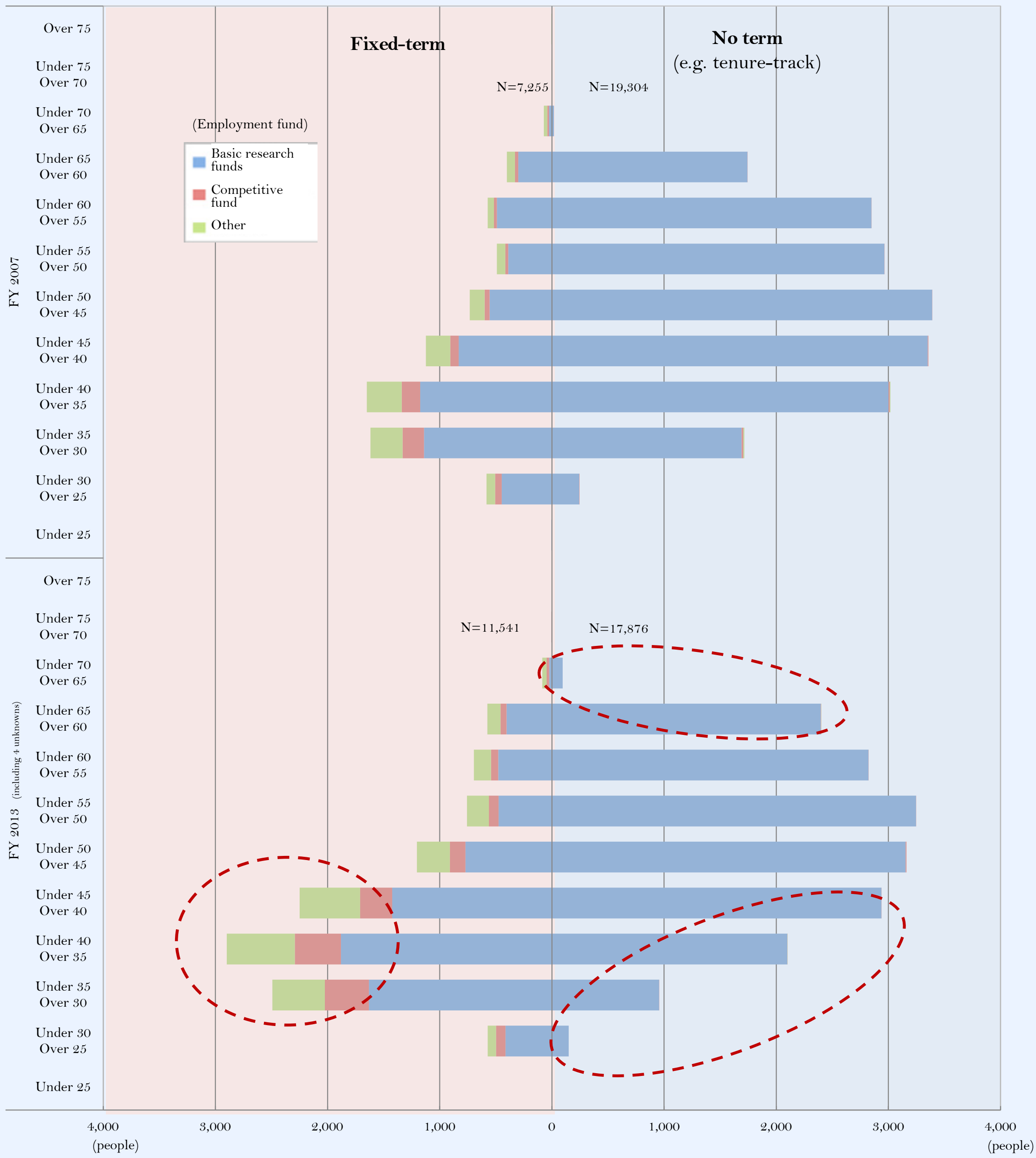
Note 3: The number of full-time researchers was used up to 2001 except for universities.

Source: Created by MEXT based on “Indicators of Science and Technology” (September 2014) and “Report on the Survey of Research and Development” (2014), Statistics Bureau of MIC.

3) Issues

One of the reasons for the decline in basic research funds in universities and R&D institutes is the significant decrease in the number of stable posts ensuring challenges by young researchers. In fact, according to a survey of major universities by MEXT, non-termed researchers over 60 increased and those under 45 decreased while the number of contracted researchers increased during the six years from FY 2007 to FY 2013 (Figure 1-2-9). This suggests that an increased number of young researchers cannot foresee their future career path. The situation highlights the “generation gap in mobility” and explains why all generations failed to get the right place for the right qualification.

■ **Figure 1-2-9 / Survey on employment of university teaching staff (preliminary report)**



Note: A survey on the employment of teaching staff in 11 major research universities meeting Council for Academic Research (RU11) which spearheads research activities in Japan.
Source: Surveyed by MEXT and consolidated and analyzed by the National Institute of Science and Technology Policy.

The reluctance of private corporations to employ postdocs is mainly attributable to the improved ability of in-house researchers through in-house education and training, which are more efficient than postdoc employment and expertise in specialized academic fields cannot be immediately applied to research in companies[1]. In addition, a quantitative gap exists between the demand and supply of human resources due

1 "NISTEP REPORT No.160. Survey on Research Activities of Private Corporations (2013)." (September 2013), National Institute of Science and Technology Policy

to mismatching of specialties (Figure 1-2-10).

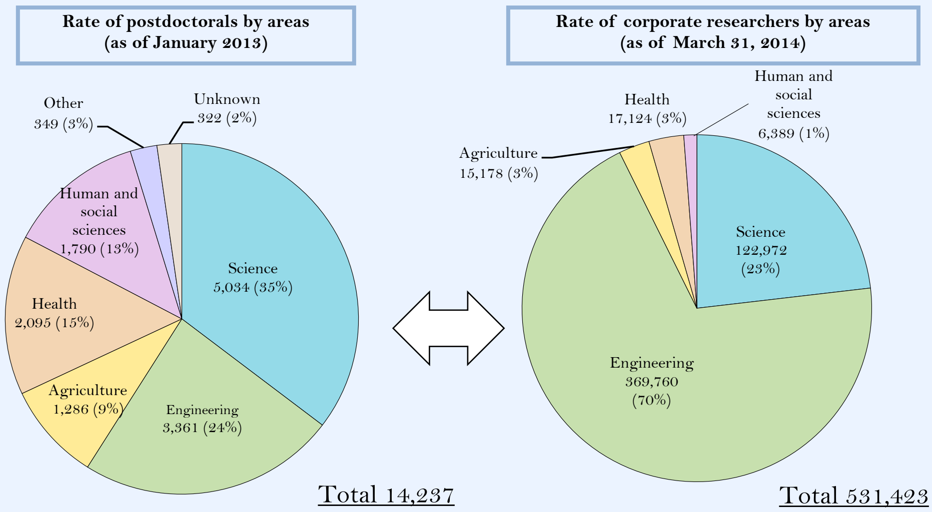
Besides, financial support for doctoral students remains insufficient. Only around 10% of all doctoral students receive economical assistance equivalent to living costs (annual income of 1.8 million yen or more)[1].

Under these circumstances, the number of students taking doctoral course has tended to decrease in recent years[2] and some critics point out that students with the required ability do not go to doctoral course[3].

The number of female and foreign researchers in Japan is fewer than those elsewhere[4] and female researchers in particular are rarely assigned to leadership positions. This is undesirable in light of diversified human resources and activities.

The mobility of human resources in universities, public research institutions and private corporations remains low and not at a stage where outstanding human resources can work in multiple organizations. Efforts to improve mobility of human resources must be made.

■ Figure 1-2-10 / Comparison of corporate researchers and postdocs by specialty



Source: "Survey on Postdoctoral Fellows Regarding Employment and Careers: Complete Survey on Universities and Public Research Institutes in Japan(actual achievement in FY 2012)-(August 2014)," National Institute of Science and Technology Policy, "Report on the Survey of Research and Development"(2014)Statistics Bureau, MIC

(2) Promotion of Industry-Academia-Government collaboration and R&D of private corporations

1) Placing in the S&T Basic Plan

The 1st Basic Plan focused on the importance of human resource exchange between industry and government to feed R&D results back to society efficiently. The objectives of the plan included R&D tax

1 Fiscal 2013 MEXT Commissioned Project for Leading University Reform "Investigation and Research of Financial Support and Carrier Options of Doctoral Students" (May 2014)
2 School Basic Survey, MEXT
3 "2014 Expert Survey on Japanese S&T System and S&T Activities by Fields" NISTEP REPORT No. 161 (March 2015), National Institute of Science and Technology Policy
4 Female researcher: "Report on the Survey of Research and Development," MIC, "Main Science and Technology Indicators," OECD, "Science and Engineering Indicators 2014," NSF, Foreign researcher: Nature 490, pp. 326-329

incentives to activate R&D of private corporations and consolidation of databases to utilize national R&D results.

The 2nd Basic Plan emphasized the importance of system reform to transfer technologies resulting from academic studies in universities. Accordingly, the objectives included, for example, facilitation of using Intellectual property by changing individual rights to organization management in principle. It also promoted the development and supply of human resources with the spirit of entrepreneurship and proactive utilization of Small Business Innovation Research (SBIR[1]) to provide an environment to support venture businesses.

The 3rd Basic Plan defined industry-academia-government collaboration as a key pillar of creating innovation and included it in the operation policy of universities. It also focused on the importance of venture businesses and human resources capable of working with standardization correctly.

The 4th Basic Plan set objectives for establishing an industry-academia-government network through collaboration between universities and with financial institutions to improve the "intellectual" network, encourage innovation in science and technology and provide an open innovation base to promote competitive and collaborative R&D.

2) Activities

(Promoting industry-academia-government collaboration and commercialization)

"Act on the Promotion of Technology Transfer from Universities to Private Business Operators (TLO Act)" (Act No. 52 of 1998) to promote the foundation of a corporation to acquire patents on the achievements of university researchers and license the right of technologies used in these patents to private corporations and "Act on Special Measures Concerning Revitalization of Industry and Innovation in Industrial Activities (Japanese version Bayh-Dole Act)" (Act No. 131 of 1999) to allow intellectual property concerning the R&D achievements supported by government funds to be owned by universities and researchers were enacted during the 1st Basic Plan. In addition, various regulations on the support of researchers in experiment and research institutions, which were state-owned at the time, were deregulated. National universities were corporatized during the 2nd Basic Plan (FY 2004).

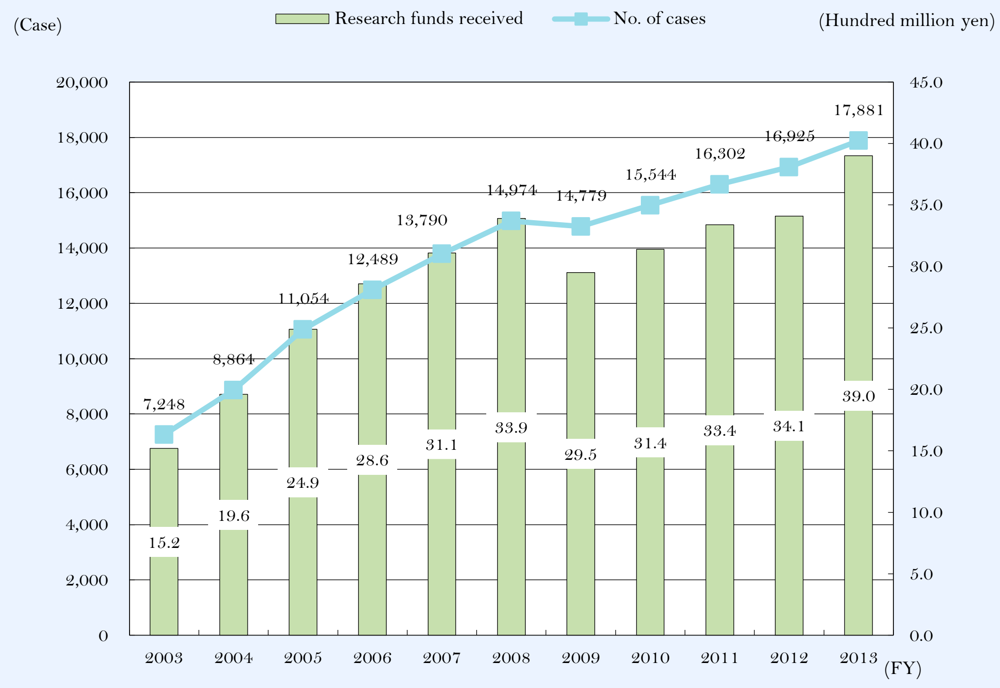
Support to commercialize research outcomes in universities includes, for example, a system like "Contract Development System" implemented by JST in FY 1958, which was used to commercialize blue LEDs, which won the Nobel Physics Prize in FY 2014 and the "Adaptable Seamless Technology Transfer Program through Target-driven R&D (A-STEP)" restructured in FY 2009, which helped commercialize technological seeds in universities and found venture companies.

JST set R&D themes based on the future social vision from FY2013 and launched the "Center of Innovation (COI) Program" to encourage universities and private companies to collaborate in challenging R&D.

These activities have increased both the number of work at universities and funding from private corporations (Figure 1-2-11).

1 Small Business Innovation Research

■ Figure 1-2-11 / Changes in the No. of joint researches with industry at universities and funds received from industry



Source: "The present state of Industry-Academia Collaboration in National University" MEXT

(Promoting R&D at private companies and supporting small and medium enterprises and ventures)

The R&D taxation scheme, which provided for private companies to set off a certain ratio of experiment and research expenses from corporation tax, was radically revised in FY 2003 and a tax credits system concerning special experiment and research expenses was enacted to promote the current system of tax exemption for overall experiment and research expenses and open innovation. In particular, the scope of the tax exemption system to cover special experiment and research expenses was expanded to include joint inter-corporation research in FY 2013 and the level of tax deduction was increased from 12% to a maximum of 30% in FY 2015.

The "Japan Open Innovation Council" (JOIC) was founded in FY 2014 to promote voluntary open innovation by private corporations. The council will hold seminars and workshops to discuss issues to promote open innovation and investigate best practices in Japan and abroad to publish the "White Paper on Open Innovation." The office is placed in NEDO.

The "Small Business Innovation Research system (SBIR)" was introduced to support business activities of small and medium enterprises by reducing patent royalties and provide a special load system using government subsidies and according to the achievements in FY 1998. In the R&D tax system, measures such as increased tax deductions were taken for small and medium enterprises.

The 1,000 University-Originated Ventures Plan" was started in FY 2001 to found university-launched 1,000 venture companies within the three years from FY 2002 to 2004, the goal of which was achieved in

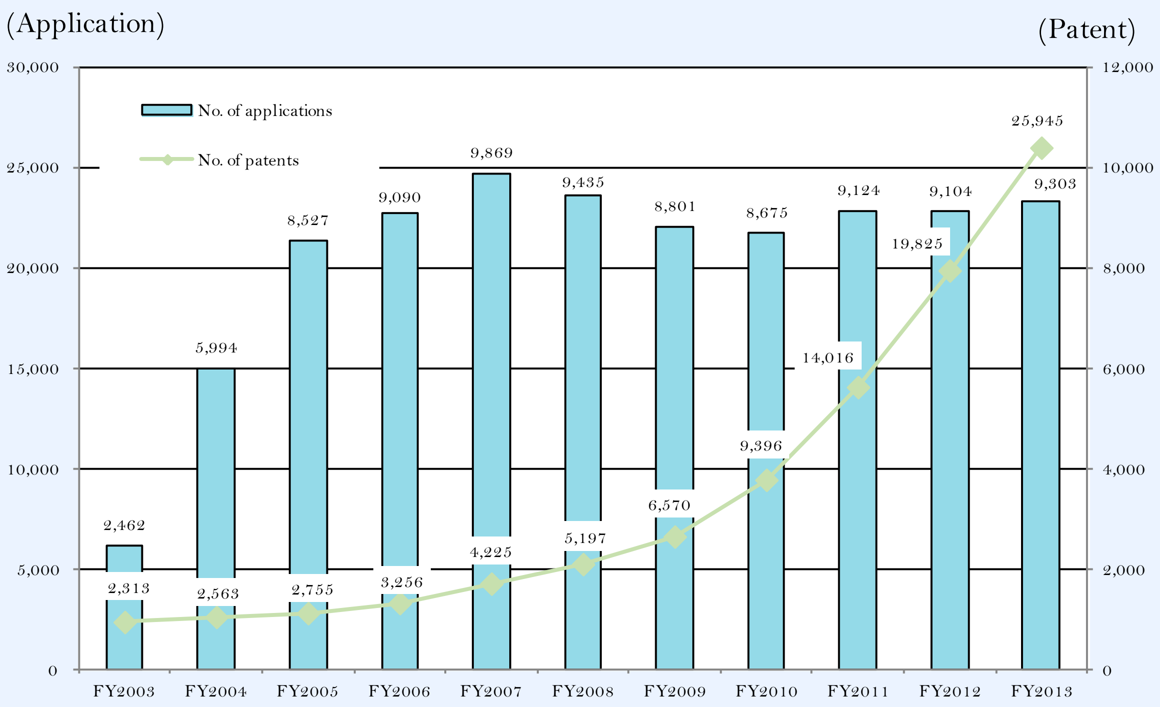
FY 2003. The "Enhancing Development of Global Entrepreneur (EDGE) Program," started by MEXT in FY 2014, supports universities developing and fostering human resources to start venture businesses and challenge industry innovations. In addition, the "Support Center for Technology Transfer," launched by NEDO the same fiscal year, supports the initial operation of new R&D venture companies which require significant investments and take time to reach the stage of commercialization, namely, being too risky to gain private sector support.

(Intellectual property, standardization)

The period of demand for examinations in the patent system was reduced from the conventional seven years to three years at the maximum, pursuant to the amendment of "Patent Act" (Act No. 121 of 1959) in FY 1999. The period of the primary examination notification of the patent examination was reduced from 26 months at the end of FY2003 to least of 11 months at the end of FY 2013, achieving the goal of a decade in the "Intellectual Property Strategic Program 2004."

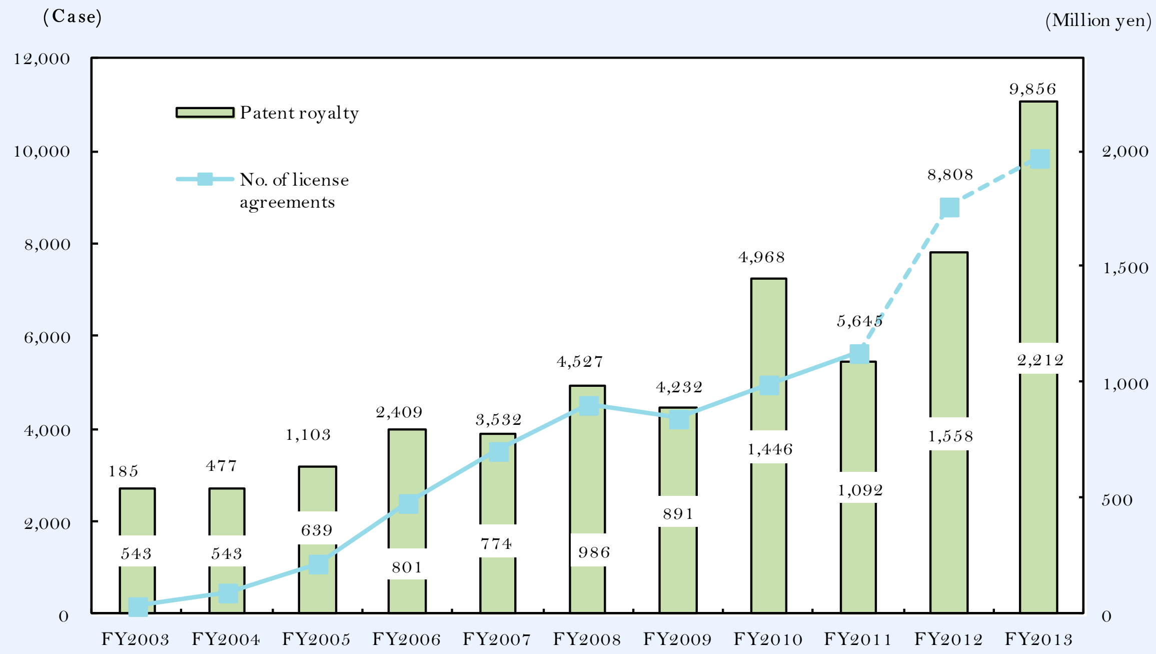
In FY 2003, MEXT launched a "University Intellectual Property Headquarters Development Project" to promote the installation of headquarters for Intellectual property in universities and JST started the "Support Center for Technology Transfer" to support the intellectual property rights of universities. Following these efforts, the number of patent applications (Figure 1-2-12) and that of patent license permissions and income (Figure 1-2-13) have been increasing.

■ Figure 1-2-12 / No. of patent license permissions and ownerships at universities



Source: "The present state of Industry-Academia Collaboration in National University", MEXT

■ Figure 1-2-13 / Changes in the No. of patent license permissions and income in universities



Note 1: Dotted lines indicate changes in the accumulation method for the number of executions from FY 2012.
Note 2: The number of patent license permissions indicates cases in which contracts were extended in the year of the survey.
Note 3: Universities, etc. include universities, junior colleges, vocational high schools and inter-university research institutes. National, public and private schools are included.
Note 4: The number of patent license permissions indicates the number of permitted and transferred stages of patent license permissions (including stages of the right to be permitted).
Source: "The present state of Industry-Academia Collaboration in National University" MEXT

Projects to support R&D intended for international standardization have been implemented, mainly by MIC and METI provides projects to improve certification capability for international standardization and support to establish and propose international standards.

(Fostering and retaining human resources to support R&D)

Programs to support human resource foster and retention such as "Priority Support Cooperation Fellowship Program Prioritized research supporter system" (from FY 1995, JST) and "Industrial technology fellowship program" (from FY 2000, NEDO) have been implemented and "Development of a System to Foster and Secure Research Administrator[1] fostering and securing system" (from FY 2011, MEXT) was launched to disseminate this highly professional post in universities.

JST started the "Human Resource Development Program for People Involved in Technology Transfer" in FY 2002 to improve the professionalism of experts (connoisseurs) dealing with technological transfers and industry-academia collaboration to commercialize R&D outcomes at universities and research institutions and connect these experts via a network.

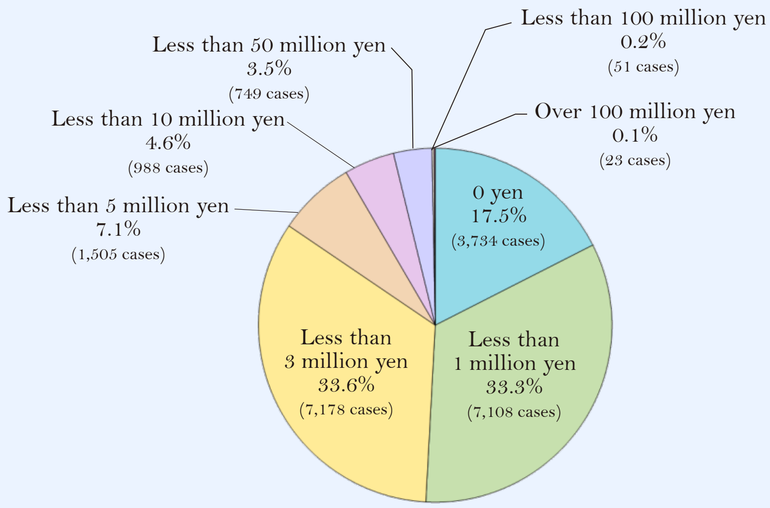
1 Human resources for highly professional posts, responsible for planning and management of research activities together with present researchers and the management and operation of universities and public research institutions in future

3) Issues

About half of all industry-academia joint research is small projects with an annual budget of less than 1 million yen and remaining at the initial stage, targeting the construction of a human network (Figure 1-2-14). An awareness gap remains between industry and university for participation in industry-academia-government collaborative approaches (Figure 1-2-15) and the movement of human resources across industry, academia and government sectors increased very little in this decade (Figure 1-2-16). These circumstances may be related to the suggestion that efforts in industry-academia collaboration has steadily increased, but knowledge and technologies developed by universities have not always been optimally exploited in domestic companies. Career paths of human resources who support research in universities are poorly paid compared with other developed countries[1].

The number of new university ventures has recently shown a downward trend[2], which may be attributable to the difficulty in financing and market development and the shortage of human resources required for venture management[3].

■ Figure 1-2-14 / University budgets for collaboration with companies and independent corporations

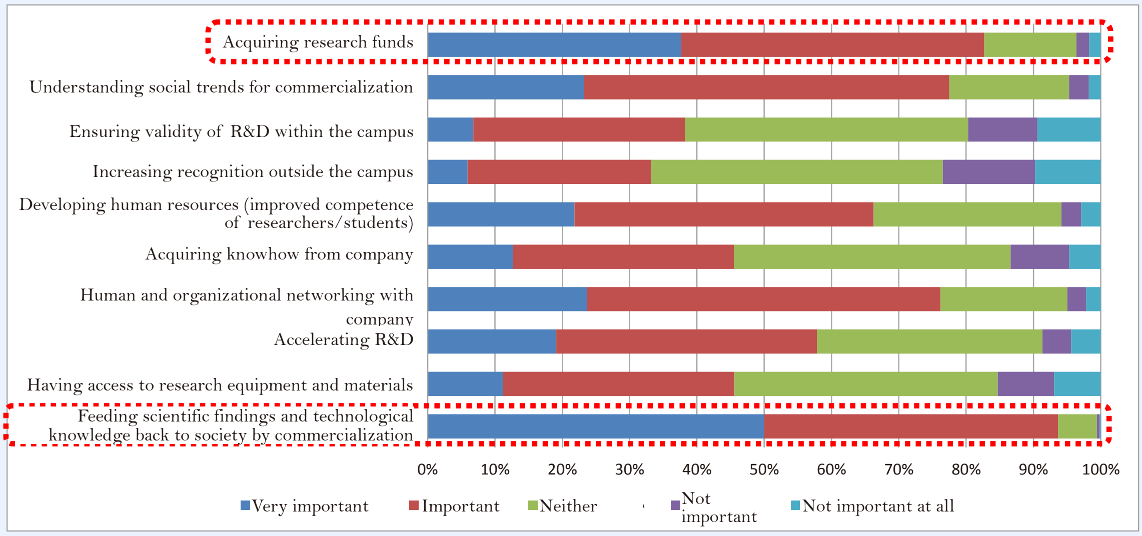


Note: "0 yen" indicates that the research fund was received in another fiscal year for a multiple year contract with the partner.
Source: Booklet -3 "Industry-Academia Collaboration and Development of University Originated Innovation (ver. 3)" (December 2014), National Institute of Science and Technology Policy

1 "FY 2013 Industry-academia collaboration status at universities" related survey, MEXT
2 "FY 2013 Industry-academia collaboration status at universities" MEXT
3 "Survey on university originated venture businesses 2010: Awareness for venture foundation and support and industry-academia collaboration" (2011), National Institute of Science and Technology Policy

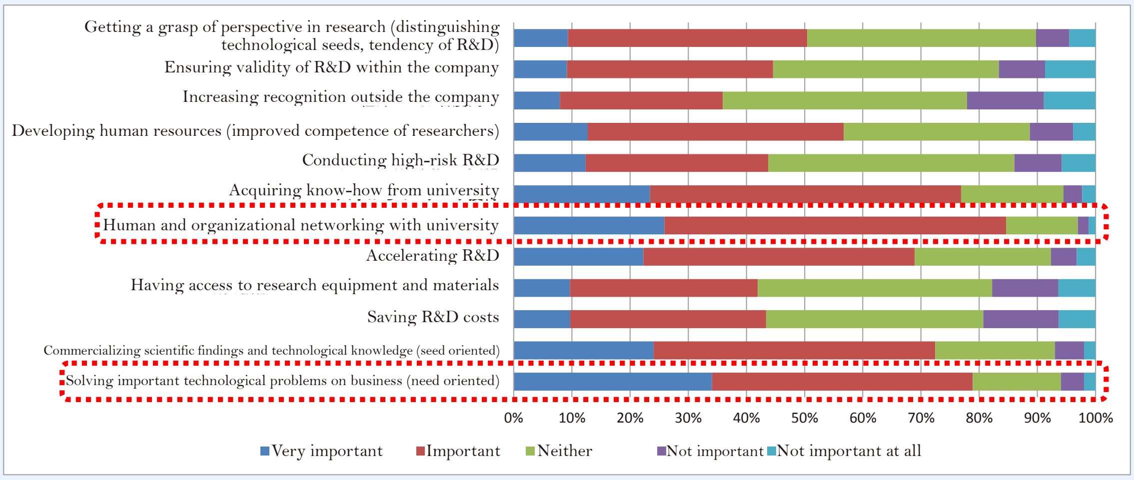
■ Figure 1-2-15 / Reasons for university and corporate researchers joining industry-academia collaboration

[University researchers]



Note: Based on the result of a questionnaire sent to 743 university researchers who took part in industry-academia joint projects and jointly applied for a patent during the period FY 2004 to 2007.

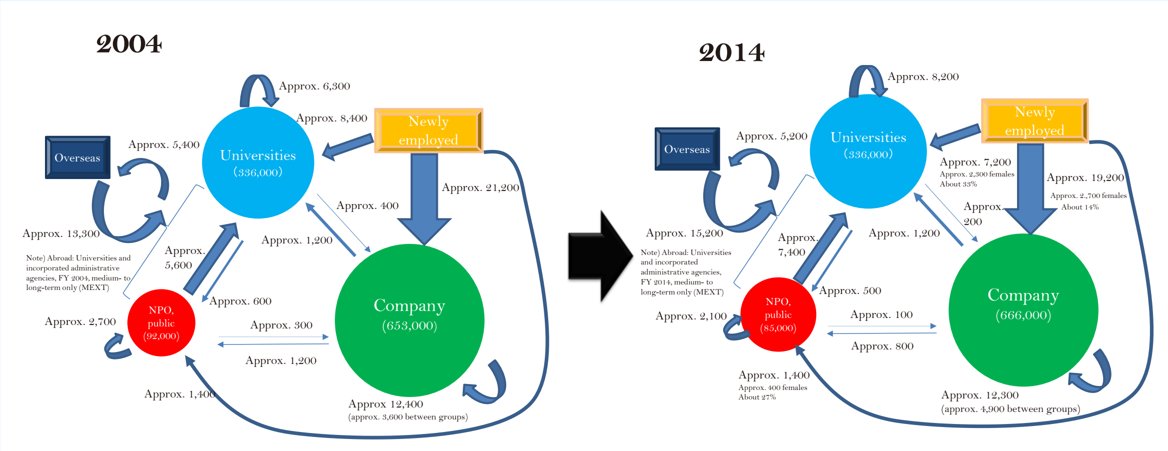
[Corporate researchers]



Note: Based on the result of questionnaire sent to 704 corporate researchers who took part in industry-academia joint projects and jointly applied for a patent in FY 2004 to 2007.

Source: "Knowledge creation and innovation by University: Basic findings from the large-scale survey of academic and corporate researchers" survey material -221, National Institute of Science and Technology Policy, MEXT, Hitotsubashi University Institute of Innovation Research/ <Mission-oriented investigation and research for SciREX>, Working paperWP#13-14 (June 2013), Hitotsubashi University Institute of Innovation Research

■ **Figure 1-2-16 / Changes in inter-sector movements**



Note: Surveys in 2004 and 2014 indicate the results of surveys as of March 31, 2004 and 2014, respectively.
Source: Created by the Cabinet Office based on "Report on the Survey of Research and Development" (2004, 2014), Statistics Bureau, MIC

(3) Regional science and technology

1) Placing in the S&T Basic Plan

The importance of regional science and technology has been continuously highlighted in the Basic Plans to date. The 1st Basic Plan focused on the importance of increasing science and technology facilities closely related to our lives and society and fostering and utilizing coordinators. The 2nd and 3rd Basic Plans sought "Knowledge Clusters" to spark innovation through networks established around public research institutions and connecting private companies. The 4th Basic Plan focused on developing and utilizing human resources to coordinate activities relating to industry-academy-government collaboration and intellectual property.

2) Activities

Based on support for coordinators in the 1st Basic Plan, projects such as the "Knowledge Cluster Initiative" (from FY 2002, MEXT) were launched in the 2nd Basic Plan. An inter-ministry system was developed to support regional science and technology; partly based on the results of the "Industry Cluster Project" (from FY 2001, METI), regions implementing voluntary and outstanding initiatives through industry-academia-government-financing collaboration are designated as "Regional Innovation Strategy Promoting Regions," and supported by the collaborating authorities concerned from research to business deployment phases. In this system, MEXT supports the formation of Intellectual property and human resource development through its "Regional Innovation Strategy Support Program."

MEXT also promotes "Research Complex Developing Program" to provide a combined center for promoting innovation in industry-academy-government collaboration and the "Matching Planner Program" to connect the needs of local companies with seeds from universities nationwide to create value-added, competitive innovations, while collaborating with the work of the "Headquarters for Overcoming Population Decline and Vitalizing Local Economy in Japan" founded in the Cabinet in FY 2014.

3) Issues

As for regional scientific and technological approaches, it has been pointed out that regional science and technology centers have not developed into growth centers in Japan due to the tendency to make a collaborative system only by players in the region, poor human resources, including management talent, to support business deployment with seeds from venture companies and the insufficient participation of local financial agencies.[1]

(4) Research foundation

1) Placing in the S&T Basic Plan

In the 1st Basic Plan, the development of advanced research facilities and equipment was promoted as well as the improvement of aged and declining facilities and equipment in universities and public research institutions. The computerization of R&D information was also promoted by distributing computers to all researcher nationwide, building local area networks (LAN) and providing fast communication and R&D databases. The Basic Plan focused on the importance of implementing an intellectual infrastructure such as measurement standards and biological resources to promote stable and efficient R&D activities.

In the 2nd Basic Plan, five-year facility improvement plans were implemented for facilities at national universities requiring urgent reconstruction, including the resolution of narrow facilities in postgraduate research institutions, development of centers of excellence and revitalization of existing facilities. When developing intellectual infrastructure, a goal of reaching the world's highest standards by 2010 was set in four areas, including study materials such as biological resources etc., measurement standards, methods of measurement, analysis, test and evaluation and advanced instruments and database.

In the 3rd Basic Plan, a comprehensive system was designed to promote the shared utilization of large research facilities and equipment, including next-generation supercomputer, from development to operation and including the development of legal systems. The intellectual infrastructure was localized by designating public research institutions in each region as the core center.

In the 4th Basic Plan, targets were set to maintain the stable operation time and improve the user support system for large-scale, high technology research facilities and equipment to eliminate problems in maintaining and managing such facilities due to reductions in basic research funds allocated to public research institutions with such facilities and equipment, while promoting the shared utilization of the same. At the same time, networking of facilities and equipment which may lead to progress in common and fundamental technologies was targeted to improve efficiency in operation and mutually complementary forms.

2) Activities

(Facilities and equipment in universities)

Maintenance of facilities at national universities has been systematically promoted by MEXT according to 5-year plans since the 2nd Basic Plan. At present, quake-resistant structures and the resolution of narrowness are promoted according to the "The 3rd Five-Year Program for Facilities of National

1 Regional science, technology and innovation in future: Vitalizing local communities through science and technology innovation and realizing affluent and vital society (August 2014, Regional Science And Technology Innovation Promotion Committee, CST Industrial Collaboration and Regional Support Subcommittee)

Universities" (determined by the Minister of Education, Culture, Sports, Science and Technology in August 2011).

A Joint Usage / Research system was built to promote sharing of equipment among national, public and private universities. To use research facilities and instruments more efficiently, MEXT implemented initiatives such as the "Development Program for Research Equipment Support Center" (from FY 2011).

(Research facilities and equipment available for industry-academia-government usage)

A system to promote the wide use of large-scale high technology research facilities by industry, academia and government was developed according to the "Act on Promotion of Shared Use of Specified Large-Scale High Technology Research Facilities" (Act No. 78 of 1994). The shared use of Super Photon ring-8 GeV "SPring-8" was started in October 1997, Japan Proton Accelerator Research Complex "J-PARC" in January 2012, SPring-8 Angstrom Compact Free Electron Laser "SACLA" in March 2012 and supercomputer "K computer" in September 2012. These facilities are located close to each other in Japan and the extensive shared use of such facilities, including for industrial purposes, spawned various outcomes, including the commercialization of low-fuel consumption tires by fine measuring of 3D nanoparticle configuration in rubber (by "SPring-8") and reduced development costs with complete wind tunnel experiment alternatives, etc. in automobile development (by "K computer").

Projects such as the "Nanotechnology Platform Japan" program(from FY 2012, MEXT) and "Construction of Innovative High-performance Computing Infrastructure (HPCI)" (from FY 2012, MEXT) help the enhancement of convenience through common usage procedures in several technological fields and construct a nationwide platform for effective and efficient shared use of advanced research facilities and equipment through mutually complementary use.

(Intellectual infrastructure)

MEXT planned to improve intellectual infrastructure by FY 2010 in its "Intellectual Infrastructure Improvement Plan" (August 2001, CST). According to this plan, the "National BioResource Project" for providing a system of collecting and preserving experimental animals, plants and microorganisms and distributing these experimental subjects among research institutions was started from FY 2002. JST launched the "Development of Systems and Technology for Advanced Measurement and Analysis" from FY 2004 to promote the development of Japanese-made innovative measurement and analytical technologies and equipment.

METI achieved its goal set for "The first Intellectual Infrastructure Improvement Plan" (June 1998, Special Committee on the Development of Intellectual Infrastructure, a joint body composed of the Industrial Structure Council Subdivision on Industrial Technology and the Japanese Industrial Standards Committee (JISC) to raise the intellectual infrastructure to a world-beating level equal to that in the U.S. and Europe by 2010. At present, "The second Intellectual Infrastructure Improvement Plan" (March 2014) dealing with measurement standards, microorganism genetic resources and geological information was implemented based on the 4th Basic Plan. Continued from the first Improvement Plan, AIST and National Institute of Technology and Evaluation (NITE) have been most active in promoting the plan.

(Data infrastructure)

The Science Information Network (SINET) was constructed as data infrastructure for various research activities and had been used more than 2 million people at over 800 universities and research institutions nationwide by the end of FY 2014.

JST provides information on wide-ranging research outcomes at universities through information services such as the platform for the electronic presentation of research papers published by the Academic Society (J-STAGE) (from FY 1999), JST General link center of basis for all STI (J-GLOBAL) (from FY 2008) for systematic storage and distribution of R&D support information and Research map (information sharing platform for the researchers) (from FY 2011) for the central management of information on researchers.

3) Issues

Even when improvements are completed, research institutions and facilities cannot be operated sufficiently and the number of researchers working there is declining due partly to recent reductions in basic research funds for universities and research institutions. In regard of facilities at national universities, earthquake-resistant construction promoted priory after the Great East Japan Earthquake. This made improvements of aged facility slow, this may weaken educational research activities, increasing accidents in life lines, suspending educational research and so on. The data infrastructure in Japan is behind that in other developed countries. For instance, the line speed of SINET is slower than that in major nations[1] and international presentation of research results through scientific journals is insufficient.

Under these circumstances, it is highlighted that universities and public institutions are reluctant to open up their research facilities and equipment to domestic and international researchers due to their lack of understanding of overall research facilities that they own and the fact that researchers active in shared study are not always highly evaluated[2]. Moreover, an increased number of foreign advanced research instruments are used on research sites[3]. This is one of the issues to address to enhance the industrial competitiveness of Japan.

(5) Science and technology diplomacy

1) Placing in the S&T Basic Plan

All Basic Plans emphasize the importance of Japan maintaining a leading position in international cooperation while differentiating the level of cooperation according to circumstances of partner nations and promoting the internationalization of the domestic research environment through overseas visits of domestic research and inviting competent foreign researchers.

After the 3rd Basic Plan, cooperation with Asian nations was focused. Also, the 4th Basic Plan put forward a new theme, “science and technology diplomacy,” in light of national benefits increased by strategic policies through dynamically connecting science and technology with diplomacy.

1 Enhancement of education and research innovative function and development of a science information infrastructure to create innovation: Science Information Network in the Cloud Era: (Summary of Deliberations) (August 2014), Science Information Committee, CST Academic Subcommittee, MEXT

2 “Proposal for sharing of research facilities and equipment at universities: Utilization of research facilities and instruments other than those of university researchers” DISCUSSION PAPER No. 85 (August 2012), National Institute of Science and Technology Policy

3 Scientific Instrument Heritage 2005 and 2013 (R&D Co., Ltd.)

2) Activities

(Overseas visits and invitation of researchers)

JSPS started a "JSPS Postdoctoral Fellowship for Research Abroad" from FY 1982 to support researchers in overseas research. 455 researchers were accepted universities and research institutions in 22 countries and regions in FY 2014 according to this program. Moreover, to invite foreign researchers, JSPS launched "Postdoctoral Fellowship for Foreign Researchers" (from FY 1988) combined with JST's "STA Fellowship Program" (from FY 1998). 240 foreign researchers were accepted according to these programs in FY 2014. JSPS promotes the "Strategic Young Researcher Overseas Visits Program for Accelerating Brain Circulation" from FY 2014 to construct networks connecting research groups in Japan to top-class foreign research groups.

(International cooperation and overseas deployment/international development)

JST and JICA jointly launched the "Science and Technology Research Partnership for Sustainable Development" (SATREPS) in FY 2008 to promote international collaborative research which can help solve global issues and issues in developing countries by linking science and technology with ODA. JST also launched the "Strategic International Cooperative Research Program" (SICORP) in FY 2009 to promote various international collaborative researches according to the circumstances of partners' country and regions. The number of this projects and partner countries concerned has been increasing and reached a total of 30 projects in seven nations and regions as end of March 2014. As one such program, JST started the "e-ASIA Joint Research Program," a multinational collaborative research aiming to solve problems common to Asian nations from FY 2012.

Japan joined large-scale R&D projects through international cooperation, such as the International Space Station Program (construction of which started in 1998 and was completed in 2011) and ITER (International Thermonuclear Experimental Reactor) program (from FY 2007, under construction) etc. These projects not only help maintain and improve the international competitiveness and presence of Japan, but also fuel the progress of science and humans.

(Enhancement of intergovernmental dialog)

Intergovernmental dialog on science and technology that Japan hold has been enhanced to date and 47 nations and regions signed 32 bilateral agreements as of the end of March 2014.

In FY 2008, the "Science and Technology Diplomacy Network" was started to connect MOFA, overseas diplomatic facilities, relevant ministries and incorporated administrative agencies, etc. Major overseas diplomatic facilities designated an "S&T officer" to build and operate the cooperative system.

3) Issues

Low mobility of human resources in the international community is one of the issues facing Japan. For instance, the insufficient number of young researchers working overseas is highlighted[1] and the proportion of foreign researchers and foreign students in Japan tends to be lower than that of most other

1 "2014 Expert Survey on the Japanese S&T System and S&T Activities by Fields," NISTEP REPORT NO. 157 (March 2015), National Institute of Science and Technology Policy

major countries[1]. International joint papers and international mobility of researchers suggest that Japan is potentially outside the center of international research networks[2].

(6) S&T and the society

1) Placing in the S&T Basic Plan

The 1st Basic Plan intended to increase public understanding and awareness of science and technology to foster national consensus to promote science and technology by providing information and places for discussion.

The 2nd Basic Plan based on the importance of communication between S&T and society, allowed researchers to convey the meaning and content of S&T to society in an easily understandable manner. And the Plan pointed out the importance of ethical, legal and social issues brought by S&T.

The 3rd Basic Plan defined "S&T to be supported by public and to benefit society" as one of the basic concepts of the plan. The 4th Basic Plan clearly prioritized science, technology and innovation policies as part of "policies for society and the public," and sought to promote risk communication and develop regulatory science[3] as "S&T to be Created and Promoted Together with Society" in light of the Great East Japan Earthquake.

2) Activities

(Spreading S&T and promoting public understanding)

As well as lectures and symposiums, various projects have been conducted, including the "Science Cafe" held nationwide as a venue for dialog between researchers and citizens and to promote social understanding of S&T, multi-event "Science Agora" (from FY 2006, JST) to provide dialog with researchers and science experiments for children and "Nobel Prize Dialog" (FY 2014, JSPS) held in Tokyo for dialog with Nobel laureates in Japan and abroad.

In FY 2001, JST founded the Miraikan (National Museum of Emerging Science and Innovation) as the center of information distribution and exchange of researchers. The annual number of visitors reached a record-high at 1,008,404 since the founding in FY 2010 and the cumulative visitor total reached 10 million in August 2014.

(Problems caused by S&T and research misconduct)

Ethical guidelines have been developed in relevant R&D areas to solve ethical, legal and social problems. In light of the Great East Japan Earthquake, MEXT implemented the "Program for developing models of Risk Communication in Science and Technology" from FY 2014 to achieve accountability to society concerning the experts involved in risks.

In the wake of research misconduct such as bogus data and data falsification and misuse of public research funds, MEXT revised the "Guidelines for Responding to Misconduct in Research" in August 2014 to reinforce preventive measures for research misconduct, including research ethics education for graduate

1 Nature 490, pp. 326-329 (Foreign researchers), "Education at a Glance 2014" (Foreign students), OECD
2 2014 White Paper on Science and Technology, Fig1-1-25, and Fig 1-1-26
3 The science to adjust S&T achievements to the most desired form in harmony with humans and society through accurate and evidence-based forecast, evaluation and judgment of S&T achievements in use for humans and society

students and young researchers, while relevant ministries have also revised their existing guidelines for research misconduct and misuse of research funds in rules.

3) Issues

S&T communication between scientists/researchers and society is still considered insufficient. Another issue is the decreased reliability of citizens to scientists[1] due to the Great East Japan Earthquake and research misconduct.

(7) R&D institutions

1) Placing in the S&T Basic Plan

Descriptions concerning the reform of universities and public research institutions, which play major roles in science, technology and innovation activities, first appeared in the 2nd Basic Plan and functional improvements through flexible organizations of national universities were recommended. The importance of extensive discretion from managers of public research institutions and the acquisition of external funds was emphasized.

The 3rd Basic Plan addressed the need for reliable measures for basic research funds to reinforce the competitiveness of national universities with various characteristics. The 4th Basic Plan established the creation of a new system for R&D institutes to improve organization governance and management based on R&D characteristics, such as the long-term nature, uncertainty, unforeseeable progress and expertise. Budget allocation measures for R&D institutes were also clearly restated.

2) Activities

National universities were corporatized in April 2004, which improved the organizational research activities and increased both the number of joint research projects with private companies (Figure 1-2-11) and the number of commissioned research projects[2] after institutionalization. MEXT implemented its "University Reform Action Plan" in November 2013 to promote focused support for functional improvement based on the strength and characteristics of individual universities and personnel and salary system reforms as well as improving governance by revising the "School Education Law" (Law No. 26 of 1947) and the "Act of National University Corporations" (Law No. 112 of 2003).

The "Act on General Rules of Incorporated Administrative Agency" (Law No. 103 of 1999) corporatized national experiment and research institutions into incorporated administrative agencies. The effects of this reform include flexible research operations and increased external funds. The Act on General Rules of Incorporated Administrative Agency was revised in June 2014 following a review of the incorporated administrative agency system and administrative agencies, aiming to maximize the R&D outcomes; designated as "national research and development agency" in FY 2015 and provided with more operational flexibility than other incorporated administrative agencies. Moreover, corporations engaged in creative work potentially attaining leading global achievements will be defined as "Specified National Research and Development Corporations (tentative)."

---

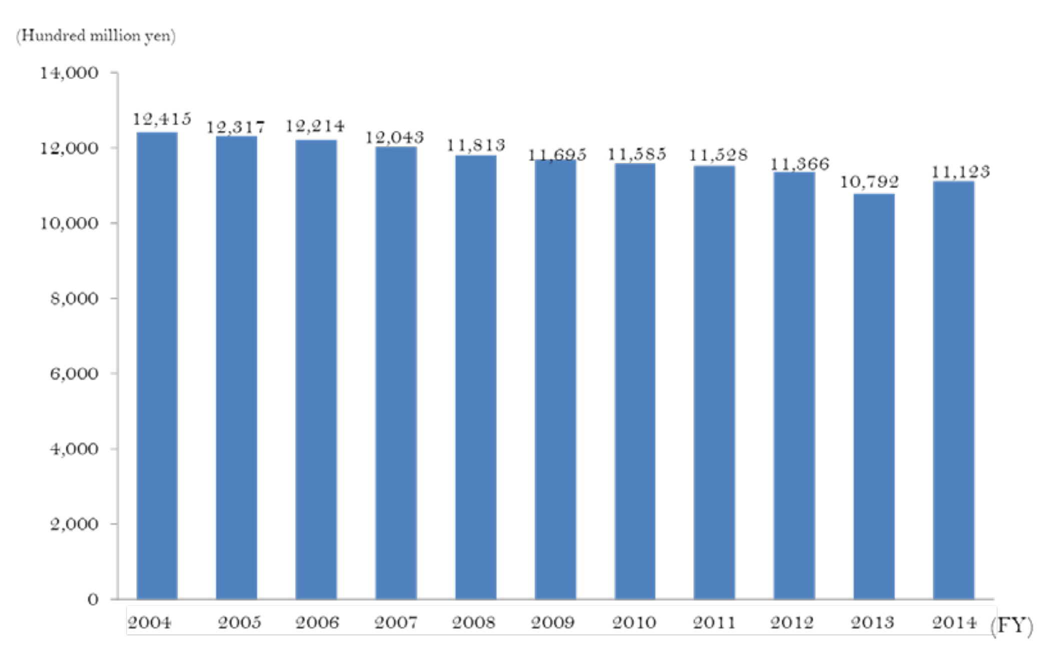
1 "Survey on the Change of the Public Attitudes to Science and Technology" NISTEP REPORT NO 211 (June 2012), National Institute of Science and Technology Policy http://data.nistep.go.jp/dspace/handle/11035/1156

2 "Industry-academia collaboration in universities" MEXT

3) Issues

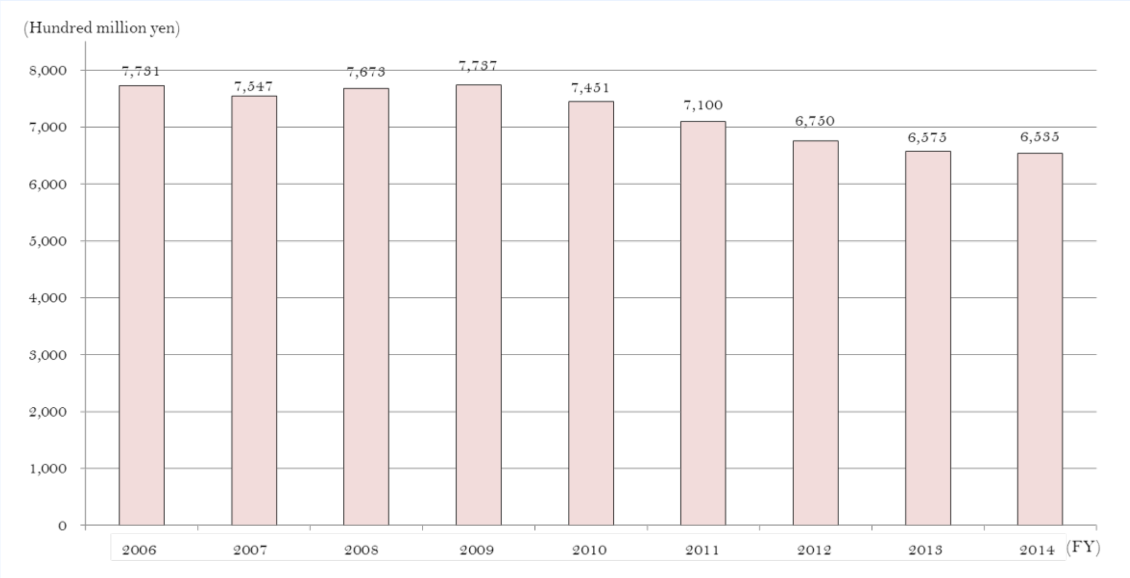
Government subsidies for national university corporations and basic research funds of national R&D institutes have been decreasing almost every year after institutionalization. (Figures 1-2-17 and 1-2-18) This caused problems in universities such as a reduction in the number of stable posts for teachers and researchers, degraded secretariat function and decreased operating research expenditure below a level allowing researchers to continue long-term research. In R&D institutes, various budget and evaluation restrictions have been highlighted as well as reductions of basic research funds. These problems are considered attributable to the failure to allow universities and R&D institutes to exploit their potential by utilizing their inherent characteristics.

■ **Figure 1-2-17 / Changes in government subsidies for national university corporations**



Source: Created by MEXT.

■ **Figure 1-2-18 / Changes in basic research funds for national R&D institutes**



Note 1: The figures in each fiscal year is the initial general account budget for the year.
Note 2: Six national centers for advanced and specialized medical care founded in FY 2010 are excluded from the above graph.
Source: Created by MEXT based on a "Outline of Fiscal Investment and Loan Program," MOF

(8) R&D funds

1) Placing in the S&T Basic Plan

The 1st to 3rd Basic Plans focused on expanding competitive funds, based on the common perception of the importance of a competitive environment for R&D funds. The 1st Basic Plan envisaged a massive expansion of funding, while the 2nd Basic Plan aimed to double the funds during the plan period. The 2nd Basic Plan also decided to introduce indirect costs (30% of direct costs) for management and other work expenditure accompanying the research.

The 3rd Basic Plan decided to reform the operational system, while allocating 30% indirect costs for all competitive fund systems.

The 4th Basic Plan attempted to ease the conditions of the competitive fund system to expand the shared use of facilities and provide intersystem links, as well as allocating 30% indirect costs while ensuring direct costs.

2) Activities

(Reform of the competitive fund system)

The total amount and the number of competitive fund systems have increased and become more diversified in line with the policy of expanding competitive funds throughout the Basic Plans. In 2001, the "Guidelines on the Proper Implementation of Competitive Funds" were determined by the consent of related ministries and indirect costs were introduced in KAKENHI at first and to other competitive funds managed by ministries. Operation has been reformed according to a proposal concerning the lack of continuity of research fund systems and feedback selection.

(Examples of achievements supported by the competitive fund system)

The achievements supported by KAKENHI and JST Strategic Basic Research Programs were explained in Section 2, 1 (1) in this chapter. On the whole, the competitive fund system has grown into a system oriented toward large funds or innovation.

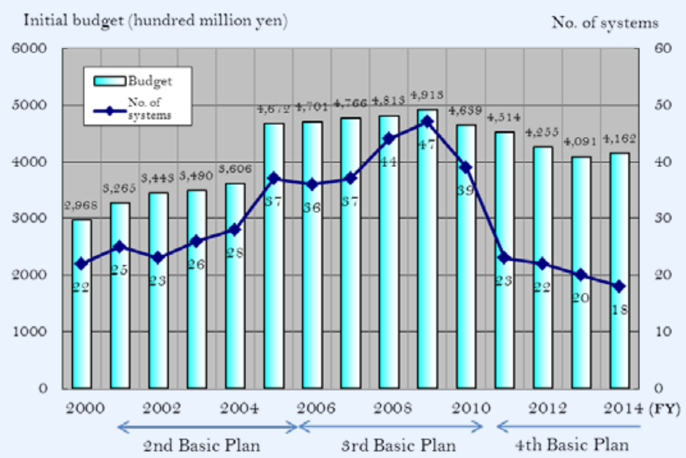
The "Special Coordination Funds for Promoting Science and Technology" established in 1981 and allocated flexibly according to the policy of the Council for Science, Technology and Innovation (former Council for Science and Technology Policy (CSTP)) helped establish for example, the life science research base in Japan through investment in neuroscience and genome science and the development of nanotechnology in Japan, including control and measurement technologies for nanomaterials. The mobility of researchers and leading approaches for diversification have also been implemented, particularly via the "Super COE Program" (FY 2001) to create research centers through organizational reform of R&D institutions, various achievements were attained including the hiring system of specially appointed faculty introduced by the University of Tokyo and now disseminated nationwide.

In FY 2009, the Cabinet Office launched an R&D support program "Funding Program for World-Leading Innovative R&D (FIRST)" including various stages and fields from basic research to create new knowledge to R&D for potential commercialization. This program manages research funds for plural year and provides a "research support organization" to support overall R&D activities to let researchers devote themselves to research. In this program, R&D for about four years has resulted in world-leading outcomes in many research subjects.

3) Issues

The budget and number of competitive fund systems increased until the 3rd Basic Plan, but since stricter requirements were adopted for competitive funds in FY 2010, the number of systems and budget decreased (Figure 1-2-19).

■ Figure 1-2-19 / Changes in budget (initial) and No. of competitive fund systems



Source: Created by the Cabinet Office.

After the 2nd Basic Plan, 30% of competitive funds were provided as indirect costs, which could be used for various indirect costs accompanying the use of competitive funds. With this measure, basic research funds can be used as initially intended, but 30% of indirect costs are not always provided for as costs "of a competitive nature" for funds which are not defined as "competitive funds."

The science, technology and innovation activities at national universities and R&D institutions have been conducted in the form of a so-called dual support system, comprising basic research funds and competitive funds. The recent reduction in basic research funds in universities and R&D institutions is one of the factors causing various problems with current science, technology and innovation policies, including human resources and is cited as a cause for insufficient functioning of competitive funds.

MEXT began discussing the reform of competitive funds from February 2015 at the Investigative Committee of Competitive Research Grants to continuously maximize research outcomes. The ministry also examines competitive research fund reform and university reform in a unified manner to make Japan an optimal nation for innovation.

(9) Evaluation of R&D

1) Placing in the S&T Basic Plan

In the 1st Basic Plan, an optimum evaluation system was to be developed to achieve accurate evaluation, revitalize R&D activities and obtain outstanding results by thoroughly reviewing evaluation procedures in the past while also considering the evaluation circumstances to date. From this point, the Plan also determined to make "National Guideline on the Method of Evaluation for Government R&D" that is common for overall R&D conducted or funded by the government.

In the 2nd Basic Plan, to maintain fairness and transparency of evaluation and reflect the results of evaluation to resource allocation, procurement of resources required for evaluation and development of evaluation were also planned.

In the 3rd Basic Plan, improvements of the evaluation system were planned for evaluation, encouraging a challenge to creation and requesting results, world-class, reliable evaluation and ensuring evaluation that is utilized and promotes innovation, avoiding unnecessary evaluation overlap, maintaining continuity and consistency of evaluation and promoting an overall, effective and efficient evaluation system.

In the 4th Basic Plan, further improvement and enrichment of R&D evaluation system were planned to promote science, technology and innovation policies effectively and efficiently and ensure evaluation results were appropriately fed back to planning of policies.

2) Activities

The R&D evaluation in Japan is based on the "National Guideline on the Method of Evaluation for Government R&D" (determined by the prime minister) (following "National Guidelines") provided according to the Basic Plan and specific guidelines determined by relevant ministries to specify the method of evaluation. For instance, MEXT revised the "Guideline for Evaluation of Research and Development in MEXT" in April 2014 based on the revision of the National Guidelines in December 2012 and recent important issues on R&D evaluation.

National university corporations and inter-university research institute corporations are evaluated based on the "National University Corporation Act" (No. 112 of 2003) and national R&D agencies are evaluated based on the Act on General Rules of Incorporated Administrative Agency, etc. However, national R&D

corporations are subject to evaluation in the Incorporated Administrative Agency system from FY 2015 based on guidelines of purposes and evaluations in which the opinion of the CSTI is reflected.

3 Strengthening of the Control Tower Function and National R&D Investment

(1) Strengthening of the control tower function

1) Placing in the S&T Basic Plan

The Basic Plan continuously suggested strengthening the control tower function of science and technology policies from the 2nd Basic Plan. During the 2nd and 3rd Basic Plans, collaboration with the control tower function of other policy areas was suggested, together with the comprehensive coordination for effective and efficient policy promotion, such as prioritization according to the resource allocation policy and elimination of overlaps in ministry policies, as well as an evaluation of R&D policies and follow-up of Basic Plans.

In the 4th Basic Plan, strengthening of the comprehensive coordinating function of CSTP was planned to further promote science, technology and innovation policies as national strategy and planning of policies based on objective evidence such as promoting "Science for science, technology and innovation policies"

2) Changes in the science and technology promotion system

(Before Central Government Reform)

After the Basic Law came into effect, science and technology policies were mainly promoted by the Council for Science and Technology and Science and Technology Agency in the Prime Minister's Office until the Central Government Reform in January, 2001. The Science and Technology Council comprised ten Diet members (four Cabinet officials, including the Minister of Finance, Minister of Education, Chief of the Economic Planning Agency and Director-General of the Science and Technology Agency, Chairman of Science Council of Japan and five academic experts) chaired by the prime minister and provided comprehensive science and technology policies and long-term, comprehensive research objectives. The Science and Technology Agency has a minister as its director and was responsible for comprehensively coordinating clerical work on science and technology in related administrative offices and the design, implementation of basic research and R&D common to ministries and planning, making, promoting basic science and technology policies.

Each ministry conducts R&D in the relevant policy areas. For instance, the Ministry of Posts and Telecommunications (MPT) promotes R&D of mobile communication system technology and satellite broadcasting technology, METI implements R&D of photovoltaic power generation technology and disseminates the outcomes. The R&D of these ministries helps society progress in Japan.

However, the promotion system at the time lacked comprehensive and strategic policy-proposing capabilities covering the whole nation and resulted in problems such as insufficient government-wide control tower function due to the coexistence of control tower and R&D implementing functions.

(After Central Government Reform)

After the Central Government Reform, the Minister of State for Science and Technology Policy and

CSTP were appointed in the Cabinet Office to discuss comprehensive science and technology policies. CSTP conducts a comprehensive coordination at a higher level than ministries, designs and plans basic policies and allocates resources for the comprehensive and planned promotion of science and technology. The Science and Technology Agency and the Ministry of Education, Science and Culture were integrated into the Ministry of Education, Culture, Sports, Science and Technology (MEXT) which accounts for 60% of the science and technology budget in Japan.

(Recent situations)

Recently, a control tower was provided for individual policies, including the Headquarters for Ocean Policy (FY 2007) and Strategic Headquarters for Space Policy (FY 2008), Headquarters for Healthcare Policy(FY 2013) to achieve comprehensive and planned promotion of policies and with this control tower as a hub, basic policies such as the Basic Plan on Ocean Policy, Basic Plan on Space Policy, “Healthcare and Medical Strategy” (Approved by the Cabinet on July 22, 2014), “Basic Energy Plan” (Approved by the Cabinet on April 11, 2014), “Basic Environment Plan” (Approved by the Cabinet on April 27, 2012), “National Security Strategy” (Approved by the National Security Council and the Cabinet on December 17, 2013,), “Basic Disaster Prevention Plan” (Central Disaster Management Council decision on March 31, 2015), “Fundamental Plan for National Resilience” (Approved by the Cabinet on June 3, 2014) and “Declaration to be the World's Most Advanced IT Nation” (Approved by the Cabinet on June 24, 2014).

In the “Comprehensive Strategy on Science, Technology and Innovation” decided by the Cabinet in June 2013 and based on the notion that strengthening the control tower function is essential to design, plan, comprehensively coordinate and promote science, technology and innovation policies in Japan, the “Cross-ministerial Strategic Innovation Promotion Program (SIP)” and “Impulsing Paradigm Change through Disruptive Technologies Program (ImPACT)” were implemented in the Cabinet Office in FY 2013. In April 2014, CSTP was reorganized to CSTI as part of revision of the Cabinet Office Establishment Act.

(2) National R&D investment

The Basic Plan set a goal for national R&D investment to promote policies implemented in the plan.

After R&D by private companies became popular during the period of high economic growth, the amount of national funds in R&D investment declined and the amount of R&D funds from private companies, that were mainly for application and development research, increased. With trade conflict between Japan and the U.S. in the latter half of the 1980s, a “free ride in basic research” criticism was sparked and restoring the former national-to-private proportion became a policy demand. In response, rapid doubling of national R&D investment was provided in the “Science and Technology Policies” (Approved by the Cabinet in April 1992). In the 1st Basic Plan, around 17 trillion yen was allocated to raise the proportion to GDP ratio to the level of the U.S. or major European nations at the beginning of the 21st century. The result was an investment of around 17.6 trillion yen during the 1st Basic Plan. The goal was attained.

After the 2nd Basic Plan, R&D investment by local governments was included in the target budget. From the perspective of raising the proportion of national investment as a proportion of overall R&D funds to the level of the U.S. and Europe, the national R&D investment was targeted at 1% of GDP. In the 2nd Basic Plan, the target was around 24 trillion yen and the result was around 21.1 trillion yen and in the

3rd Basic Plan, the target was around 25 trillion yen and the result was around 21.7 trillion yen, meaning the expansion of investment failed to attain the goal.

In the 4th Basic Plan, the total public and private R&D investment was set at 4% or over of the GDP ratio and the national R&D investment 1% of GDP, or around 25 trillion yen, but the result was a total of around 22.3 trillion yen, including till the initial budget in FY 2015. [1]

The target was clearly set for the total amount of national R&D investment, continuously through 1st to 4th 5-year Basic Plans to promote science and technology and the policy of Japan for continuous growth through revitalizing economy by science, technology and innovation has been indicated domestically and worldwide.

4 Summary of 20 years of the Science and Technology Basic Plan

This chapter described the 20-year history of the Basic Plans since the 1st Basic Plan was deployed and the major results of core policies, as summarized in Figure 1-2-20.

1 A total amount including the initial budget for FY 2015, but excluding funds from local public authorities in FY 2015

■ **Figure 1-2-20 / 20-year results of the Science and Technology Basic Plan: Main points**

[Main achievements]

○ **Globally-esteemed excellent achievement have been successively obtained** in scientific and basic researches in Japan. Papers are internationally acclaimed, and **highly competent papers are increasing**.

○ Prioritization of science and technology resulted in **the creation of platforms for various S&T fields that are advantageous for Japan**, including life science and nanotechnology/material, and **the results are world class**

○ **The number of researches in Japan has increased to some extend** through the activities specified in the Basic Plans, including the Program to support 10,000 postdoctorals and contractual employment system, and mobility has also been improved mainly among young researchers. An **environment to provide opportunities for success to various human resources** has been constructed through innovations of a number of human resource systems.

○ **Industry-academia-government collaboration has been largely increased over 20 years** through deregulations and institutional reforms for promoting collaboration and exchange of industry, academia and government sectors, support for commercializing research achievements at universities, corporatization of national universities, and restructuring of national experiment and research institutions to incorporated administrative agencies. **Some achievements have an impact to the society**

○ While facilities at universities and public research institutions have been improved and expanded, **a number of cutting-edge research facilities were built at geographically proximate locations**. This **facilitates the utilization by the industry, academia and the government**, and good results have been obtained.

○ The number of foreign researchers at universities and R&D institutes in Japan has gradually increased through **the increased efforts to accept of foreign researchers and send domestic researchers overseas, and internationalize universities**.

○ Focusing on the relationships between S&T and society, **improving the public understanding on S&T, dealing with ethics issues, and promoting the participation of citizens in S&T policies have been implemented**.

○ Corporatization of national universities and restructuring of national experiment and research institutions into incorporated administrative agencies allow flexible operation of researches at these organizations. **The reform of universities and R&D institutes has been promoted** by reforming national university governance and personnel and salary systems, and revising the system of incorporated administrative agencies.

○ **Control-tower function for STI policies has been improved** through changes such as the reorganization of Council for Science and Technology Policy to Council for STI.

○ **The target for the total amount of national R&D investment has been clearly set consecutively** from the 1st Basic Plan to **show the commitment of Japan for STI domestically and worldwide**.

[Major issues]

○ **Excellent researchers are not always placed in the right jobs** due to **unclear carrier path of young researchers, unstable employment, and "generation gap in mobility**." This is the reasons for the **reluctance of students to go to the doctoral course** in these days. There is a sense of uncertainty for securing the human resources for STI in future.

○ **Japan's international position in papers is on the decline in terms of quality and quantity recently. Problems also lie in the decreased diversity and uniqueness of basic researches**.

○ **Full-scale industry-academia-government cooperation is still limited, and mobility of human resources across the industry, academia and government sectors is not sufficient. A system to** produce innovations one after another does **not exist in Japan**.

○ Japan is increasingly **out of the central position in the international research network**.

○ **Insufficient basic research funds interfere universities and national R&D administrative agencies**, which constitute an important sectors to lead STI activities in Japan, **to take their expected, central roles to the full extent**, and also cause **insufficient functioning of the role of competitive funds**.

Source: Created by MEXT.

Since the Basic Law was enacted in 1995, based on the former 4 stages of the Basic Plan, S&T policies have been comprehensively promoted by government as well as prioritized resource allocation, collaboration of related ministries and agencies and strengthening of R&D institutes. An environment to promote science, technology and innovation has been nurtured and the science and technology base of Japan has been reinforced through steady investment in R&D funds and development and procurement of human resources. This is linked to way such initiatives have helped improve our lives and solve global issues. It is a significant result achieved by the policy frame, which means the Basic Law and 20 years of the Basic Plans.

The government is responsible for increasing the impact of investment over 20 years and maximizing the effect of future investment based on accomplishments to date. For this purpose, policies for universities, academia, science, technology and innovation should be implemented with a unified and flexible approach, transcending the organizational and policy framework to resolve ongoing and obvious problems. Science, technology and innovation policies that boost the sustainable development of Japan and the international community must be promoted with close collaboration involving government, universities, industry and any other stakeholders relating to science, technology and innovation policies with flexible association to social changes.