[Tentative translation]

Integrated Innovation Strategy 2022

June 3, 2022
Cabinet decision

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Chapter I Overview (Science, technology and innovation to underpin the virtuous cycle of growth and distribution in the New Form of Capitalism)

1. Basic concept

Integrated Innovation Strategy 2022 (hereinafter referred to as "Integrated Strategy 2022") is the second annual strategy, positioned as an action plan, of the Sixth Science, Technology and Innovation Basic Plan (hereinafter referred to as the "Sixth STI Basic Plan") approved by the Cabinet on March 26, 2021. The Sixth STI Basic Plan sets out the medium- to long-term direction of our country's science, technology and innovation policies toward the realization of Society 5.0 by 2025, with a view to 2030. It consists of major and medium-term goals, as well as a series of programs aimed at achieving those goals. In order to evaluate progress, indicators linked to each goal are listed.

Unlike "Integrated Innovation Strategy 2021[1]", which was formulated almost immediately after the establishment of the Sixth STI Basic Plan, Integrated Strategy 2022 requires flexible review and implementation of policy measures, taking into account not only the recent changes in domestic and overseas circumstances but also the trends of indicators across the first year of the Sixth STI Basic Plan. To this end, the Government will continue to improve the quality of science, technology and innovation policy on a constant basis, with a view to further enhancing the role of the Integrated Strategy as an annual strategy and establishing an effective and efficient policy promotion model, including the formulation process, during the Sixth STI Basic Plan period.

(1) The current situation

Science, technology and innovation are not only generating the driving force of economic growth, but they are also becoming the lifeblood of the nation from the viewpoint of overcoming social issues represented by climate change and ensuring the safety and security of the people against threats such as infectious diseases, natural disasters, and cyber terrorism. In particular, the scope of science, technology and innovation is rapidly expanding as a key means of demonstrating national power, boosting our presence in the international community, and realizing comprehensive security in the face of an increasingly severe security environment, as underlined by Russia's aggression against Ukraine. This is not unrelated to the vulnerability and precariousness of international supply chains, built with an exclusive focus on efficiency, and the constraints on the supply of resources and food on a global scale, which have become strongly recognized in the wake of the COVID-19 pandemic. Furthermore, coupled with development of emerging technologies such as AI and quantum technology at unprecedented speed, technological trends are changing rapidly. Against this backdrop, international competition centered on science, technology, and innovation is accelerating. In order to respond to the rapidly changing times, countries have expanded investment in science, technology and innovation and have been working to transform their industrial structures.

In fact, in the United States, with technology competition with China in mind, President Biden has announced a bold policy of increasing investment in science and technology to about 2% of GDP, and is intending to increase the overall R&D budget by proposing the establishment of Defense Advanced

[1] Cabinet decision on June 18, 2021

Research Projects Agency (DARPA)-type organizations in fields such as health care and infrastructure. A similar trend can be seen in the United Kingdom, where a bill was passed in February 2022 to establish the Advanced Research and Invention Authority (ARIA), which will provide high-risk, high-reward funding by building an integrated system from agenda-setting to budget execution under a clear science and technology mission. In Europe, Horizon Europe, a seven-year research and innovation framework program launched in 2021, is accelerating economic recovery from COVID-19 by leveraging green investment, allocating at least 35% of its total budget of 95.5 billion euros to climate change measures, an increase of more than 20% from the previous period. In addition, the Global Approach to Research and Innovation, an international cooperation strategy announced in May 2021, set forth a policy that emphasizes ensuring open strategic autonomy for the European Union. In addition, the European Council endorsed the Strategic Compass in March 2022, which provides guidance for the next decade and defines a coherent set of actions that will help to secure EU interests and protect European citizens in all aspects of its security and defense policy. In addition to bolstering investments in defense technologies and industrial infrastructure, it also calls for eliminating strategic dependencies on emerging technologies such as AI, quantum technology, biotechnology, and materials. Under China's 14th Five-Year Plan, which began in 2021, R&D expenditures increased by 14.2% over the previous year, reaching an annual average increase of more than 7%, which is the target figure. In addition to these developments, the impact of Russia's aggression against Ukraine has led to a review of science and technology cooperation between Russia and the West, and the situation remains unpredictable.

Meanwhile, Japan's research and innovation capacity is on a relative decline. Taking research capacity as an example, in recent years, our ranking in terms of the number of highly cited papers (adjusted top 10% papers for number of citations) has declined significantly[2], although it should not be judged one-sidedly only by indicators that are easy to grasp quantitatively. In terms of innovation, Japan's ranking in global competitiveness reports has long been stagnant.[3] In order to overcome this critical situation and to strongly advance science, technology and innovation policy, Japan set a target of approximately 30 trillion yen for the government as a whole and 120 trillion yen for the public and private sectors combined for research and development investment over the five years from FY2021 in the Sixth STI Basic Plan, which greatly exceeds the target of the 5th Basic Plan. It also aims for Society 5.0, a "society that is sustainable and resilient in the face of threats and uncertain situations, ensures the safety and security of the people, and enables each and every person to realize diverse well-being".

The total budget for science and technology during the period of the Sixth STI Basic Plan, including the initial budget for FY2022, now stands at approximately 12.4 trillion yen, making steady progress toward the achievement of the government target. In addition, conditions are being met to utilize new funding that did not exist at the time of the formulation of the Sixth STI Basic Plan, such as the 10 trillion-yen University

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[2] According to "Science and Technology Indicators 2021" (August 2021) published by the National Institute of Science and Technology Policy of the Ministry of Education, Culture, Sports, Science and Technology, Japan's ranking in the number of adjusted top 10% papers in terms of the number of citations dropped from fifth (2007 – 2009) to tenth (2017 – 2019) compared to 10 years ago. Calculated by fractional counting.

[3] For example, in the Global Competitiveness Ranking published in June 2021 by Swiss business school IMD, Japan ranked 31st out of 64 major countries and has remained in the 30s since 2019. Although it scores highly in some categories such as employment and scientific infrastructure, the efficiency of government and business is generally rated low.

Endowment Fund and the program to foster critical and emerging technologies for economic security. As countries move toward a post-COVID-19 world, beginning with the easing of measures to combat COVID-19 in Europe, we must continue to harness these resources with foresight to invest in basic research, foster human resources and social implementation. We must tackle important national issues through science, technology and innovation by attracting private investment and public-private partnership and cooperation.

(2) The government's agenda

The Kishida Cabinet, which was inaugurated in October 2021, set out a vision in which Japan would lead the realization of the "New Form of Capitalism", in light of the current trend in countries around the world toward building a new capitalism that emphasizes sustainability and "people" and leads to new investment and growth, through a virtuous cycle of growth and distribution. The realization of a nation based on science and technology is the first pillar of Japan's growth strategy. Our country will work to establish world-class research universities, and make bold investments in research and development of advanced science and technology in order to outstrip in fierce competition with other nations.

The government has also made economic security an important pillar of the New Form of Capitalism, including radical funding startups to realize a "second renaissance" following the post-war renaissance, promoting the Vision for a Digital Garden City Nation, to revitalize rural areas through the use of digital technology, and fostering and supporting leading-edge important technologies vital to economic security.

In addition, since people are the driving force behind creating added value through ingenuity and new ideas and driving economic affluence and power, the central pillar of the distribution strategy is to drastically strengthen investment in people. Fostering human resources in the field of science and technology, a driver of innovation, is truly an investment in the future catering to the next generation.

This agenda for the realization of the New Form of Capitalism cannot be achieved without sustained economic growth and the resolution of social issues. In this sense, it is in line with the vision for Society 5.0, a people-centered society that balances these goals. At the same time, it is no exaggeration to say that the principle of "a virtuous cycle of 'social transformation through Convergence Knowledge (So-Go-Chi)' and 'investment in knowledge and people'" presented in the Sixth STI Basic Plan embodies the virtuous cycle of growth and distribution in science, technology and innovation policy. In an age in which science, technology and innovation are so closely entwined in all areas of the economy and society, it is urgent to drastically strengthen their contribution as a trigger for converting societal issues into engines of "growth" while making the best use of Convergence Knowledge (So-Go-Chi). This can also be a trump card for bringing a real sense of growth through social implementation and leading to "distribution" in the form of an investment toward the next endeavor.

To this end, it is important to assess the advantage and indispensability of Japan's cutting-edge science and technology and based on this, clearly delineate a strategic process for realizing Society 5.0, which aims to resolve global challenges, achieve sustainable economic growth, and expand our contribution to the international community while developing international partnerships and cooperation. It is also essential that the government and the private sector share this vision as the Scenario to Goals, and that the government and the private sector flexibly work to further give shape to this policy direction and vision under the Sixth STI Basic Plan so that they can mobilize across organizational and sectoral boundaries.

From this perspective, Integrated Strategy 2022 should play a major role in improving predictability through the clarification of priority measures for the year. If the fruits of R&D are to be delivered to the people, society and local communities, we must foster a virtuous cycle of growth and distribution through science, technology and innovation.

2. The three pillars of science, technology and innovation policy

In light of recent changes in domestic and international circumstances, the importance of ensuring the safety and security of the people and the well-being of each individual has never been greater. In this sense, the society that Japan aims for will not waver from Society 5.0 in any way, but rather must realize it with a greater sense of speed and urgency. To focus on the important measures that need to be taken as soon as possible, science, technology and innovation policy can be broadly divided into three pillars.

One of the basic pillars is to strengthen the knowledge base and foster human resources in lockstep, and to continuously create new "knowledge" as a source of science, technology and innovation. Leveraging the establishment of a 10 trillion-yen University Endowment Fund, the Government will not only develop internationally outstanding research universities, but also promote basic research and academic research to produce diverse and preeminent knowledge by strengthening the functions of regional core universities and universities with specific niches. We will also build a foundation for broad and multilayered knowledge throughout the country. Furthermore, for all universities, we will strengthen the development of diverse human resources such as doctoral candidates who lead creative research without being bound by the rigid framework of the science versus the humanities or boundaries between fields. At the same time, we will promote recurrent education that meets changing social needs over time and address the demand from those pursuing self-development. Doing so will ensure that the intellectual assets generated by universities flow back to society.

Another basic pillar is the strategic promotion of R&D by strengthening sectoral strategies and think-tank functions, with a view to enhancing the self-determination over Japan's economic structure and ensuring the advantage and indispensability of our technology, as well as fostering technologies that will enable Japan to advance. In light of the fact that Japan remains superior in technology but inferior in its application, the government will formulate new strategies in AI and quantum technologies and evolve a think tank that conducts research and analysis on key advanced critical technologies. We will identify the Scenario to Goals in line with social needs and steadily pursue initiatives that lead to social implementation, such as the program to foster critical and emerging technologies for economic security and the Next Cross-ministerial Strategic Innovation Promotion Program (SIP). Applying the knowledge and human resources from the aforementioned pillars will build strong momentum here. In addition, the government and the private sector will work together to address important national issues such as the digital transformation (DX) of society with the Digital Agency as the control center, the expansion of assistance provided by the Green Innovation Fund, and the enhancement of resilience the semiconductor industrial bases. Japan will make a fully-fledged comeback in areas where it should be leading the world.

At that point, the central pillar will be to shape an innovation ecosystem and chart a new path of economic growth, to overcome societal challenges that are difficult to deal with based on existing ideas, and to return the benefits of science, technology and innovation to the people, society and communities. Our aim is to

revitalize the economy and society by focusing on startups as key innovators and creating new businesses, including narrowing the rural-urban divide through digital transformation. This will unleash the potential of Japan's talented people, especially Gen Z and other youth generations and drastically strengthen the startup ecosystem, characterized by a succession of deep tech and digital startups that harness Japan's world-leading strengths. Furthermore, in addition to initiatives for the development of the venture capital market, the government will utilize all policy tools, such as R&D Promotion Tax System, the SBIR system, and the promotion of public procurement of research results, to induce private capital to expand R&D funding both for the public and private sectors.

In particular, following the formulation of the Sixth STI Basic Plan, starting with the establishment of a 10 trillion-yen University Endowment Fund, progress was made in formulating the "Final Report on the Future of Research Universities Standing Up to the World[4]", the "Comprehensive Promotion Package for Regional Core and Distinctive Research Universities[5]" and the "Policy Package for Education and Capacity Building for Society 5.0[6]." On the other hand, with the establishment of the program to foster critical and emerging technologies for economic security, which aims for research, development and demonstration from a different perspective than before, there is growing impetus for research and development of cutting-edge science and technology such as AI and quantum technology that addresses important national issues including the strengthening of economic security. Based on these changes in the environment, the intellectual assets and technological seeds developed by the previous two core pillars will serve as the game-changing wings to propel us into the future. We will dramatically develop the startup ecosystem that forms the core of the main pillar, and through the creation of new industries and the regeneration of existing industries, the social transformation highlighted in the Sixth STI Basic Plan will be attained. Forging that path is the core concept of Integration Strategy 2022.

In this way, the science, technology and innovation policy is expected to embody the administration's agenda of establishing Japan a world leader in science and technology, thoroughly supporting startups, pursuing the Vision for a Digital Garden City Nation, and ensuring economic security through integrated efforts including (1) enhancement of knowledge base (research capabilities) and human resource development, (2) creation of innovation ecosystem, and (3) strategic promotion of advanced science and technology, and in turn contribute to the realization of the New Form of Capitalism.

In light of the fact that approximately one year has passed since the formulation of the Sixth STI Basic Plan, the following section examines notable trends during the year and identifies priority measures in line with these three pillars. In addition, Chapter 2 provides an analysis of the implementation status and current status of the measures organized in accordance with the table of contents of the Sixth STI Basic Plan, future plans, and lists specific annual measures. Integrating these measures, the government will set priorities centered on the three pillars and comprehensively advance the Sixth STI Basic Plan, while strongly promoting science, technology and innovation policy toward the realization of Society 5.0.

(1) Enhancement of knowledge base (research capabilities) and human resource development

[4] Decision of the Council for Science, Technology and Innovation on February 1, 2022

[5] Decision of the Council for Science, Technology and Innovation on February 1, 2022

[6] Decision of the Council for Science, Technology and Innovation on June 2, 2022

① Promotion of next-generation research bases led by the 10 trillion-yen University Endowment Fund and university reform

Enhancing the research infrastructure with the University Endowment Fund

In future, universities—central players in the innovation ecosystem—will need to play an even greater role in producing graduates who will lead society, generating world-class research findings and creating university-originated startups that will lead social transformation in order to reverse the current decline in the international competitiveness of Japanese universities and their weakened financial foundations. This will require universities in Japan to become world-class research universities by attracting talented human resources and abundant funding. To this end, University Endowment Fund of approximately 10 trillion yen will be established. Research capabilities at Japanese research universities will be drastically enhanced by utilizing the investment profits to provide long-term and stable support for the research infrastructure. In addition, with the aim of fostering world-class research universities, the government will promptly establish a new framework under which the national government will certify universities as universities for research excellence if they meet the following requirements: (1) generation of internationally outstanding research results; (2) highly effective and ambitious business and financial strategies; and (3) an autonomous and responsible governance system. The government will also start the process of selecting target universities as early as possible during FY2022. The government also plans to submit to the next ordinary Diet session a bill to revise the National University Corporation Act, which would enable governance based on council system. From FY2024, the government will provide comprehensive support, including grants from the University Endowment Fund, to the universities for research excellence.

Support for doctoral students

In response to the major challenge of improving the environment for younger researchers in particular, such as the falling rate of advancement to a doctoral program (18.7%: 1981 → 16.7%: 2000 → 9.7%: 2021), unstable employment for young researchers, and the decrease in the number of research hours they have available, efforts have been made to improve conditions based on "the comprehensive package to strengthen research capacity and support young researchers[7]" and the Sixth STI Basic Plan. For doctoral students, in particular, approximately 8,800 students will be funded (the total amount of assistance will be more than twice the existing level) through Support for Pioneering Research Initiated by the Next Generation, University Fellowship Program and other sources, providing an amount equivalent to living expenses and research expenses. In addition, the government will implement fully-fledged long-term paid internships, which began in FY2021, so that young researchers can create a vision of a career path to not only in academia but also in a wide range of fields and industries. Furthermore, the system of discovering (matching) outstanding young researchers by companies with universities will continue. The government will also consider improving the treatment of doctorate holders working as national public employees, diversifying their career paths and progressively following up on "the comprehensive package to strengthen research capacity and support young researchers".

[7] Decision of the Council for Science, Technology and Innovation on January 23, 2020

Improving the research environment for young researchers

In order to improve Japan's research capabilities, it is vital to secure excellent researchers, especially younger ones, and create an environment in which they devote themselves to their research. However, the proportion of the full-time university faculty aged under 40 has decreased to about 20% (from 29.5% in FY2001 to 22.1% in FY2019), and the proportion of national university faculty under 40 years of age on limited-term contracts has also increased to about 70% (from 38.7% in FY2007 to 68.2% in FY2021). These and other issues associated with unstable employment in young researchers have become apparent, making the improvement of the environment for young researchers an urgent matter. Therefore, in order to create an environment in which excellent young researchers can take on the challenge of becoming independent researchers while ensuring sufficient time to devote to research, the government will disseminate to universities the supplementary edition of the Guidelines for Reform of Personnel and Payroll Management published in December 2021 and build a sustainable research workforce by securing posts for young researchers throughout the organization and supporting the development and activities of young researchers. For this reason, with regard to budgetary support for national universities, the government will evaluate the implementation of personnel and salary management reforms, including the formulation of medium- to long-term personnel plans and the utilization of external funds for personnel expenses, and will continue to make efforts to reflect these in the allocation of national university grants. In addition, the program of Fusion Oriented Research for disruptive Science and Technology (FOREST), which provides integrated support, securing stable research funding and an environment in which researchers can devote themselves to research for up to 10 years, targets a diverse researchers gaining independence to continue to take on free, challenging and fusion-oriented concepts without fear of risk. Based on the assessment of the impacts of the system related to the improvement of the research environment in the program and the review of other research funding programs, this program will promote stable support for researchers while striving to enhance the program with a view to making it permanent.

A research environment that allows full focus on research

The decrease in research time is a problem that leads to a decline not only in research capabilities but also in the attractiveness of research as a profession, and is thought to be one of the causes of the decrease in the number of doctoral degree holders, the source of our future research capabilities. Therefore, in the course of FY2022, the government will consider measures to create research environments in which researchers can devote themselves more freely to cutting-edge research, such as sharing of research facilities and equipment, promoting the management and utilization of research data, and promoting the use of university research administrators (URAs) and support staff, in cooperation with support measures for universities such as the University Endowment Fund and the Comprehensive Promotion Package for Regional Core and Distinctive Research Universities.

Promotion of careers for women in research

From the viewpoint of increasing the diversity of research, it is necessary to further accelerate the development of female researchers by eliminating the gender gap. However, while there is an increasing proportion of women in full-time university faculty from year to year, it is still below 30% (26.4% in

FY2021), and the percentage of female professors (university president, vice president, professor) among faculty has been increasing year by year, it is still below 20% (18.2% in FY2021). Therefore, based on the Sixth STI Basic Plan and the Fifth Basic Plan for Gender Equality[8], the government will continue to steadily enact initiatives to further promote the careers of female researchers, including in leadership positions. These include supporting the efforts of universities and public research institutes to enhance diversity in the research environment, such as accommodating life events like childbirth and childcare with research and promoting female researchers' activities. In addition, the government will promote an initiative to consider the period of life events in terms of the age limits set forth in the application guidelines for public funding programs for young researchers, as well as strengthen initiatives to encourage female junior high school and high school students to choose careers in science and engineering.

Promotion of internationalization

In order for Japan to produce outstanding research, it is important to increase opportunities for overseas training and experience so that researchers can gain experience of different research cultures and environments overseas and engage in diverse active intellectual exchanges. However, the number of researchers dispatched overseas for the medium or long term has been on a decreasing trend in recent years (from 7,674 in FY2000 to 4,178 in FY2019), and the number of foreign researchers hosted for the medium or long term has remained flat (from 13,878 in FY2000 to 13,280 in FY2019). Thus, Japan is falling behind in international brain circulation among research network countries. To overcome this situation, it is an urgent task to internationalize our universities. Therefore, based on the results of studies on the international development of science and technology, the government will strongly promote international joint research in various R&D projects to strategically boost Japan's active participation in cutting-edge research through international open calls for collaboration, which are now very common around the world. In addition, the government will systematically and continuously promote the formation of hubs for international brain circulation, including the new World Premier International Research Center Initiative (WPI) research hubs to be established in FY2022, in order to develop attractive research hubs and build an international research network of students, researchers and others.

Promotion of management and utilization of publicly funded research data

The "National Data Policy: Principle on Management and Utilization of Publicly Funded Research Data[9]," which was formulated to promote the management and utilization of research data based on open and closed strategies in light of the globally accelerating trend to digital transformation of research activities (Research DX), stipulates that researchers identify research data to be managed and provide its metadata. The metadata can be retrieved on the NII Research Data Cloud, the core infrastructure for research data, so that data users from industry, academia or government can quickly and easily access research data. To this end, the government will introduce a mechanism to assign metadata to all new research using public research funds by FY2023. As a pilot initiative, advanced data management has been adopted for the Moonshot Research and Development Program, and based on the knowledge and use cases gained, similar

[8] Cabinet decision on December 25, 2020

[9] Decision of the Integrated Innovation Strategy Promotion Council on April 27, 2021.

data management will be introduced in the next SIP. In addition, the government will consider the provision of metadata in related organizations and research fields, the formulation of data policies on the part of organizations engaged in R&D, the inclusion of research data in institutional repositories, the development of funding programs for researchers to provide metadata, and capacity building.

Development of infrastructure supporting research DX, sharing of research facilities and equipment, and promotion of data-driven research

In April 2022, the integrated development and operation of the ultra-high-speed, large-capacity network infrastructure (SINET) with the research data infrastructure began. The government will continue to advance this infrastructure and the research and development of necessary technologies. At the same time, we will consider measures to develop the settings for this to be utilized not only as an academic information infrastructure but also as a public infrastructure to harness the knowledge of universities in cooperation with the private sector. The government will also continue the steady operation of the Fugaku supercomputer and its wide use by academia and industry, and will promote R&D and improvement of the utilization environment to accelerate the generation of findings so that Japan can flexibly respond to the challenges it faces. In addition, in FY2022, a review of the specific performance and functions of next-generation computing resources and survey on the development of elemental technologies will begin, based on the guidelines compiled in March 2022. In addition to the development and upgrading of such research infrastructure, advanced shared facilities and large-scale research facilities, the government will establish a sharing system by FY2025 by disseminating the "Guidelines for Shared Use of Research Facilities and Equipment" and promoting the formulation and publication of policies by universities and other institutions for sharing research facilities and equipment internally and externally.

Furthermore, in promoting data-driven research, we will strengthen the creation, integration, management, and utilization of materials data on the Materials DX Platform, while passing this knowledge on to other fields. In the biosciences/life sciences including genome analysis, global environment, oceans, disaster prevention, mathematical science, humanities, social sciences and beyond, we will promote data-driven R&D and infrastructure/environment to support it, and work to build a national research data infrastructure to manage and utilize research data across fields and institutions.

② Promotion of regional core and distinctive research universities

In February 2022, the "Comprehensive Promotions Package for Regional Core and Distinctive Research Universities" was formulated so that motivated and diverse universities could fully demonstrate their unique strengths and characteristics, lead local economic and social development, resolve domestic and international challenges, and strive for the international development of distinctive research. After that, while evolving the package, necessary support will be sequentially implemented such as developing human resource based on regional characteristics and needs; fostering universities that conduct world-class research in specific fields; forming attractive bases and promoting partnerships such as "co-creation platforms" for industry-academia-government collaboration; strengthening support for universities that contribute to solving regional issues through collaboration between various ministries, and encouraging strategic management of universities to develop their strengths and distinctive features will be provided,

harnessing the latest digital technology.

③ Promotion of inquiry-based/STEAM education and recurrent education

Formulation of the Policy Package for Education and Capacity Building for Society 5.0

The Education and Capacity Building Working Group was established under Council for Science, Technology and Innovation (CSTI) with the participation of members of the Central Council for Education and the Industrial Structure Council. The working group formulated "the Policy Package for Education and Capacity Building for Society 5.0" in June 2022. The package consists of the following three policies: (1) diversification of "time" and "space" in learning that emphasizes children's distinctive characteristics; (2) establishment of an ecosystem that supports inquiry-based and STEAM education throughout society; and (3) overcoming the division between humanities and sciences and closing the gender gap in science and mathematics education. The package sets out a roadmap of measures to be taken by the relevant ministries and agencies over the next five years. In collaboration across ministries and agencies, follow up will be conducted on this roadmap, while working on implementation and demonstration from the perspective of innovation, assembling policies in an agile manner, discussing them professionally at CSTI and in other venues, and deepening the measures.

Drastic strengthening of inquiry-based and STEAM education

To enhance inquiry-based, STEAM, and entrepreneurship education at the elementary and secondary levels, based on "the Policy Package for Education and Capacity Building for Society 5.0", the government, from FY2023, will make colleges of technology(KOSEN) the hub of STEAM education for elementary and secondary school students, provide opportunities for students to experience high-level inquiry at universities and other institutions, reform the general high school curriculum, build a platform to connect schools and their students with companies, universities, and research institutes that support inquiry-based, STEAM, and entrepreneurship education, expansively promote public-private partnership projects that encourage study abroad from the high school stage through society as a whole, and develop a community using science museums and other venues for dialogue and collaboration. In addition, to boost the Super Science High School (SSH)-designated schools initiative, the government will fund the deployment of coordinators and experts to promote cooperation between SSH-designated schools and other schools and universities in their region.

The curriculum and educational guidelines of children with specific talents in a particular field, including participation in out-of-school programs, will be concluded during 2022, and implemented from those that are possible.

Elimination of the gender gap in mathematics and science

In order not only to increase the number of potential bearers of knowledge that contribute to the improvement of research diversity, but also to realize the individual well-being in all its diversity, it is important to promote the career development of female researchers, encourage the independent career choice among young people, and eliminate the disengagement of girls from science. Therefore, in order to eliminate gender biases related to in the study of science and mathematics and gender roles among parents,

schools, and the wider community, the government will continue to implement initiatives to encourage female middle and high school students to choose science and engineering paths. From FY2023, the government will disseminate information and hold events to foster a social movement in cooperation with industry, present role models who have made careers harnessing their science and mathematics backgrounds, and conduct a large-scale survey and factor analysis of the reasons why women are not choosing to pursue science and mathematics.

Enhancement of recurrent education

It is necessary to establish a system in which society as a whole rewards those who relearn and continue to learn, to adapt to changes in the economic and social structure, and to create an environment in which those who wish to can receive diverse and high-quality recurrent education. In addition, countries with higher participation in work-related adult learning tend to have higher labor productivity per hour[10]. Recurrent education also has the potential to transform industrial structures. Therefore, in order to ensure that individual learning is evaluated appropriately, the government will promote transparency of academic records, required abilities and study, and the evaluation of learning in companies. In addition, the government will enhance support and improve the conditions for those who are willing to learn with a new menu of training support grants included in a package of measures worth 400 billion yen over three years. In addition, the government will create opportunities for students to study by setting up forums to promote dialogue and collaboration on recurrent education among industry, academia and government, and by strengthening recurrent education at companies, universities and other institutions.

(2) Creation of innovation ecosystem

① Thorough support for startups and promotion of fund circulation involving private funds

Developing a world-class startup ecosystem

A world-class startup ecosystem is essential to unleash the potential of young people with outstanding skills and abilities produced at universities and other institutions and to continuously create innovations that lead to new industries and societal change.

In order to support the creation and growth of startups based on social needs and create Japanese unicorns that will take on the world, we have been actively engaged in the revision and effective operation of the Japanese version of the SBIR system (hereinafter referred to as "SBIR system"), the designation of startup ecosystem hub cities and the strengthening of collaboration between hubs and universities, more gap funding, the establishment of the Platform for unified support for startups (Plus) and the development of a startup funding programs.

Due to the implementation of these startup policies and growing investment by venture capital (hereinafter referred to as “VC”), the amount of funding for Japanese startups increased from 533.4 billion yen in 2020 to 780.1 billion yen in 2021. The number of startups created and unicorns is also increasing. However, the startup ecosystems in other countries are growing much faster– and the gap is widening. In addition, many startups in Japan are domestically oriented and small, and it is difficult to say that they have

[10] OECD Programme for the International Assessment of Adult Competencies (2012, 2015, 2019)

formed an ecosystem that matches our economic status.

To this end, in order to develop an innovation ecosystem centered on universities that will serve as a source of innovation and to create large-scale startups centered on the deep tech field, and the digital field including Web 3.0 with its tremendous growth potential, the government will promote the enhancement of hub cities functions and the strengthening of the SBIR system, as well as the strengthening of the foundations of growth-oriented capital circulation and capacity building.

Growth-oriented funding cycle formation

It is necessary to create a virtuous circle in which Japan's funding pool, which is among the world's deepest and has potential as growth capital, with individuals such as angel investors, long-term investment funds such as pensions and insurance, and record-breaking internal reserves and cash and deposits of companies, is pushed into circulation in long-term investments in startups to create innovation in society. Successful entrepreneurs and others who have created social and economic value can in turn become angel investors themselves.

To this end, efforts will be made to promote the adoption of fair value assessment for VC funds in order to promote VC investment among institutional investors, to promote favorable conditions such as the sharing of audit practices related to such assessments, to drastically strengthen domestic risk money using public funds as a trigger, and to strengthen relationships between Japan and foreign VC. In addition, from the viewpoint of stabilizing the livelihoods of risk-taking entrepreneurs, the stock option system needs to be revised from the viewpoint of acquiring excellent human resources in Japan and overseas, and there needs to be an improvement of conditions such as the establishment of a market for the purpose of trading unlisted stocks as introduced in foreign countries and stronger funding at the pre-seed and seed stage including R&D support for deep tech startups through cooperation with domestic and overseas VC.

Strengthening the human resources infrastructure

To provide incentives to entrepreneurs and employees to create startups that will drive growth, we will review the stock option system as necessary. At the elementary and high school levels, the government will drastically strengthen inquiry-based, STEAM and entrepreneurship education, and provide opportunities for all university students who wish to start their own businesses to receive high-quality entrepreneurship education and support from mentors and accelerators.

Strengthening cities and universities

In the startup ecosystem hub cities in Japan, the issues include a shortage of growth capital, human resources, information, and options for global expansion support, especially in regions outside metropolitan cities. In order to accelerate the global expansion of startups, the government will enhance global acceleration programs and promote efforts to strengthen startup ecosystem functions through cooperation between local governments and universities. In addition, it is essential to attract excellent entrepreneurs to generate startups that can expand globally. Supports such as babysitting subsidies will enable such people to play an active role even while raising young children. To develop a system that is internationally competitive, the government will also consider measures adopted in other countries such as issuing startup

visas to founders and startups that have received invested or been adopted by government-accredited VCs, incubators or accelerators.

Strengthening universities and boosting startups are twin axes of innovation. The potential of new technologies born from high-quality basic research needs to be translated into businesses that can take the world by storm. Therefore, we aim to form an ecosystem that will produce world-class businesses in collaboration with top foreign universities and VC in order to advance the vision of a startup campus that has both research functions in the deep tech field and startup incubation functions.

Furthermore, as the importance for startups of an intellectual property strategy as a determinant of the success or failure of a business becomes more recognized, the government will develop the conditions for sustainable innovation by building a startup-focused intellectual property ecosystem.

Strengthening the SBIR system and the use of government procurement

In April 2021, the SBIR system was transferred to the Act on the Revitalization of Science, Technology and Innovation to create a new system focused on generating innovation, with the Cabinet Office as the control center, and that strengthens continuous funding by progressively selecting initiatives across central government agencies. The system is on the cusp of full launch, but there are challenges such as an insufficient amount of SBIR subsidies for startups compared to the United States. To this end, the government will drastically expand the scope and scale of "designated subsidies" under this system, and consider promoting the participation of startups in research and development funds budgeted in recent years and expected to be spent in the future. It will also drastically improve the usability of the system for startups.

It is also important to use government procurement to nurture startups. Government procurement procedures will be revisited with a view to facilitating the participation of startups, such as the qualifications to participate in bidding. The government will consider making it possible to enter into discretionary contracts with J-Startup selected companies with advanced new technologies in the same manner as the procurement method for R&D results under the SBIR system.

Strengthening industry-academia-government collaboration and innovation

In order to promote the creation of new value through industry-academia-government collaboration, efforts have been made to promote industry-academia-government joint research, strengthen the matching of young researchers with industry, and support the formation of sustainable industry-academia-government collaboration projects and the upgrading of projects to a higher level. As a result, the amount of joint research funding received by universities and other institutions from private companies more than doubled from 45.2 billion yen in FY2013 to 96.1 billion yen in FY2019 and 106.2 billion yen in FY2020. However, the situation is expected to be severe for the time being due to the impact of COVID-19. Therefore, the government will strongly accelerate the matching of knowledge held by universities and national research and development agencies with social needs and establish open innovation hubs in order to further strengthen intersectoral collaboration and integration.

In addition, efforts have been made to clarify the requirements for innovative management and to select excellent companies. To further promote corporate innovation, the government will continue to develop the conditions so that companies taking on the challenge of innovation management are valued strongly by the

capital market, and under which companies such as those that pursue corporate diversity are able to thrive in global competition and respond to new societal challenges.

Expansion of research and development investment by revitalizing the flow of funds

While investment in science, technology and innovation is growing significantly in other countries, Japan must secure a bold scale of government R&D investment and use this as a springboard to expand R&D investment by the public and private sectors if we are to win out in the fierce competition among countries. In the Prime Minister's policy statement at the 205th session of the Diet in October 2021, he stated that "We will boldly fund research and development in advanced science and technology, including in the areas of digital, green, artificial intelligence, quantum, bio, and space. We will realize a tax system that provides all-out support for investments into the future made by private sector companies" toward becoming a science and technology nation.

During the term of the Sixth STI Basic Plan, while paying due attention to the constant improvement of the quality of science, technology and innovation policy and fiscal sustainability, the government will steadily expand the budget for science and technology and lead the international R&D competition to reach the targets of approximately 30 trillion yen in government R&D investment and approximately 120 trillion yen in public and private sector R&D investment. At the same time, we will take necessary measures to induce private investment by mobilizing all policy tools, such as the R&D Promotion Tax System, the SBIR system, innovation in government projects, and public procurement of research findings.

② Accelerating the Vision for a Digital Garden City Nation

The Vision for a Digital Garden City Nation, first discussed in FY2021, calls for promotion of smart cities in conjunction with initiatives for Super City and Digital Garden Health Special Zone. Therefore, it is necessary to create good examples of diverse initiatives that make use of local resources and present them to local governments to further encourage their own initiatives and their implementation.

Currently, the smart city project is moving from the demonstration stage to the implementation stage. In addition to disseminating information via the smart city public-private partnership platform, the joint review committee selected projects in August 2021 and promoted the integrated implementation of smart city projects with support from relevant ministries and agencies for local public-private implementation in cities. The government will focus on setting out a long-term roadmap, the further elaboration of measures and initiatives by the public and private sectors supporting the roadmap, consideration of issues for sustained action, the creation of support hubs, training and other areas, and will further study the application of standards and R&D with a view to social implementation.

The government will also promote the utilization of research data through the use of research digital infrastructure and, promote industry-academia-government collaboration with regional universities at its core as well as open innovation based on the Comprehensive Promotion Package for Regional Core and Distinctive Research Universities, which aims to contribute to solving community issues through digital transformation in various fields. In addition, through coordination of efforts to form district hubs in various fields centering on universities and startups, venues for the development of managers to lead community initiatives will be established, building up the personnel and ecosystems to tackle community issues.

(3) Strategic promotion of advanced science and technology

① Promoting national strategies for key technologies and responding to critical national issues

AI technology

Based on AI Strategy 2021[11], updated after the follow-up to AI Strategy 2019[12], the relevant ministries and agencies have cooperated to steadily advance education reform, reconstruction of the research and development system, social implementation, development of data-related infrastructure, ethics and other issues. Based on the results of these efforts to realize a better social economy and people's lives as soon as possible, AI Strategy 2022[13] was formulated in April 2022 with an emphasis on the promotion and strengthening of AI in social implementation, as well as measures for imminent crises such as large-scale earthquakes such as the Tokyo Metropolitan Inland Earthquake and the Nankai Trough Earthquake, large-scale volcanic eruptions including Mt. Fuji, and large-scale disasters such as heavy rain that are becoming more severe and frequent due to the impact of climate change. Based on this strategy, the following initiatives will be prioritized. With regard to AI, in light of the fact that efforts will also begin from the viewpoint of economic security, relevant measures will be coordinated so that the government as a whole can effectively prioritize.

- To promote social implementation of AI, priority will be placed on deep learning, which is expected to be used widely and effectively in areas such as image recognition and natural language processing. Keeping in mind social implementation of AI by private companies, we will work to improve the reliability of AI, enhance the data that supports AI utilization, further foster conditions including human resources, technical information, and rules for handling data related to AI, promote AI utilization in government, and integrate AI into areas where Japan has competitive advantages.
- In order to cope with imminent crises, digital twins will be created as a foundation for AI utilization, AI will be applied to sustainability such as global environmental issues, and initiatives for realizing Responsible AI will be pursued such as Explainable AI.

Biotechnology

The relevant ministries and agencies have been collaborating on measures to realize the world's most advanced bio-economy in 2030 based on the Bio Strategy Follow-up[14], a refinement of Bio Strategy 2019[15] and Bio Strategy 2020[16]. Furthermore, global bio-communities in the Tokyo and Kansai regions were certified in April 2022. This opportunity must be leveraged to put the implementation stage of the strategy on a solid track toward the expansion of this market domain. To achieve this, the following measures in particular will be pursued based on the Bio Strategy Follow-up.

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[11] Decision of Integrated Innovation Strategy Promotion Council on June 11, 2021.

[12] Decision of Integrated Innovation Strategy Promotion Council on June 11, 2019.

[13] Decision of Integrated Innovation Strategy Promotion Council on April 22, 2022.

[14] Decision of the Integrated Innovation Strategy Promotion Council on June 11, 2021.

[15] Decision of Integrated Innovation Strategy Promotion Council on June 11, 2019.

[16] Fundamental measures: Decision made by Integrated Innovation Strategy Promotion Council on June 26, 2020, Definitive Edition of Market Domain Measures: Decision made by Integrated Innovation Strategy Promotion Council on January 19, 2021

- By the end of FY2022, the government will compile a "Package of measures for the growth of bio-communities (tentative name)" and promote the concentrated input of various policy resources to bio-communities. In addition, the development and utilization of bio-manufacturing demonstration bases, which are the core of the bio-communities, will be accelerated, thereby speeding up the expansion of market domains through the integration of biotechnology into existing industries and the creation of new industries.
- In conjunction with the Clean Energy Strategy, the government will accelerate the bio-manufacturing revolution across the entire economy as an innovation to pursue both economic growth and solutions to social issues by strengthening biotechnology R&D and social implementation in a wide range of fields. These include innovative materials and fuels, as well as harnessing CO2-absorbing microorganisms such as hydrogen bacteria whose functions have been enhanced by biotechnology as a trump card against climate change.
- Taking advantage of the characteristic of biotechnology, its applicability to a wide range of fields, the government will accelerate biotechnology-based multidisciplinary fusion. This includes joint development with players from different fields harnessing synthetic biology, bearing in mind the fostering of microorganism design platform businesses that will form the core of bio-manufacturing. It also includes development of the basic technologies, establishment of hubs and acceleration of capacity building, pursuing the Action Plan for Whole Genome Analysis, collaboration and development of the results of the three major bio-manufacturing banks, and enhancement and reinforcement of the smart breeding platform based on the Green Food System Strategy and the Big Data Utilization Platform for Biological Genetic Resources.

Quantum technology

Based on the Quantum Technology and Innovation Strategy[17], the Quantum Technology Innovation Hubs were launched in February 2021 as an industry-academia-government collaboration to carry out everything from basic research through to social implementation. In September 2021, major Japanese companies joined forces to establish the Quantum Strategic Industry Alliance for Revolution (Q-STAR).

Meanwhile, since publication the strategy, the environment surrounding quantum technology has changed significantly, with intensification of global competition in the quantum industry centered on overseas private companies, the rapid progress of DX triggered by the COVID-19 pandemic, and the full-fledged efforts to realize carbon-neutral society. Given the explosive growth of data and communication volumes in the future and the decrease of the working-age population in Japan, high-speed, real-time processing of vast amounts of data and a productivity revolution will become indispensable for creating growth opportunities for our industries and solving social issues. The role of quantum technologies such as quantum computers and quantum cryptography, which are superior in computational complexity and security, is expected to grow. Quantum technology is also extremely important from the viewpoint of economic security. We must possess advanced technologies at home, develop human resources capable of realizing them in the future, secure supply chains for the key basic parts and materials, and respond to cyber

[17] Decision of the Integrated Innovation Strategy Promotion Council on January 21, 2020.

attacks.

Under these circumstances, in order to realize the transformation of society as a whole with an eye on the future society by utilizing quantum technology, the "Vision of Quantum Future Society"[18] was formulated as a new strategy in April 2022. Under this vision:

- By integrating quantum technology into the entire socioeconomic system, there will be opportunities for new industrial growth and resolving social issues in Japan through hybridization with computer science such as AI and advanced simulations, information and communication technologies such as 5G/Beyond 5G[19], and conventional (classical) technological systems such as semiconductors and measurement and sensing technologies;
- Utilization of leading-edge quantum technologies will be promoted (test bed development for quantum computers and communications, etc.);
- New or revitalized industries and startups harnessing quantum technology will emerge.

Based on these three basic concepts, the goals for 2030 are:

- 10 million quantum technology users in Japan
- Production value of quantum technologies of 50 trillion yen
- Quantum unicorn ventures pioneering future markets

and initiatives are being put in place to achieve these goals. To this end, the government will fundamentally strengthen R&D in each technology domain (quantum computers, quantum software, quantum security and networks, quantum measurement, sensing/quantum materials) with a view to providing services through the hybridization and integration of quantum technology and conventional (classical) technology systems, as well as improving the user environment. The groundwork will also be laid for innovation, such as the creation and activation of startups, the enhancement of the quantum technology innovation hubs network, the development and securing of human resources, standardization of quantum technology intellectual property, international cooperation/industry-academia-government collaboration, outreach activities, and the improvement of economic security and the business environment.

Materials

Materials are fields of key basic technologies that are a strength of Japan's industry and academia as well as key elements of the growth strategy for the New Form of Capitalism: science, technology and innovation, the Vision for a Digital Garden City Nation, net-zero greenhouse gas emissions and economic security. Given the growing global awareness of ESG and SDGs, and the intensifying competition in the materials industry due to the entry of manufacturers from emerging economies, R&D must become more efficient, faster, and more sophisticated using data and AI based on Japan's strengths. To this end, based on the Materials Innovation Strategy[20], the following initiatives will be strongly pursued based on priority themes:

- Common facilities and equipment capable of capturing high-quality data will be further developed,

[18] Decision of the Integrated Innovation Strategy Promotion Council on April 22, 2022.

[19] Key infrastructure for the Society 5.0 era with features of next-generation 5G such as ultra-high speed and high capacity, ultra-low latency, ultra-massive connectivity, ultra-low power consumption, ultra-security and ultra-reliability. It is expected to start service around 2030 as the basis of all industries and social life in the 2030s.

[20] Decision of the Integrated Innovation Strategy Promotion Council on April 27, 2021.

data collection and management systems enhanced and the AI analysis base strengthened to promote data-driven research in the field of materials.

- The government will harness predictive tools using data and AI and promote the application of data management knowledge across ministries and agencies, as well as the fully backing data-driven R&D
- that contributes to decarbonization and overcoming resource constraints from the perspective of strengthening Japan's R&D capabilities and industrial competitiveness.
- With regard to manufacturing processes, which are the source of competitiveness in the materials field, the government will work on the developing and upgrading the basic technologies for acquiring data on highly reliable fine ceramics, functional chemicals, etc., as well as the establishment and utilization of process databases.

Strategic applied fields to be addressed[21]

Health and medical care

Based on the Healthcare Policy[22] and the Plan for Promotion of Medical Research and Development[23], the following initiatives will be pursued:

- In order to promote research and development in the medical field, the government will promote integrated research and development from the basics to practical application in the medical field, centering on support from AMED, in cooperation with other funding agencies, in-house research institutes, and private companies. At the same time, the government will promote challenging research and development in the Moonshot Research and Development Program and accelerate the rapid social implementation of cutting-edge technologies.
- In terms of regenerative /cellular medicine and gene therapies, based on fruits of fundamental research to date, practical applications such as development of treatments, drug discovery, etc. as next-generation medical treatments will be promoted. Specifically, initiatives will include promoting strongly clinical research and trials of new medical technologies, R&D oriented toward commercializing these medical technologies, supports for exploring new markets by startups, strengthening the manufacturing platform for cells and vectors (media by which introduce genes to cells) utilized in treatments, and human resources development, leading to practical application of effective technologies. Looking ahead, in addition to genome editing technology, revolutionary R&D and infrastructure development will be pursued including next-generation iPS cells with high differentiation efficiency or low immunological rejection, organoids (miniature internal organs that are created artificially in vitro) which can examine drug efficacy etc. tailored to individual characteristics, as well as R&D of exosomes that are secreted from cells, aiming at application to diagnosis and treatment of disease.
- In order to improve the R&D environment in the medical field, personnel and mechanisms at clinical

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[21] The environmental and energy fields are described in the latter part of this section (Promoting social change and disruptive innovation to overcome global challenges). The fields of safety and security are described in the latter part (Building a resilient, safe and secure society) and Chapter 1, 2 (3) (2).

[22] Cabinet decision on March 27, 2020

[23] Decision by Headquarters for Healthcare Policy on March 27, 2020

research core hospitals will be prepared, experts including biostatisticians and specialists in regulatory science will be secured or developed, and there will be awareness raised and improvement of regulatory science in R&D.

- In preparation for future pandemics and in order to research and develop safe and effective vaccines as quickly as possible in the event of an infectious disease emergency, AMED will tap funds to support R&D with a view to innovative outcomes for industry, academia, and government through new drug discovery methods, form world-class R&D hubs, foster drug discovery ventures, and develop dual-use vaccine production bases by autumn 2022, based on the Strategy for Strengthening Vaccine Development and Production Systems[24].
- AMED will support research and development on effective treatments for COVID-19 and emerging/re-emerging infectious diseases as part of a fundamental strengthening of the emergency preparedness and response to infectious diseases.
- As a platform for the utilization of data obtained from AMED-funded R&D, the government will study a mechanism for the safe, secure and efficient utilization of quality-controlled data has been in industrial and academic R&D, with the aim of launching operation as soon as possible.
- To create new industries, the government will focus on health management to advance the healthcare industry outside the public insurance system, promote regional and occupational cooperation, and promote efforts to improve the health of individuals.
- The Action Plan for Whole Genome Analysis will be revised promptly and intensive whole genome sequencing for cancer and intractable diseases will start in FY2022, and research and drug discovery will be advanced by harnessing accumulated data, aiming at efforts on a scale of 100,000 genomes as seen in the United Kingdom and other countries.

Space

Based on the Basic Plan on Space Policy[25] and the Roadmap, following initiatives will be steadily pursed:

- The Constellation of the network of numerous small satellites will be in place by 2025 through Public-Private Partnership in order to enable the speedy grasp of the situation from outer space regardless of time or weather conditions in the event of large-scale disasters. Verification of optical communications using the constellations of small satellites, which is considered to be an important technology for the future, will be further pursued. The research and development of the space network basic technologies necessary for improved space communications, such as quantum cryptography, will be advanced. Research and development of satellites for disaster prevention, building national resilience and the addressing of global challenges will also be pursued.
- In order to enable more private satellite launches from Japan, the measures will be pursued to raise international competitiveness of domestic flagship rockets such as the H3 launch vehicle. Simultaneously, the commercialization of small private rockets, the development of space ports and nurturing personnel to support these efforts will be pursued.

[24] Cabinet decision on June 1, 2021

[25] Cabinet decision on June 30, 2020

- In order to drastically reduce the cost of space transportation, based on the Innovative Space Transportation Roadmap, research and development of future space transport systems including reuse of airframes will be promoted through Public-Private Partnership, and necessary environment for such development will be established.
- The Constellation comprised of seven Quasi-Zenith Satellite System satellites will be realized in order to enable the stable positioning. For improving the accuracy of predicting phenomena such as stationary linear mesoscale convective systems, the production of next-generation geostationary meteorological satellites with the latest observation technologies such as three-dimensional atmospheric observation will be started in FY 2023 and aimed to be in operation in FY2029.
- In pursuance of the Martian Moons eXploration (MMX) Program and the Artemis program, which includes manned activities on the Moon, the development of transportation means on the lunar surface (crewed pressurized rover) and the realization of Japanese astronauts' landing on the lunar surface in the latter half of the 2020s will be pursued. Space science and exploration to generate new knowledge such as the world's first sample from the Martian sphere will also be promoted. In addition, as for the International Space Station (ISS), which is expected to serve as a demonstration site for the Artemis program, the government will examine the extension of its operation including the issue of expanding the participation of private companies.
- Japan will promote cooperation with the United States, Australia and India in the space sector.

Oceans

Based on the Basic Plan on Ocean Policy[26], the following initiatives will be strongly pursued:

- Efforts will be made to conserve the marine environment, promote maritime industries, and contribute to net-zero greenhouse gas emissions by tackling marine plastic pollution; developing and demonstrating technologies for the investigation of marine resources such as rare earths-rich sediment; promoting the introduction of offshore wind power generation in light of the Offshore Wind Industry Vision (Phase 1) published in December 2020; studying the practical application and dissemination of tidal power generation, a type of ocean energy; developing and demonstrating technologies for Carbon dioxide Capture and Storage (CCS); and, as a contribution to measures against climate change in the international maritime field, establishing international rules to promote the development and practical application of low-carbon and decarbonization technologies for vessels and the development of new vessels with improved environmental performance.
- As an Arctic policy initiative, the Arctic research vessel will be built with the aim of launching in FY2026. Based on the Joint Statement adopted at the 3rd Arctic Science Ministerial in May 2021, Japan will engage in observation and research through international cooperation, nurturing of researchers and the collaboration with Indigenous peoples, and will advance the observation and research in the Arctic where observation data is missing, and contribute our scientific knowledge and evidence, which are Japan's strengths, to discussions at the Arctic Council and rulemaking on the Arctic issues to enhance our national presence.

[26] The third Basic Plan on Ocean Policy was approved by the Cabinet on May 15, 2018. The Basic Act on Ocean Policy stipulates that the Basic Plan on Ocean Policy be reviewed approximately every five years.

To strengthen Maritime Domain Awareness (MDA), efforts will be made to build an unmanned ocean observation system that utilizes autonomous underwater vehicles (AUVs) and smart sensing cables, with the aim of improving the sophistication and efficiency of ocean observation technologies in order to make maximum use of vast Japan's Exclusive Economic Zone. Additionally, to enhance the ocean data sharing and utilization, we will improve the functions of advanced information sharing system. Specifically for the MDA Situational Indication Linkages (MSIL), we will set up the environment for the steady promotion of ocean data linkage by FY2022.

Food, Agriculture, Forestry and Fisheries

In light of the emergence of risks concerning global food supply and demand, it is important to ensure food security in Japan, which depends on imports for much of its food and farming supplies. In order to develop the primary industries and ensure a stable food supply in the future, it is essential to establish a food system that achieves both productivity improvement and sustainability. Such a system would also contribute to ensuring food security. To this end, based on the Green Food System Strategy, from a medium- to long-term perspective, the Government will promote innovations in the procurement, production, processing, distribution, and consumption of food and supplies in the agriculture, forestry, and fisheries industries, such as maximizing the use of local resources, decarbonization, labor-saving and productivity improvements, with the aim of achieving a rich and varied diet. In particular, efforts will be strengthened with a focus on the following three points: early implementation of smart agriculture, forestry, and fisheries; contribution to achieving net-zero greenhouse gas emissions by 2050 and pursuit of resource recycling; and realization of sustainable and healthy food, as set forth in the Agriculture, Forestry, and Fisheries Research and Innovation Strategy 2022, which was formulated based on the recent social, economic, and policy conditions in Japan and trends in research and development.

Creating new value through the fusion of cyberspace and physical space

To realize the Society 5.0, digital twin implementations by utilizing state of the art technologies including AI are fundamental elements to form a digital society. The Digital Agency was established in September 2021 as the government's observatory with a view to developing the digital society. Under the National Data Strategy[27], the government is developing the infrastructure for data utilization, such as a base registry, digitalization in quasi-public fields such as education, healthcare/care management and disaster risk management, and the realization of a framework for securing trust, through the cooperation of relevant ministries and agencies led by the Digital Agency. The government and related organizations, led by the Digital Agency, will continue to work together to build a digital society.

National data strategy

In order to create new businesses and administrative services utilizing data, further concrete initiatives will be pursued under the National Data Strategy. Discussions are progressing on specific data specifications for base registries, development and expansion of digital infrastructure, platforms, trust

[27] Cabinet decision on June 18, 2021

infrastructure, and -human resource development in the data field.

Countries around the world are also developing and pursuing data strategies based on the belief that data is foundational to their national wealth and global competitiveness. However, social implementation of e-local governments, the base registry and the platform necessary for linking AI and data in Japan lags behind some of Europe's technologically-advanced countries and the efforts of the big four U.S. giant tech companies, GAFA.

For this reason, the government will clarify the ideal form of the base registry, which will be the basis of services utilizing data, and identify use cases. The ID system will be set up, the data identified, and other issues tackled to realize the base registry by the end of FY2022, with the aim of fully implementing the system by 2025. To activate public and private sector data utilization services, the full-scale operation of connectors, which serve as the technology for the data linkage infrastructure, will begin, consideration of rules to promote data distribution and eliminate impediments will be accelerated, and the platform will be launched and establish as infrastructure. In addition, the government will consider the establishment of a data transaction market and steadily promote social implementation such as the establishment of an information bank. At the same time, it is important to coordinate with the AI strategy with regard to AI utilization in social implementation of the data strategy and the development of AI-ready workers for.

Building digital twins

In order to construct digital twins, it is necessary to take in information about various things that constitute the physical space in the form of data. It is also important to enhance the data that can be utilized by AI by making reference easier through standardization of data and initiatives such as linking up dispersed databases. For this reason, in the field of autonomous driving, efforts have been made to build a three-dimensional map infrastructure with various uses including mobility in mind, such as establishing the concept of dynamic maps under the Strategic Innovation Promotion Program and working on the creation and dissemination of traffic environment information, and to develop more advanced measurement and positioning technologies for this purpose. Nevertheless, in the field of disaster prevention, which utilization of this technology is highly anticipated, further efforts are required. Based on AI Strategy 2022, with the cooperation of the relevant ministries and agencies, efforts will be made to efficiently construct digital twins and establish systems for their operation.

Building a data linkage platform

It is desirable to promote the use of data by AI, for example, by appropriately linking databases built for various sectors. For this reason, in addition to efforts to develop related technologies necessary for intersectoral data linkage infrastructure, the Ministry of Internal Affairs and Communication (MIC) put together Practical Guidance for Data Handling Rules on Platforms v1.0, which describes the approach for implementing data handling rules on platforms, with a view to their practical application in the future. New knowledge gained through addressing issues identified in the process of implementation and operation of rules will be reflected in updates to the implementation guidance as necessary. In addition to establishing technologies for developing data linkage platforms that provide the data linkage infrastructure (tools), the utilization environment, and the rules necessary for data linkage, various related matters will be considered

with a view to international data circulation, such as implementation of rules and initiatives to appropriately secure trust, in R&D projects conducted under the AI Strategy. The effective use of data generated by schemes and projects will also be tackled as a cross-cutting initiative across government ministries and agencies.

Development and next-generation social infrastructure suitable for using AI

In order to upgrade the communications infrastructure for using data and AI, MIC will promote R&D and international standardization with the aim of progressively implementing Beyond 5G, the next generation of ICT infrastructure, from 2025. As part of the creation of conditions for AI utilization, core research and development based on the AI strategy will steadily be pursued, in addition to improving and upgrading data infrastructure and computing resources.

Promoting social change and disruptive innovation to overcome global issues

Addressing climate change issues

Since the formulation of Integrated Innovation Strategy 2021 in June 2021, various initiatives have been announced to address the issue of global warming in Japan and overseas. Global movement toward decarbonization has been accelerated. For example, the 26th session of the Conference of the Parties of the United Nations Framework Convention on Climate Change (COP 26) held in the United Kingdom from October to November 2021 adopted a decision which includes a statement calling on the Parties to implement ambitious climate action by 2030 and net zero emissions by around mid-century, on the basis of the best available scientific knowledge. In Japan, the announcement of the FY2030 Emission Reduction Targets in April 2021 and the revision of the Act on Promotion of Global Warming Countermeasures[28] in May 2021 were followed in October by the Cabinet approving the Sixth Strategic Energy Plan, the Plan for Global Warming Countermeasures, and Japan's Long-term Strategy under the Paris Agreement under the newly inaugurated Kishida Administration.[29] In October 2021 Prime Minister Kishida also announced to formulate a Clean Energy Strategy which has been considered by the relevant ministries and agencies in a cooperative manner. In the Interim Report of May 2022, measures for energy security and decarbonization based on it, and measures for economic, social, and industrial structural reform toward a carbon-neutral society have been set out. The relevant ministries and agencies will continue to cooperate and elaborate on the measures.

The Progressive Environment Innovation Strategy[30] and Green Growth Strategy Through Achieving Carbon Neutrality in 2050 will continue to be steadily pursued based on the results of the integral follow-up conducted by the relevant ministries and agencies. In addition, the Green Innovation Fund, which was established in conjunction with the Green Growth Strategy for Carbon Neutrality by 2050 to provide continuous support for the research, development and application of innovative technologies, plans to successively launch its projects.

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[28] The achievement of a decarbonized society by 2050 (net-zero greenhouse gas emissions by 2050) was enshrined in law.

[29] Cabinet decision on October 22, 2021

[30] Decision of Integrated Innovation Strategy Promotion Council made on January 21, 2020.

Promotion of global cooperation in the development of green energy technologies is also important. Through continuous coordination with the international community, the functions of related research centers[31] will be strengthened, and the exchange of human resources and knowledge in Japan and overseas will continue to be promoted. Under Japan-U.S. Climate Partnership on Ambition, Decarbonization, and Clean Energy and the Japan-EU Green Alliance, cooperation in the development of technologies for energy transition and innovation for green growth would also be promoted.

In addition, the Act on Promotion of Business Activities with Reduced Environmental Impact for the Establishment of Environmentally Harmonious Food Systems (Green Food System Act) was established in April 2022 as a new regulatory framework to support the efforts of agriculture, forestry, and fishery operators to reduce their environmental burden as well as the efforts of business operators to develop and demonstrate new technologies. The measures related to technology development under this law would be pursued.

Harnessing diverse energy sources

The Sixth Strategic Energy Plan was formulated with the following important themes: (1) setting a course for energy policy to achieve net-zero greenhouse gas emissions by 2050 and the greenhouse gas emissions reduction target in FY2030; and (2) demonstrating efforts to safely secure a stable energy supply and reduce energy costs to overcome challenges in Japan's energy supply-demand structure while tackling climate change. In addition, the aforementioned Clean Energy Strategy Interim Report states that, in light of the crisis in Ukraine and the tightening supply/ demand of electricity, with regard to ensuring energy security, the government will take every precaution to ensure a stable energy supply, and on the basis of it, efforts toward decarbonization will be accelerated.

We will also engage in energy innovation and technology development based on the Strategic Energy Plan. Specifically, to harness a variety of energy sources, the government will promote the necessary R&D, demonstration, and international cooperation on energy efficiency improvement, renewable energy, nuclear power and fusion energy, taking into account the Strategic Energy Plan. With regard to energy efficiency improvement, in order to further develop potential energy efficiency improvement, the government will develop, commercialize, and demonstrate innovative energy efficiency improvement technologies across various fields, as well as demonstrate the adoption of net-zero energy houses and buildings and the improvement of transportation efficiency throughout the supply chain. To maximize the uptake of renewable energy, the government will promote the development of next-generation solar cells and elemental technologies related to floating offshore wind power based on the Technology Development Roadmap for the Enhancement of Industrial Competitiveness for Offshore Wind, tapping the Green Innovation Fund. With regard to nuclear power, a decarbonization option at the practical use stage, in light of the domestic and international circumstances surrounding nuclear power, including the goal of net-zero greenhouse gas emissions, we will steadily promote R&D and training from the viewpoint of further improving safety and promoting innovation that meets diverse needs, such as coexistence with renewable energy, hydrogen production, and heat utilization.

[31] Innovative global research centers such as the AIST Global Zero Emission Research Center, next-generation energy infrastructure research centers, and the Tokyo Zero-Emission Innovation Bay Council

Redesigning the economy and society by shifting to a decarbonized society, a circular economy, and a decentralized society

A range of measures will be taken to accelerate the "three transitions" to a decarbonized society, a circular economy and a decentralized society toward net-zero greenhouse gas emissions by 2050, and to strongly promote redesign for a sustainable and resilient economy, taking into account the revision of the Plan for Global Warming Countermeasures and Japan's Long-term Strategy under the Paris Agreement in October 2021, and the coming into force of the Act on the Promotion of Resource Circulation for Plastics in April 2022. Specifically, based on the Regional Decarbonization Roadmap[32], for example, in order to intensively support regional decarbonization efforts over five years, the government promotes the creation of "Decarbonization Leading Areas", accelerates priority measures as foundations for decarbonization, and supports them with subsidies. In the field of plastics, the government will also promote the investment in the development of advanced recycling technologies such as efficient sorting of used products, and the research and development of innovative materials with low environmental impact, such as marine-degradable plastics and other innovation. Furthermore, in order to achieve the "30 by 30 target" to conserve at least 30 percent globally of land and of sea areas by 2030, and which is one of the proposed targets of the post-2020 Global Biodiversity Framework currently being discussed in the run-up to Part Two of the 15th meeting of the Conference of the Parties to the Convention on Biological Diversity (COP 15), efforts will be made to expand protected areas and improve the quality of their management, to establish and manage other effective area-based conservation measures (OECMs), to visualize the importance of biodiversity and the effects of conservation activities on the map, and to review the National Biodiversity Strategy. Through these efforts, Japan will accelerate efforts in the field of climate change and the environment, leading international discussions and cooperation, in preparation for a series of international conferences including Part Two of the COP 15 of the Convention on Biological Diversity, to be held in the third quarter of 2022, and the 27th Conference of the Parties of the United Nations Framework Convention on Climate Change (COP 27), to be held in Egypt in November 2022.

Building a resilient, safe and secure society

Response to natural disasters

Challenges we face include the risk of a huge earthquake (Nankai Trough earthquake and tsunami, Tokyo inland earthquake, etc.), frequent and severe wind and flood damage due to the impact of climate change, a growing labor shortage in Japan and the weakening of disaster prevention capacity. These challenges must be addressed by improving observation and prediction capabilities, efficiently sharing and transmitting information, and implementing quick and effective responses through the use of DX. In order to strengthen our national resilience in SIP Phase 2 by FY2022, satellite observation and prediction of stationary linear mesoscale convective systems and super typhoons are being pursued, as are information-sharing with local governments (linking to the Shared Information Platform for Disaster Management, SIP4D) and decision

[32] Decided by the Council for National and Local Decarbonization on June 9, 2021

support (CPS4D[33], IDR4M[34], disaster prevention chatbot development, etc.) The newly developed technique for detecting stationary linear mesoscale convective systems is also used in issuing Information related to localized heavy rainfalls brought by stationary linear mesoscale convective systems which the Japan Meteorological Agency launched in June 2021. In addition, since FY2021, the SIP4D information sharing platform has been progressively linked to prefectural disaster information systems. It is currently in operation in 18 prefectures and being trialed in eight prefectures. Furthermore, with regard to the disaster prevention chatbot, information gathering functions have been developed and development of evacuation support functions continues. In addition, in order to secure a power supply in the event of a natural disaster, a disaster prevention and infectious disease control system is being developed using a hydrogen fuel cell bus able to independently supply power. A demonstration was conducted in FY2021.

In addition, one of the strategic goals of AI Strategy 2022 is to build a system and technology infrastructure (Digital twins) to protect people's lives and property to the maximum extent possible in the event of imminent crises such as pandemics or large-scale disaster, and operate them appropriately and sustainably.

Based on the above, in order to ensure zero strandings, prompt and appropriate rescue and relief supplies, and disaster-resistant local governments, businesses and communities, we will work on the construction of digital twins and information infrastructure that enable effective disaster response by means of real-time observation and data integration infrastructure such as small SAR satellites for the more rapid collection of detailed disaster information, the development of disaster prevention IoT, and disaster prediction simulation technology for risk prediction that takes into account the severity of disasters, given the impact of climate change. In addition, Japan will harness its disaster prevention know-how as an advanced country in disaster risk reduction to standardize the concept of resilience in order to improve the country's ability to recover quickly, by establishing international standardization (ISO) standards.

The government will also work toward the establishment of Fukushima Institute for Research, Education and Innovation (F-REI) in April 2023, aiming to use science, technology and innovation to solve medium to long-term and difficult problems in Fukushima, which suffered from the nuclear disaster caused by Great East Japan Earthquake, and to realize a new model for sustainable communities.

Strengthening the resilience of the infrastructure sector

In response to issues such as the deterioration of urban and rural areas due to accelerating infrastructure aging and labor shortages, as well as the risk of massive earthquakes, and to realize efficient infrastructure management to build greater national resilience, advanced technologies are being applied to public works. At the same time, the digital transformation and 3D rendering of infrastructure data is being implemented for managers and rules and platforms for their utilization are being developed. In the area of innovative construction, infrastructure maintenance and management technologies, and innovative disaster prevention

[33] Cyber-Physical Synthesis for
Disaster Resilience is a system that generates and transmits information to optimize disaster response by transferring data collected on disasters and damage in the physical space to cyberspace in order to forecast trends.

[34] Integrated Disaster Reduction for Municipalities is a system that uses AI technology to assist municipalities in issuing evacuation orders at appropriate times and within appropriate geographical range in the event of a disaster.

and mitigation technologies under the Public/Private R&D Investment Strategic Expansion Program (PRISM), efforts are being made to create a database of the results of periodic inspections of infrastructure such as bridges every five years, develop inspection and update technologies, develop ICT construction technologies and build the-MLIT Data Platform. In the future, based on field trials of advanced technologies, a compilation of trial technologies will be published, nationwide guidelines for trials will be established, and standards will be revised. In addition, in the development of the-MLIT Data Platform, it will be linked with data on land, economic activities and natural phenomena held by the national government, local governments and the private sector. There will also be development of digital twins using digitized and 3D infrastructure data, development of simulation technologies for future prediction and overall optimization, unitization of construction infrastructure and increasing automated and autonomous construction machinery in order to cope with ageing infrastructure and the shortage of engineers, monitoring of infrastructure, development of network formation technologies using sensors for various other applications (autonomous driving, logistics, medical care, tourism, etc.), and development of green infrastructure technologies contributing to the creation of sustainable and attractive country, cities, and communities.

Enhancement of analysis functions by utilizing the evidence system (e-CSTI)

Since the launch of e-CSTI in March 2020, analytical functions that contribute to Evidence-based Policy Making (EBPM) and EBMgt have been developed, with the analytical functions shared among relevant ministries and agencies, national universities, and National Research and Development Agencies. In the future, it will be important to contribute to the examination of the effective allocation of funds by analyzing global R&D trends, global networks, as well as analyzing the strengths and weaknesses of Japan, and the important science and technology areas in Japan based on resource allocation and Japanese winners. More sophisticated analysis of the relationship between government research expenditures and research outputs such as research papers would also contribute to this.

As such, regarding the analysis of research expenditures and research outputs, the government will improve the data to capture outputs other than research papers such as patents by the end of FY2022. In addition, we will produce an analysis to contribute to the consideration of the important science and technology areas, taking into account trends in the number of top 10% cited papers and the status of patent citations by country and field.

② Promotion of safety and security initiatives, including think tank functions and the program to foster critical and emerging technologies for economic security

In recent years, science, technology and innovation have become central to the international competition, and from the viewpoint of building a safe and secure society, there are extremely high expectations for advanced technology to ensure security in such as cyberspace, where attacks are becoming more diverse and sophisticated and risks are growing due to recent changes in the global situation to address new biological threats, threats to safety and security in space and oceans, and to respond to crosscutting risks, threats, and crises.

In order to ensure the safety and security of the nation and its people against these various threats, the utilization of advanced technology is extremely important, and various efforts are being made in Japan and

overseas. In light of the equivocal nature of science and technology, and with a view to strengthening science and technology endeavors as the foundation for comprehensive security, Japan has made various efforts for "knowledge" and "fostering" technologies to respond to threats, "harnessing" those technologies by applying them in the real world, and "protecting" those technologies by preventing leakage. The government will continue to take necessary measures on major urgent issues.

With regard to "knowledge," a think tank that conducts research and analysis on key advanced critical technologies will continue their pilot projects and based on their findings, we will consider launching them in earnest by FY2023.

With regard to "fostering" and "harnessing" technologies, the government will steadily implement the program to foster critical and emerging technologies for economic security, which aims for broad civilian and public adoption of these technologies, taking into account the multi-use nature of such technologies, and will provide strong support for the practical application of critical technologies by utilizing the results of a think tank. In particular, in FY2022, we will discuss key advanced critical technologies recognized as important by the government, present an "R&D Vision" consisting of technologies that Japan should acquire, and start accepting application publicly. In addition, the scale of this program should quickly reach 500 billion yen as new frameworks and initiatives are developed to strengthen economic security.

With regard to "protecting" such technologies, we will strive to autonomously ensure the soundness and fairness of research (research integrity) at universities and research institutes in response to the new risks associated with globalized and open research.[35] In addition, the Government will pursue appropriate measures against technology leakage, such as strengthening systems for investment screening and ex-post monitoring, screening for the acceptance of foreign students and researchers, and management of sensitive technology information management at universities, research institutes and companies, and establishing requirements for security export controls in government R&D projects.

Under the Economic Security Promotion Act, the government will steadily implement policies on technical cooperation between the public and private sectors and the non-disclosure of patent applications, and will strengthen the systems necessary for the promotion of economic security and the collection and analysis of information by the ministries and agencies concerned.

③ Promotion of R&D for solving social issues and advancing social implementation and utilization of Convergence Knowledge (So-Go-Chi)

Enhanced utilization of Convergence Knowledge (So-Go-Chi)

In order for Japanese science, technology and innovation to respond appropriately to various challenges and rank with the advanced countries, it is essential to bring together diverse forms of knowledge and create intellectual vitality that generates new value. Here, to “gather diverse knowledge” means to “think outside the box” to which the organization belongs, unbound by the framework of its expertise. To create new value means not only to set out a vision for securing safety and security and maximizing well-being, but also to find concrete means for social implementation and bring about social transformation. Generating "intellectual vitality" in this way is "Convergence Knowledge (So-Go-Chi)," which leads to enhanced

[35] Details are given in later section (Strategic promotion of science and technology diplomacy).

science, technology and innovation capability.

In order to realize Society 5.0, it is necessary both to systematize policies with a backcasting approach based on an ideal of society, and to grasp and analyze the current situation in order to formulate new policies for the future with a forecasting approach, and on that basis to social implementation of those findings. In doing so, by sharing an image of the utilization of Convergence Knowledge (So-Go-Chi) across Japanese society, this series of important processes will lead to "social transformation through Convergence Knowledge (So-Go-Chi)".

In March 2022, in addition to the basic concept, strategic measures for the Convergence Knowledge (So-Go-Chi) were classified under the categories of "place", "fostering human resources", "human resource utilization (evaluation) ", and "questions", and preliminary use cases and examples of measures that are expected to generate synergies were added. In the future, efforts will be made to disseminate the basic concept of Convergence Knowledge (So-Go-Chi) and examples of its utilization to the public, and to apply it in measures that are expected to generate synergies.

2nd period of SIP and preparation for the next SIP

SIP is a program that utilizes the headquarters function of the CSTI to engage in cross-ministerial research and development. In the 1st period of SIP, the R&D findings led to applications such as SIP4D, forging simulator, dynamic map, and a system for monitoring road surface conditions by smartphone. The 2nd period of SIP addresses 12 issues for resolving social issues faced by Japan and strengthening our industrial competitiveness, including autonomous driving, optical quantum technology, strengthening of national resilience, and an advanced diagnosis and treatment system using an AI hospital. Based on the results of FY2022, the final year of the 2nd period, relevant ministries and agencies will make efforts toward social implementation of findings.

In addition, Japan conducted backcasting from its Vision for the Future (Society 5.0) to identify issues to be addressed in the next SIP from FY2023, and finalized 15 issues (target areas) at the end of December 2021. In FY2022, under the leadership of a Program Director (PD) candidate, feasibility studies (FS) will be jointly conducted on R&D themes as a collaboration between relevant ministries and agencies. The feasibility studies will use evidence to narrow down the themes to those that have a large impact in terms of both technology and business. Plans and personnel need for social implementation, including not only technological development but also social system reforms related to such technologies, will be established. The next SIP will be launched in FY2023 with a mission orientation, based on these plans and personnel.

The Moonshot Research and Development Program

In response to changes in the socioeconomic situation caused by COVID-19 and climate change, R&D related to two additional goals (weather, mental health) for the Moonshot Research and Development Program, which were set in September 2021 based on proposals by young researchers, will begin after the end of May 2022. R&D projects in the environment, agriculture, AI, robotics, quantum, health and medical fields will also be strengthened and accelerated. For effective and efficient use of research funds

, stage gates will be conducted for the environment- and agriculture-related goals in FY2022, the third year of the programs, based on external evaluations to review the direction of the projects and enhance the

R&D. In addition, we will enhance cross-disciplinary support (ELSI (ethical, legal and social issues), mathematical science, etc.) in order to promote R&D by utilizing the Convergence Knowledge(So-Go-Chi) and strengthen international collaboration with Europe, the U.S., and other countries , as well as outreach and publicity activities (SNS, ambassadors, etc.) for research findings, and collaboration with industry, which will play a role in social implementation to achieve the goals.

Enhancement of International Standards Strategy

Global awareness is rising on the importance of international standards strategies as a factor in the success of companies and industries. Global companies and governments in their industrial policies are jostling to take the initiative in setting international standards. For example, the European Union published the EU Strategy on Standardisation in February 2022; China published its National Standardization Development Outline in October 2021. Meanwhile, Japan has yet to formulate an international standards strategy that takes current international trends into account. In order to promote and strengthen social implementation of science, technology and innovation in Japan amid the progress of such efforts in other countries, awareness-raising among the public and private sector of the strategic formation and utilization of international standards in Japan is required, as are efforts to improve their capabilities.

Therefore, in order to ensure a higher level of social implementation and international competitiveness in government R&D projects in critical fields under science, technology and innovation policy, the government will articulate a social implementation strategy, an international competitiveness strategy and an international standards strategy. To achieve this, we will strive for the adoption of mechanisms of project management and follow up that are committed by corporate leaders as well as the infiltration of a system to support the strategic use of international standards by companies. As a result, with regard to the strategic use of international standards, the government will promote the establishment of a public-private partnership system in order to boost awareness of the issue among corporate leaders as a management priority and to strengthen the human resource base (improvement of status and career paths of internal personnel, utilization of external personnel, etc.) of private companies throughout the industry. The initial focus is on initiatives in specific fields, such as net-zero greenhouse gas emissions and telecommunications (Beyond 5G). Furthermore, from the viewpoint of economic security, ministries and agencies concerned will work together to articulate quantum technology, telecommunications and semiconductors as critical industrial and technological fields in which Japan should promote the strategic use of international standards, and develop a system in which the ministries and agencies concerned will carve up responsibilities to achieve this.

Strategic science and technology diplomacy

In recent years, science, technology and innovation have become central to the international competition, yet the appropriate use of science and technology and international cooperation are essential in resolving global challenges such as climate change and pandemics. Japan is under pressure to take a high-level approach to developing optimal international partnerships with countries and regions representing diverse values, while enhancing the self-determination over Japan's economic structure and ensuring the advantage and indispensability of our technology. Against this backdrop, in order to build strong partnerships in the

field of science, technology and innovation with countries that share the same values as Japan, opportunities have arisen to deepen international cooperation, including the launch of the Japan-U.S. Competitiveness and Resilience (CoRe) Partnership in April 2021. It has been confirmed that the G7 will work together for the principles that support open, safe and effective international cooperation as much as possible. Looking ahead to 2023, when Japan holds the presidency, Japan must actively contribute to discussions on international collaboration in the future, taking into consideration the importance of both "open science" for better interoperability of research data infrastructure and the sharing of research data, and "research security and integrity" leading to safe international collaboration.

Japan has pursued science and technology diplomacy through various international joint research projects, researcher exchange projects, diplomatic opportunities, and programs to contribute to international organizations. In light of the recent changes in the geopolitical environment, the challenge now is to strengthen the foundations that support the strategic development of our science and technology diplomacy, driven by greater awareness of international cooperation and competition. To this end, we are pursuing an all-Japan science and technology diplomacy consisting of strengthening the strategic partnerships between the Science and Technology Advisor to the Minister for Foreign Affairs, the Advisory Board for Promoting Science and Technology Diplomacy and other relevant ministries, agencies, and organizations, strengthening the systems for collecting and disseminating information on science and technology at diplomatic missions in major countries overseas, and building partnerships by harnessing these systems. In addition, the government will utilize, disseminate, and apply Japanese science, technology and innovation knowledge to help resolve societal challenges in developing countries through contributions to international organizations.

In addition, amid changes in the international situation, interest in science and technology cooperation with Japan, including from developed Western countries, is stronger than ever. The government will strongly promote joint research through international joint research calls across the broad range of R&D projects, development of attractive international research centers, and creation of an international research network for students and researchers.

To autonomously ensure research integrity in the face of the new risks associated with the globalization and opening-up of research activities in Japan, cooperation between academia and the government will be strengthened in order to give more effect to the government policy decided in April 2021 while harmonizing it with international standards. The government will also study the efforts of researchers, universities, research institutes and research funding agencies in this regard, conduct follow-up and consider further measures as required.

3. Integrated delivery of science, technology and innovation policy

In order to effectively and efficiently pursue the three pillars of science, technology and innovation policy in a coordinated manner toward the realization of Society 5.0, it is important to continuously comprehend and analyze the latest trends, including changes in domestic and international conditions, to monitor the appropriateness of initiatives in light of these trends, and to flexibly review and implement policies in a way that reflects the findings. Approximately one year has passed since the launch of the Sixth STI Basic Plan, and trials are being run to improve the policy process by expanding the functions of the Evidence

System (e-CSTI), adding the evaluation of the Expert Panel on Evaluation and by reviewing and updating the sectoral strategies.

In particular, against the backdrop of the unpredictable and chaotic times of late as encapsulated by the COVID-19 pandemic, it is no longer possible to overcome complex societal issues with the technologies of individual fields alone. There is an increasing need to continue creating new value through cross-disciplinary integration and complementary coordination of various measures. For this reason, when identifying the superiority of our country based on the technological and market areas that have been prioritized as set out in the sector-specific strategies, the integrity of science, technology and innovation policy must be urgently improved through collaboration among diverse fields, without limiting to research and development of individual technologies, to achieve world-leading social implementation.

Therefore, the first step to ensure more strategic research and development of key technologies that are directly linked to advance our country is to enhance strategic linkages between new R&D and demonstration programs such as the program to foster critical and emerging technologies for economic security and the next SIP by not only drastically strengthening the place of economic security and social implementation in each sectoral strategy but also by applying these perspectives as a means of connecting sectoral strategies into a coherent whole. In addition, the government will enhance meaningful coordination among the three pillars of key measures and sectoral strategies in order to achieve important national goals and to further cement the Scenario to Goals, by mobilizing all science, technology and innovation policies. A mechanism will also be established to follow up on sectoral strategies in order to develop timely policies encompassing the whole process from R&D to social implementation.

From the viewpoint of steadily improving and enhancing the policy process and enabling the integrated delivery of science, technology and innovation policy, the government will start to consider concrete measures for coordination among major policies and sectoral strategies. This will require a cross-sectional approach from a comprehensive perspective, bearing in mind the overall picture of the Sixth STI Basic Plan. The CSTI, which is the national command post for science, technology and innovation policy, will play a central role in this effort, utilizing the Expert Panel on Evaluation, together with related headquarters councils and the relevant ministries and agencies. In line with the direction of science, technology and innovation policies set forth in the Sixth STI Basic Plan, which calls for "a virtuous cycle of ‘social transformation through Convergence Knowledge (So-Go-Chi)’ and ‘investment in knowledge and people’", the nation as a whole must take on the challenge for the Scenario to Goals and contributing even more to the international community, while making strong strides toward the realization of Society 5.0.