provisional
translation

Integrated Innovation Strategy

Contents

Introduction

(1) Positioning of the Fifth Basic Plan and Comprehensive Strategy 2017

The Fifth Science and Technology Basic Plan (Approved by the Cabinet in January 2016. Hereinafter referred to as “the Fifth Basic Plan”), based on the results and through issues for the 20 years after the First Sciences and Technology Basic Plan, making our country “The most innovation-friendly country in the world” was held up to be materialized as “Super Smart Society =Society 5.0”[1]（”Plan” in PDCA Cycle）.

Regarding the adoption of the Fifth Basic Plan, the “Comprehensive Strategy on Science, Technology and Innovation 2017” (Approved by the Cabinet in June of 2017. Hereinafter referred to as “Comprehensive Strategy 2017”) states that in particular, the realization of "Society 5.0" and the steady implementation of the "Public-Private Investment Expansion Initiative of STI"[2], are of great significance ("Do" in PDCA Practical Cycle).

(2) Evaluation of Current Status and Necessity of Integrated Innovation Strategy

Three years have passed since the formulating of the Fifth Basic Plan, and progress is being made in many domestic fields. Meanwhile, as an unprecedented disruptive innovation[3] is developing worldwide, it has been pointed of relative level down of STI innovative capability in Japan.

While fundamental game changes[4] such as knowledge merging, rapid advances of disruptive innovations, changing roles of entrepreneurship, e.g. the rapid expansion of so-called “platforms” and their advances into the real economy, the exposure to the battle for innovation supremacy, and the transgression towards a sustainable economy are occurring globally at all levels, the limitations of advancing science and technology innovation policies as an extension of past measures have been revealed. Japan is pressed to reconsider its entire socioeconomic system with its organizations, structures, enterprises conducts, customs, and ways of working that Japan has built up for so many years.

At the same time, five and a half years after the adoption of the so-called Abenomics, initially, aiming at the sloughing off from deflation and the increase of wealth, the so-called "three arrows", a policy package consisting of monetary and fiscal policies, as well

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[1] In the Fifth Basic Plan, “provide the needed things・to persons needing things at the needed times as much as needed, thus being able to receive high-quality services by everyone overcoming such differences as age, gender, region, language and the society to be able to vividly and comfortably live” are intended and “the human-centered society to be able to for people to enjoy quality living full of vitality and comfort compatible with economic development by providing things and services, coping finely and attentively with a variety of needs and those of latent and dormant, cyberspace and physical space highly merged” in the Comprehensive Strategy 2017.

[2] CAO, "Report of Socioeconomic and STI Vitalization Council"(December 2016)

[3] "Disruptive Innovation" in “The Innovator’s Dilemma”（Written by Clayton M. Christensen, Audited by Shunpeita Tamada, Translated by Yumi Izuhara, 2001, Shoeisha）

[4] Refer Chapter 1 (2) from 1 to 4

as a growth strategy, was carried out. In 2015, policies with the aim to realize a "Dynamic Engagement of All Citizens" were introduced ("The New Three Arrows"). At the end of 2017, policies such as the productivity revolution were compiled into the "New Economic Policy Package". Today, with the progress of structural changes, the improvement of the employment situation, and the revitalization of business activities, Japan's economy continuous to recover in many areas.

However, switching our eyes to the future, our country's labor productivity ranked the lowest in G7[5], it shall be feared that the international competitiveness as seen in the sudden drop in various rankings. As the innovation including those of scientific technologies-induced would hold the key of growth of developed countries, improving these capabilities dramatically and increasing its productivity greatly is an urgent issue that needs to be tackled in order to ensure the sustainability of the Abenomics' actions.

The Society 5.0 as proposed in the Fifth Basic Plan envisions a grand concept to build a human-centered society that through the utilization of STI will not only contribute to the increase in productivity, but whose significance will start to gain global attention in times of growing disparity divide and trends towards data-ism. In order to realize these plans in the context of a rapidly changing and ever evolving world, societal change towards a so-called "Next-Generation-type System of Balance"[6] will be necessary. An alert, dynamic, active system that can quickly respond to change and always looks for an optimal solution has to be constructed (hereinafter referred to as the "Next-Generation-type System of Balance"). To make this possible, it needs a unified government with strong willpower, and an "Integrated policy package" that is capable of boldly changing the entire socioeconomic system.

On that occasion, while boldly envisioning what might be important in the uncertain future, the key to create "the most innovation-friendly country in the world" lies in the fundamental reorganization of all the elements that sustained "the stability of our existing system" such as an excellent real economy, intellectual assets including technological seeds, universities and human resources, all in accordance with the world's changing environment.

Therefore, in the FY of 2018, at the halfway point of the Fifth Basic Plan, in addition to confirming and evaluating the progress status of various measures ("Check" of the PDCA cycle) of the "Comprehensive Strategy 2017" and other actions, we will verify policies and socioeconomic systems

[5] In 2016 Japan's labor productivity is 20th in OECD member countries and at the bottom in G7 countries (OECD Stat).

[6] In his book authored by Masahiko Aoki "Toward Comparative Institutional Analysis (New Edition)" on Page 4 (Translated by Hirokazu Takizawa, Kazuhiro Taniguchi, 2003, NTT Publishing), "Rule by Rule of Game" the system is conceptualized by Douglas North's thinking by quotation and written "the most appropriate method is to conceptualize the system as equilibrium of game"

that are widely related with STI, and develop a "Integrated Innovation Strategy" (hereafter referred to as "Integrated Strategy[7]"), which will be carried out as the "Action" (Improvement) phase of the PDCA cycle.

(3) New Strategy Formation Process and Structure

Japan is a developed country that is facing many challenges[8], e.g. declining birth rate, aging population, widening of regional disparities, mature economy, and stricter financial constraints. In order to achieve sustainable growth through innovation, the "design" of the strategy formation process and the implementation structure itself has to be reviewed and limited resources need to be utilized at maximum by shifting from an optimization model focusing on parts of the system to an optimization model targeting the entire system.

For this purpose, firstly, after the government gets a better understanding of the entire domestic socioeconomic structure, it is required to review and if needed reconstruct all the government businesses and policies from the viewpoint of STI. At its base will be "Evidence-Based Policy Making", a core element of the “Source of Knowledge” concept, and one of the endeavors will be mainly focusing on the innovation of government businesses and systems. In addition, with the planning and implementation of the "Integrated Strategy" in mind and from the viewpoint of innovation, it will be necessary to work across organizational boundaries, involving not only various stakeholders from related government agencies and control tower departments, but also outside experts. In order to be able to flexibly adopt the opinions of a variety of stakeholders ranging from CSTI executive members, outside opinion makers, and related government agency executives, "Policy deliberations" were established, and discussions focusing on key fields were hold.

Further, in order to strengthen the cross-sectional coordination between CSTI, IT General Strategy Headquarters, IP Headquarters, Headquarters for Healthcare Policy, National Space Policy Secretariat, and the National Ocean Policy Secretariat, functions[9] related to the coordination and promotion of projects will be centered around the Chief Cabinet Secretary, enhancing control tower functions. Additionally, we plan to establish an "Integrated Innovation Strategy Promotion Council" by summer 2018, and continue our work on the improvement of the control tower function.

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[7] The Integrated Strategy applies to ”Science, Technology, and Innovation Comprehensive Strategy” formulated each year based on the Fifth Basic Plan.

[8] “Developed country which has new problems, Japan-from catch-up to front runner” （Hiroshi Komiyama,2007, Chuo Koron Shinsha).

[9] For instance, such as Meeting for the Advancement of Utilizing Geospatial Information, innovation-related meetings of various types are included.

CHAPTER 1: General

(1) Status of the Action on the Fifth Basic Plan and Comprehensive Strategy 2017

Until now, the government has been promoting efforts to achieve the investment target for R&D set forth in the Fifth Basic Plan, and it has to continue these efforts. The goal is to make R&D investment combined by the public and private sectors equal to or more than 4% of GDP, and for government research and development investment, to achieve a GDP ratio of 1% while maintaining consistency with the targets set in the "Economic and Fiscal Revitalization Plan" of the "Basic Policy on Economic and Fiscal Management and Reform". Furthermore, the total size of the government R&D investment amount necessary for the said period of the Fifth Basic Plan shall be about 26 billion yen in case of a trial calculation on an assumption that the nominal growth rate of the GDP during the period of the Fifth Basic Plan would be set to an annual average of 3.3 %. Also, based on "Public-Private Investment Expansion Initiative of STI", which is one of the key initiatives of the Comprehensive Strategy 2017, CSTI, functioning as control tower for government STI policies, has been promoting efforts to expand the Public-Private R&D investment, and has e.g. started the project PRISM in FY 2018. When we examine the progress status and results of the four central undertakings (1 to 4 hereinafter) of the Fifth Basic Plan and the Comprehensive Strategy 2017, it's hard to say that satisfactory results were produced, despite the progress that can be seen in many areas. In order to achieve the original goal within the running period of the Fifth Basic Plan, a drastic strategic change is imminent.

① “The new value creation towards future business development and social change”

As part of the "Efforts of new value creation towards future business development and social change", we have implemented programs to realize Society 5.0 and other initiatives to encourage challenging research and development. Regarding the efforts made in realizing Society 5.0, the development of essential technologies and platforms in important areas e.g. "Intelligent Transport Systems", in which social implementation can be expected in the near future, were conducted through SIP[10] and other projects, yet an overall system design does not exist. In the future, it will be necessary to design the entire social infrastructure for the realization of Society 5.0, to clarify the direction of the platform development in all areas, and to promptly tackle the construction of a collaborative data infrastructure between the different areas. Furthermore, in addition to R&D towards the establishment and application of AI technology for data analysis and data utilization, there is great demand for training and securing IT professionals in quality and quantity. On top of that, regarding possible obstacles to the realization of Society 5.0, reforms and other measures should be considered immediately.

[10] CSTI by displaying its tower function, it shall be the program created to realize the scientific innovation through fulfilling the leading role to the management outside the hitherto frames of the Office, Ministries & Agencies and such.

As for challenging R&D, projects such as ImPACT[11] have been conducted, and some research results are already appearing.

However, if questioned about the achievements while overlooking the entire R&D of the government, we can say that although "opportunities for challenging research and development activities that are responsible for social change through innovative ideas without fear of risk" have been widely provided, and many "human resources with an orientation towards achieving breakthroughs by innovation" have been created, we are still midway in comparison to the rest of the world.

② Response to economic and social issues

As for "Response to economic and social issues", Japan has been engaged in numerous efforts towards the opening of frontiers that are important for the national strategy, e.g. securing a stable supply of energy, resources, and food; realizing a sustainable society with the aim to create a health-oriented country that is capable of coping with the phenomena of super-ageing on the one side and a decreasing population on the other side; improving competitiveness in the areas of "Monozukuri" (Manufacturing) and “Kotozukuri”(Value Creation); ensuring safety and security of Japan and its citizens; as well as responding to global issues and contributing to the development of the world.

As a result, steady progress is being made in the fields of automated driving, materials development, disaster prevention, frontier exploration (marine/space development) through intra-ministry and agency projects such as SIP.

However, in light of the global trends after the formulation of the Fifth Basic Plan and in consideration of the progress of STI efforts, it is necessary to review and strengthen the strategy by focusing on several areas.

Regarding the efforts in the field of environmental energy, it is necessary to take actions taking into account the effect of the Paris Agreement[12] and the subsequent rapid changes in policy trends that occurred afterwards. In the field of agriculture, the utilization of drones, sensors, and data for precision farming has been dramatically progressing. As for "Monozukuri" (Manufacturing) and "Kotozukuri" (Value creation), when looking at the development of the global strategy of the European project Industry 4.0[13], we need to greatly intensify our efforts and examine how we should proceed with Society 5.0 and its cross-cutting social infrastructure while keeping collaborations across other areas in mind. Regarding the efforts in the area of safety and security, in the face of unprecedented natural

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[11] ImPACT is program that has been founded in order to promote high-risk-high-return and challenging research development to create science, technology and innovation which could bring large-scale change in industry and society.

[12] New international framework adopted at COP 21 in December, 2015, effected in November, 2016 for the purpose of exhaust restraint of greenhouse effects gas. In pursuant to the restraints of the same framework, each signatory is required to formulate long-term low exhaust development and turn it in before 2020.

[13] Through I o T of manufacturing industries, networking industrial machines・facilities and production processes themselves and the government-private linkage projects centering on Germany who aims at actual utilization in society “the 4th industrial revolution” which connects value chains control real-time from order to shipping (July, 2017)

hazards and Japan's increasing national security level, a reworking of our strategy is necessary. Although a severe global competition exists in the field of biotechnology, the only strategies Japan has at hand are the Biotechnology Strategy Outline (decided at the BT Strategy Meeting of 2002) and Dream BT (decided at the BT Strategic Promotion of Government and Private Meeting of 2008), which were formulated in the beginning of this century, leaving Japan practically strategy less. Also, with regard to SDGs[14] that aim to solve global economic and social issues, an increase of ESG investment in recent years, progress of strategic efforts of other nations, and an acceleration of detailed studies in the United Nations can be observed.

③ **"Reinforcing the Fundamentals for STI"**

As for "Strengthening the fundamental power of science, technology, and innovation", until now, efforts were conducted e.g. to enhance Japan's human resource capabilities (promotion of the training and participation of young talents), to strengthen our knowledge foundation (university reforms, enhancement of operational functions), and to reinforce fund reforms.

As a result, some progress can be seen in the rise in numbers of tenure track[15] faculty, the higher employment rate of young staff, the increase of excellent research papers at WPIs[16], the stimulation of collaborations between industry and academia, and in the advanced approach towards open innovation among others within the COI Program[17].

However, the scale and speed of our efforts are not sufficient. Indices based on the number of the top 10% most-often cited papers or world university rankings indicate that Japan is lagging behind.

Regarding our efforts towards the enhancement of human resources supporting science, technology and innovation, on the one hand, our universities are facing an organizational inertia, manifastating in the decreasing ratio of young researchers and the continuous brain drain of female researchers. On the other hand, universities are promoting efforts to train and secure a rich diversity of young researchers including female researcher and talents from overseas, other efforts focus on mobility or international brain circulation, but still Japan is backward compared to other major countries.

As for our undertakings towards the strengthening of our knowledge foundation, in order to stop the relative decline of the basic research strength of our country, we need to make sure that public competitive grants are going to excellent young researchers and that the research environment for young researchers is also improved, in other words, stimulating research activities at universities and

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[14] International objective from 2016 till 2030 entered in 2030 agenda for"sustainable development" adopted at the UN Summit in September, 2015.

[15] The system in which young researchers hired through highly transparent screening accumulate experiences before gaining stable job.

[16] The MEXT is aiming at formulation of experiences as scholar boasting front-line study environment and high-level study standard assembling first-rate scholars from the world over suggesting independent tackling such as introduction of system renewal and such by governmental concentrated assistance to a world top-level research stronghold formation.

[17] Program which assist vision-foreseeing and challenging plus high-risk R&D for 9 years at the longest, foreseeing social image of 10 years ahead.

other institutions is of utmost urgency.

In addition, awareness and efforts of universities and research institutes in Japan are not enough when it comes to stimulating international collaborative research and open science.

As for our actions towards the reinforcement of fund reforms, compared to European or US top research universities, the management foundations Japanese universities are built upon are weak. Even after the incorporation of Japanese universities into more autonomous national university corporations, the amount of external funding, in particular, private funding is still small, and the dependency on governmental spending remains high, at the same time diversification of financial resources is also insufficient. Thus, it is necessary to improve management functions fundamentally and to promote actions aiming to expand the access to external funding through corporate-academia collaborations.

④ "Establishing a Virtuous Cycle System of Human Resources, Knowledge and Funds for Creating Innovation" etc.

Regarding our efforts towards "Establishing a Systemic Virtuous Cycle of Human Resources, Knowledge and Funds for Creating Innovation" we have been implementing measures to strengthen the promotion of open innovation, stimulate the establishment of medium and small startup companies, and promote regional revitalization.

As a result, for example, partial progress can be seen in the growing trend around top research universities to create university-initiated ventures and in the formation of knowledge concentration clusters with universities at the core.

But still, compared to examples of other countries, Japan is lagging behind in all given aspects: numbers of R&D type ventures, speed of growth, size, influence, investment amount and size of fund composition. Support by government agencies and public-private partnerships are indispensable in Japan, where the amount of support provided by angel investors is very small compared to the US. Cooperation between the government and related organizations is not sufficient to realize an innovation ecosystem. Also the thinking of all related stakeholders including businesses and universities hasn't changed that much, and as a result, a comprehensive innovation / ecosystem has not been emerged yet.

Although our actions were supposed to mobilize all core company support related measures to realize an innovation ecosystem that contributes to the vitalization of the regions, they rather advanced the overcentralization of Tokyo. The Science Council of Japan was set up with the objective of promoting science and technology so that innovations can pervade administrative bodies, the industry sector and every aspect of national life including that in the regions, and while the council further strengthens its links with CSTI and other related departments in Tokyo, it is expected to start major planning on the promotion of science in the rural regions.

Besides the above mentioned 4 fields, the Fifth Basic Plan had listed necessary measures for ethical,

legal and social issues and the establishment of trust relationships among stakeholders, but however, social trust relationships that play an important role when it comes to accepting science, technology and innovation in fields related to such topics as privacy, gene diagnosis, and AI, are not sufficiently established and because of that are even considered an obstacle for the social implementation of new seeds.

(2) Global Trend

The Fifth Basic Plan was formulated in full recognition of the newly emerging scientific, technological and innovative discoveries that digital revolution and globalization made possible. However, STI around the world, such as disruptive innovation in fields related to e.g. photon and quantum technology, cyberspace infrastructure technology and biotechnology, the transformation of platform business, diversification of innovation ecosystems and the explosive advances of AI technology, these technologies have greatly surpassed our expectations of the time the Fifth Basic Plan was formulated.

When technologies and ideas generated in separate fields merge with those of different fields, and when those new discoveries are accepted by users (here used in a broader sense)[18], that will create innovation.

It is thought that, in regard to the global game-changing developments in recent years, the dramatic evolution of the cyber space and other key technologies have led to a mechanism, where "All elements of diverse knowledge blend together to create innovation, form platforms, upon those new diversity is created, leading to a cycle of fusion, platform formation and diversification in upper dimensions. In order to overcome the innovation competition, the key lies in designing today's businesses through backcasting from a future image that reflects the destination of disruptive innovation as well as user needs on the premise of this mechanism.

① Toward the Century that “Merging of Knowledge” would be the key

Under the 20th century’s capital economy, national power had largely relied on population size, accumulation of financial capital, the natural resources reserves, and other factors; on the other hand, intellectual resources had been important but not decisive. The influence of blended knowledge was limited.

But in recent years, due to the rapid development and spreading of analysis techniques related to the rapid digitalization, shift to IoT, biometric authentication, sensors, AI, and further due to advances in biotechnology and the study of brain activities, the “psychological space” (e.g. brain) was added to

[18] Including not only present clients but also people contemplating new businesses in view of future society and users.

the existing “sphere of information” (cyberspace) and “reality” (physical space), leading to a continuously fusion without any limitations. As a result, the acquisition of diverse knowledge (including information, data, etc.) both in quality and quantity, its merged forms, its analysis and platforms hold a critical meaning for to the real world and human behavior.

② Rapid advances of “disruptive innovation” and change of external conditions around “Startups”

By merging knowledge, not only is an unseen disruptive innovation progressing in all fields, the time it takes from basic research to social implementation is also significantly shortening. As a result, the creation and growth of R&D-based venture businesses is increasing rapidly, and it is said that we have recently entered the so-called “Cambrian Period[19] of Entrepreneurship”, which is characterized by rapid diversification. Its role, that is not limited to niche areas, has extended to a degree where not only large companies but also governments considerably depend on it and its impacts on global economic activities, social structure and even politics are growing.

On the background of the so-called Cambrian Period of startup businesses, process can be seen in the diversification of ecosystems of venture businesses around the world. In the recent past, the Silicon Valley-type of startup companies, that have built up free and open-minded environments mainly around universities, have been a standard model for startup ecosystems. However, in the recent years, the number of diverse startup ecosystems utilizing the unique features of urban regions are increasing in a rapid pace. On the other hand, there are concerns about competition policies in regard to the motives of some global companies which are selecting, enclosing and reorganizing diverse startup companies in the world for the advantage of global business expansion.

③ Rapid Expansion of Platforms and Advances into the Real Economy.

Given the progress of disruptive innovation and entrepreneurship through the merging of knowledge, the rapidly growing platform business that has commenced this century is undergoing a major transformation. Concerns exist, that business platforms that have originally evolved in cyber space centering on the ICT services of C2C, are now expanding globally with a momentum threating to fundamentally destroy related businesses in various areas of real space such as distribution, automobile, medicine, agriculture, and energy. In addition, there is also concern about data monopoly by huge platformers. This trend threatens not only privacy and security, but also the existence of the existing concepts of value and order, but even if we look around the world, the direction of policy actions and corporate activities is still not decided.

[19] “Minister and Minister of State for Science and Technology Policy, Science, Technology, and Innovation Meeting with the learned Diet persons” (April, 2018) Cabinet Office (STA) Submitted Literature “Political Discussions "Sohgyo" Points at issue”

④ Rivalry of Each Country and Expectation of Sustainable World

On one side, disruptive innovation and the advancement of platform businesses into the real world, what was triggered by the merging of knowledge, are influencing the economic and social activities of humanity on a large scale, e.g. widening inequalities, fighting for supremacy over science and technology innovation, causing global uncertainty and instability. On the other side, these developments are expected to be the key to achieve "SDGs" so as to sustainably solve issues such as environmental destruction or poverty. It is highly expected that the alterations of the innovation mechanism originating from the merging of knowledge will greatly influence the structure of cities and regions. Hence the role of future innovation and ecosystems will even greater.

⑤ Actions adopted by other countries' governments, Etc.

In response to the changing trend around innovation, drastic policy measures are taken by governments around the world. For example, "China" that through the initiative "Made in China 2025 [20] and the establishment of a Central Commission for Integrated Military and Civilian Development, etc., aims for world domination of industries employing the most advanced technologies, "Singapore" and "Israel" have drastically reformed their education system to strengthen human resources development, "Europe" regulates platformer's activities by a newly introduced personal information protection system, "African countries" aggressively introducing innovation in the fields of finances and communications, aim to achieve "leap-frog" developments, "India " aggressively aiming for efficiency by introducing the world's largest biometric authentication system and "the US", the leader of innovation, is making use of all available policy tools from safety security policies to trade investment policies, in order to hold on its position as innovation leader. Each country is striving to survive in order to lead the global trend, while making best use of its unique national characteristics

(3) Our Strength in the Context of Game-Changing Developments

While game-changing innovation is progressing, there is a chance, that certain characteristics of Japan, from the view of international competitiveness, once believed to be a weakness, might become our strength. How to utilize these characteristics and lead the world innovation is crucial.

＜Merging of knowledge>

In the age of AI where the Cyberspace fuses with the Physical space, it's important how to get and process high-quality information from real space. Since Japan has various consumers and users seeking high-quality sites and high demand levels making full use of its features in the fields of manufacturing, medical care, agriculture, etc., if we could create conditions that would enable us to

[20] 10-year action plan formulated by the Chinese Government in May of 2015 aimed at its high-degree manufacturing industry.

collect, store and utilize necessary information, data, etc. possibilities exist for Japan to become a dominant global player. Then, active use of all kinds of public data for academic research and an accelerated industrial development through industry-university collaboration will become important.

<Disruptive innovation and startup>

Today, basic research results lead to disruptive innovations and business foundation; the accumulation of 'fundamental technology' as the seeds and 'funds' that support business foundation up to commercialization decisively influences future competitiveness. In this regard, our universities and research institutes have high R&D capabilities that are on an overall high level even if you look around the world; industries have excellent technology; and companies have accumulated abundant funds. Also, Japan has an accumulation of small-and-medium-sized companies rarely seen in the world, with an infrastructure environment including communication infrastructure and high-quality markets of a certain scale. . In addition, cities in East Asia including Tokyo and others that have diversity and accumulation have the potential of becoming venues for state-of-the-art science and technology innovation by making full use of its characteristics.

In recent years, there has been a change of public consciousness, as can be seen e.g. in the upward trend of entrepreneurhip of bright young researchers at universities and other venues creating more new businesses, and knowledge-intensive clusters centering round universities that participate in programs such as COI or SIP, producing first results. . By merging the knowledge and resources owned by our country, we will foster such emerging efforts. How to realize a "Japanese-type innovation and ecosystem" is becoming crucial. There are several preconditions that have to be met in order to achieve “success”. In addition of overcoming the shortcomings of our country in matching “inventions/discoveries” with “business model designs”, we need to ask ourselves how we can perform a shift from a “culture not allowing failure” to a “culture not only allowing failure, but also learning from it”, how we can gather remarkable talents and geniuses, and increase the number of places enabling various participants to make use of the full extent of their abilities to create innovation, these are the preconditions of “success”.

<Platforms>

In Japan, there is no international giant platformers those emerging in the U.S. and China. On one hand, there are viewpoints that with regard to platform business, where economic scale is important, it might be difficult for Japanese companies to construct a global system.

On the other hand, with a strong national commitment we are aiming for the implementation of the Society 5.0, that in itself is a platform concept that subsumes all socioeconomic activities, adequately combining a system consisting of a proper overall architecture and data integration/linkage capabilities and international standards, strategies for international intellectual property[21], open-close strategies

[21] June, 2018 Decided “Intellectual Property Strategic Vision” at IP Headquarters. In the future, this vision is intended to realize through “Intellectual Property Strategic Program 2018” (June, 2018, IP Headquarters Decided)

and technologies such as AI and blockchain and strategies has the potential to become world's most advanced comprehensive public and private platform capable of developing various businesses such as applications realted to health care and the agriculture sector. through the improvement of the IT literacy of all Japanese citizens.

<International cooperation(s)>

For Japan, that has become an environmentally advanced country after it struggeled with major pollution, is now becoming a model for the whole world as a problem-solving advanced country, as such, SDGs aiming for sustainability are a golden opportunity for the creation and development of innovation Also, since the "culture of sustainability " in the broad sense has taken root in Japan as it is represented by the Omi merchant's spirit “three-way satisfaction” ("Vendor, customer, and society, everybody is doing well. ") from the past, the concept of SDGs is compatible to even Japanese companies. Japan has a proven track record of building up schemes for mutual development through investment and business mainly in Southeast Asia. Also, as seen in the conclusion of negotiations between Japan and the EU/EPA in 2017 and the signing of the TPP 11 Agreement, we are making efforts to positively establish international mutually beneficial relationships. This can be a strength in developing our country's innovation globally.

(4) Basic Concept of Integrated Strategy

Taking into consideration global trends and strengths of Japan, the significance of reforming our nation into “the most innovation-friendly country in the world” and “aiming at the realization of Society 5.0 through STI” is increasing, hence we should adhere to the fundamental views set forth in the Fifth Basic Plan. On top of that, it is important for Japan to design an Integration Strategy as a policy model for the realization of Society 5.0, to steadily implement it, and to demonstrate the solution to our structural problems of society and the economy including the declining birthrate first in the world. It will also show the countries where disparities and confrontational structures are becoming sharper the future course they should follow. In order to comprehensively transform our country's socioeconomic infrastructure through STI, it is necessary for the government to assume a strong leadership role to transform the former century's “system balance” to a sustainable and flexible “Next-generation-type System of Balance”, not something to be accomplished metaphorically speaking though a limited local battle. For this purpose, we intend to formulate an Integration Strategy that will initiate STI policy measures in an “organic and integrated way” and implement it with a sense of speed, by closely collaborating with related ministries and agencies and the relevant control tower departments.[22]

The Integrated Strategy will construct the “source” of knowledge as the foundation of STI, and we

[22] In “New Economic Policy Package” (December, 2017 decided in the Cabinet) In order to maintain and improve our country's international competitiveness extending to the future, together with speeding up the scheme streamlining, it is necessary to make the world standard in cope with the disruptive innovation. For this, (middle part omitted) It is mentioned that 3 years till 2020 set “productivity revolution・concentrate investment term” and to mobilize drastic taxation, budget restraints renewal l measures.

expect that through knowledge creation by universities, national institutes, and industry etc., this newly created knowledge through entrepreneurship and government projects lead to a domestic and international “development” of “social implementations” and that will cause social change and will present us with a “seamless strategy” from fundamental research to social implementation and global deployment.

To lead our nation to become “the world’s most innovation-friendly country”, we set integrative and cross-sectional goals for the realization of Society 5.0, and at the same time define “global goals” (benchmark) to be achieved in every field, as well as a “logical road map” and a fixed “timeline”, and a PDCA cycle will be steadily and flexibly advanced. Furthermore, in implementing the Integrated Strategy, each of the various issues will be individually addressed while considering the diverse circumstances “layer by layer” (example: industry, human resource development, workplace, etc.) or “unit by unit” (example: region, company, university, etc.).

(5) Future Issues

The most important key in creating science, technology and innovation is human resources. In a world where disruptive innovation will gain momentum, it will be crucial to ensure mobility and diversity of human resources coming from various occupations and secure excellent and ingenious researchers and entrepreneurs, but, in this respect, Japan lags behind major countries. In the future, we will need to examine measures for excellent young researchers and students from around the world to aim for Japanese universities, measures that contribute to the promotion of international brain circulation; and how to ensure mobility and diversity of human resources including women and foreigners will also be examined.

In addition, establishing an educational system in order to produce human resources who are capable of creating scientific and technological innovation is a fundamental task. It is necessary to build an educational system that combines science and engineering sciences with various fields including humanities and social sciences and we have to consider how we can apply this knowledge from non-science and engineering fields to science and technology innovation.

In view of the fact that the merging of information, human resources and knowledge is the essence of STI, Japan not only needs to establish an appealing entrepreneurship, business and employment environment that attracts various human resources and businesses from abroad, but it is also necessary to promote Co-Creation by various stakeholders. In cases where innovative initiatives developed in other countries have not been introduced in our country, we need to examine the factors, hindering scientific innovation from the viewpoint of ”Japanology (Japanese studies)” as a theoretical base for comparative institutional analysis. And, it will be important to disseminate the results for inclusion in awareness and behavior reforms of industry, academia and government, respectively.

In light of the fundamental changes of the science, technology, and innovation mechanism it is

important to substantially reform the current system structure from a vertical, rigid and deterrent system to a cross-sectional, flexible and free one. Particularly, in Japan where Society 5.0 was proposed, social implementation of STI should never be hindererd by a rigid system. It will be the touchstone to success for Japan whether or not we will be able to construct a comprehensive social verfication model ahead of other countries as a showcase.

Furthermore, as has been already described, our efforts towards the realization of an innovation ecosystem capable of contributing to “the vitalization of the regions” is insufficient. Universities and research institutions that are at the heart of regional knowledge-intensive economies should be able to promote the vitalization of the regions even more than in the past. It needs further examinations in the coming years on how this hidden potential can be revealed.

In addition, the Integrated Strategy has taken up urgent current issues, and steadily promotes various policies included in the Fifth Basic Plan and the Comprehensive Strategy 2017 even for issues that have not been addressed in the integrated strategy.

CHAPTER 2: Source of Knowledge

The key to today's “Source of Knowledge” is data・information, and particularly, the quality and quantity of data arising from economic and social activities hold the future of science, technology and innovation such as reliable evidence which would be required.

In the Fifth Basic Plan, it was decided to propel introduction, needed for EBPM scheme and construct in stages common platforms in order to gather and analyze a variety of data.

Looking at the status of data collection, analysis, and linkage we have been proceeding in view of the Society 5.0 realization as mentioned earlier, the total formulating hasn't been made yet, and even though Japan’s initiatives in certain areas are at the world’s latest level in SIP, there are other areas where we are lagging behind. It is necessary for Japan to undertake without delay “overall architecture planning” including mutual operability among basis. In Europe, the North America and China, initiatives covering the government-data standardization and management, etc. are in progress. To Japan, it would be necessary to go ahead without delay in unison with the public and private sectors combined taking into account possibilities of such cross-domain exchange platform with foreign countries.

(⇒”Chapter 2 (1) Construction of the Cross-domain Exchange Platform towards the Society 5.0 realization ”)

As for Open Science Propulsion, creating bases for management and utilization of research data lags behind schedule with the number of the national institutes remaining only two (as of the end of 2017) it is necessary to hasten to link with foreign research data bases, and machine readability of

research data, formulating policies and plans of management and utilization of research data.
(⇒"Chapter 2 (2) The Cross-domain Exchange Platform Constructing for Open Science")

As for promoting EBPM and such, while the necessity of data collection and analysis is gaining support, data is scattered among offices, ministries and agencies, and universities and that most of these data are stored separately and are in non-usable for secondary usage and non-machine-readable style. For this reason, machine readability and standardization should be completed early and prompt construction of "Evidence System" should be pursued.

New policy package construction involving data analysis as above is the construction of knowledge to be the bases for new policy making in scientific innovation. For that, it is necessary to collect/analyze information for presentation to each government office, ministry and agency and strengthen the role of CSTI, the control tower for scientific innovation policies, as "think tank".
(⇒"Chapter 2 (3) Evidence Based Policy Making/Propulsion University Corporation Management")

(1) Construction of the Cross-domain Exchange Platform towards the Society 5.0 Realization

○ **Future visions to be pursued**

- Creating new values by constructing the cross-domain data exchange platform with function[23] to utilize data in a safe/secure way and constructing data exchange platform connecting data beyond organizations and domains through the use of AI ahead of the world.
- Creating the global data distribution market by fulfilling data exchange platform with major countries in North America and Europe sharing the common values on data distribution and protection.

○ **Objective**

-Constructing the cross-domain data exchange platform[24] in 3 years, full operation in 5 years while securing interoperability with other data exchange platforms,

-Offering the service platform capable of analyzing big data with AI within 5 years on the cross-domain data exchange platform.

○ **Major challenges in achieving goals and future direction**

-Cross-domain data exchange platform is yet to be construct because government has not sufficiently exerted the control tower role, though constructing of the individual domain data exchange platform is in progress,

- CSTI and IT Integrated Strategy Headquarters to exert the control tower role to set detailed

[23] Function to correspond to the world most advanced cyber security and personal information protection issues
[24] Data exchange platform across domains.

target deadline for cross-domain data exchange platform, with the relevant offices, ministries and agencies and private councils, etc., cooperating to meet such deadline.

-Acceleration of constructing the cross-domain data exchange platform, following the progress of the grand design for such platform while securing interoperability.

-For constructing the data exchange platform while securing interoperability with the North America and Europe, capabilities to cope with such challenges as cyber security and personal information protection to be secured.

① Necessity and importance of data exchange platform in innovation

In the society we aim at as the Society 5.0, paradigm shift is expected to happen where the cyber and physical spaces would be highly integrated and innovation born from the big data and AI utilization would create new business models and values in different domains.

To realize this type of innovation, it might be important for us to exchange data not only in a individual domain but also beyond barriers of different domains.

So, it is indispensable to construct the cross-domain data exchange platform in order to exchange data scattered in government, municipality and private sectors, and to make use of them across borders of domains.

② Recognition of the current situation

New values such a utilizing data across domains and usage as a training data for AI are expected to be created by exchanging such beneficial data as often called new resources. In other countries, too, similar projects are undertaken by the public and private sectors.

For instance, as in private-sector initiatives in the US, giant platformers are offering innovative services by collecting/storing/utilizing data.

Additionally, as the Government-led initiatives, they started upgrading framework of data exchange platform and data standardization initiatives[25] such as NIEM in the US in 2005 and SEMIC in Europe in 2011. In China, by enacting a law[26] to regulate the transferring of domestic personal information abroad, data access control has been strengthening.

As in these cases, between certain countries led by the US and China, the severe fights for supremacy have been going on in platform business using big data in the world.

In Japan, in some cases including SIP and such, construction of data exchange platform at individual domains has been in progress, but it is still on the way. On the other hand, as the control tower role of the government regarding data exchange and collaboration between the relevant offices, ministries and agencies have been insufficient, the cross-domain data exchange platform has not been adequately

[25] Actions needed for vocabulary, data structure, tool preparation and data exchange.
[26] Cyber Security Act was enacted in June, 2017 (MIC "Information Communications White Paper" July, 2017)

implemented.

Furthermore, it is necessary for us to cope with such challenges as cyber security, personal information protection so that everyone may use global data distribution in a safe and secure way.

③ Future direction and major policies to be concretely implemented

The data exchange platform is constructed, while proceeding in cyber security and personal information protection with keeping interoperability with other countries such as the US and Europe.

i) Construction of the cross-domain data exchange platform

- With the CSTI and IT Strategic Headquarters exerting as control tower role, the cross-domain data exchange platform would like to be constructed in 3 years and put it fully operational within 5 years by SIP etc. through the collaboration of the related offices, ministries and agencies. In the ensuing years, the transferring operation of cross-domain data platform to the private sector will be studied.

[CAS, STI, IP, Individuals, MIC, MEXT, METI]

・Proceeding with construction of vocabulary, meta data[27], API etc. verifying in specified domains and areas (local public sectors, etc.), the initiatives will be undertaken in stages while activating the PDCA cycle.

・Constructing as consorted fields as to the basic functions and tools leading to promote data utilization/utilization, and as competitive fields about functions to be the source of value creation and tools upon construction of the cross-domain data exchange platform [28].

・International standardization of data exchange platform in corporation with industry-academic-government sectors by putting tools and schemes to be used/activated cross-domain data exchange platform among while maintaining consistency with trend about data protection, data distribution and intellectual properties strategy in foreign countries.

・Ensuring security function needed for cross-domain data exchange platform, by utilizing cyber/physical security measure platform, keeping coherence with Europe and North America etc.

・While keeping appropriate protection of personal information, initiatives for building environments conducive to its smooth transfer across borders will be promoted.

・Verification of construction of cross-domain data exchange platform as a test bed, by reviewing usage of university network basis in all Japan in order to activate regions' creation, utilizing the data exchange, making use of universities in a variety of regions as nucleus.

[27] Information to show what type of the data is about (IT General Strategy Office “Let's Begin the Open data ~ The Initial Manual for Local Authority~” (December, 2017))

[28] For example, vocabulary and code management function and such will be considered to be in the cooperation region, high-degree simulation and that of analysis in the competitive.

ii) Construction of the data exchange platforms on individual domains

- The relevant offices, ministries and agencies will secure interoperability of the cross-domain data exchange platform by maintaining domain vocabulary[29], meta data and API on individual domains in following domains for a time, in step with the advance of entire designing of the cross-domain data exchange platform.

[CAS, STI, Space, Ocean, MEXT, MHLW, MAFF, METI, MLIT, MOE]

<Agriculture>

-Strengthening and expanding the agricultural data exchange platform from production to processing, distribution through consumption in order to construct smart food chain system by fiscal 2022 to enable the interoperable utilization of data in the entire food chain.

<Energy>

-For building the framework of data exchange platform about energy domain in 3 years, planning to achieve it in fiscal 2018, with cooperating the relevant offices, ministries and agencies.

<Health/Medicine/Nursing>

-After the implementation of the Next Generation Medical Infrastructure Act[30], business operators involved in acquisition of medical information and making offering anonymized medical data[31] should be approved without delay.

-Full operation of data use/utilization platform from fiscal 2020 towards healthy longevity, together with data health reform.

<Autonomous Driving>

・Drafting technological specifications in fiscal 2018 while verifying dynamic map[31] and confirming its effectiveness.

・Initiatives for international standardization of dynamic map and its usages in other domains should be promoted.

< Manufacture>

・Towards realization of Connected Industries[32], bases for data utilization to be newly built for exchange data for manufacture to distribute and utilize data among different companies.

<Logistic/Commercial distribution>

・To create smart logistic services, constructing logistic/commercial distribution data platform by fiscal 2022 in order to share data among supply chains and collect/analyze distribution of individual product.

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[29] The vocabulary peculiar of an area, particularly major vocabulary put in order as the domain's mutual cording (hospital, station name, shelter and such), referenced in other areas, specified wording in each region in the domain specific vocabulary (hospital bed number, timetable and such) (IPA" Common Vocabulary Glimpse").

[30] Regarding anonymized medical data to contribute to R&D in the medical field. （Act No. 28 of 2017）

[31] The information connected with constructions and congestion changing with passage of time such as high-degree 3-dimensional map

[32] Seizing the opportunity of technical innovation utilizing the 4th industrial revolution, how the industry should be in the Society 5.0 composed of in the aimed future society. .

<Infrastructure>

・By opening of the infrastructure data, to accelerate open innovation by IT startup companies etc. for enhancing productivity through expanding i-Construction[33] and others, constructing of the infrastructure data exchange platform to exchange data among the Government, local autonomies and the private.

<Disaster Prevention>

- Expanding SIP4D for consolidation/integration/processing and provision disaster information in order to enable the local autonomies and the private sector to use disaster information by providing its data with more ease, not only by the relevant offices, ministries and agencies.

<Earth Environments>

-Maintaining stable, user-friendly operational environment by fiscal 2020 to develop the applications adapted for users' needs in DIAS, and to enhance academic and industrial to use the earth environment big data.

<Oceans>

-As part of enhancing MDA capabilities, continuously maintaining advanced information sharing system which collects and shares effectively and adequately ocean information by strengthening information collection structure, including development of auto-observation technologies by AUV and such.

<Outer Space>

- Constructing anew the satellite data platform to promote industrial use by offering satellite data which JAXA etc. owns, in a more user-friendly format to industries and universities, with promoting Geo space project[34] utilizing Geo Space Information Center and constructing of infrastructure of various satellites at the source of satellite data, along with

[33] Actions that progress productivity radically in whole construction process including survey, measurement, planning, execution, inspection, maintenance and renovation.

[34] Based on "Basic Act on Advancement of Utilizing Geospatial Information"（Act No. 63 of 2007）, geological space information (information indicating specified position & its related information. Also known as "G space information". Tackling to fulfill the people's safety & security and economic growth by realizing society enabling us to use the world advanced technologies.

(2)Construction of Data Infrastructure for Open Science

○ **Future visions to be pursued**

・Storage and management of research data[35] in cyberspace, considering the national interests, research areas, and open-and-close strategies[36], and construction of big "Source of Innovation" linking with foreign data infrastructure, thus allowing all the people to utilize the research results.

・Accordingly, acceleration of knowledge creation beyond the borders of the institution, specialized fields, and national borders.

○ **Objectives**

<Development and deployment of the repository[37]>

・Developing a system to facilitate the management, release, and search of research data utilizing institutional repositories[38] and starting operation in fiscal 2020.

<Development of the policies and plans for management/utilization of research data>

- Promoting the development policies and plans[39] for management and utilization of research data generated in the research projects.
- Based on the above policies and plans, promoting the release of the research data generated in the publicly funded research on data infrastructure, such as an institutional repository.
- Securing the interoperability and machine-readability of the research data generated in the publicly funded research by being mounted to the data infrastructure, and facilitating the linkage with data infrastructures in foreign countries, concerning the released data

<Personnel training and survey on the utilization of research data>

・Promoting the utilization of a skill-development program, and the improving the awareness of the researchers and research administrators in the universities and research institutes, conducting surveys.

○ **Major issues concerning accomplishing goals and future direction**

・Insufficiency of actions, such as non-publication of research results, with the exception of research papers, to the institutional repository, and insufficiency of the development of policies and plans on management and utilization of research data, and also insufficiency of awareness and basic idea of the researchers about management and utilization of the research data.

・Formulation of the guidelines by the CAO(STI) in fiscal 2018 to develop and manage a repository based on international certification standards and to promote the development of data policy in

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[35] Strategy of classifying data as to release in view of characteristics of data (open) and to protect (closed).
[36] Including evidence data of the research results such as research papers.
[37] Archive system on the Internet to store and release electronic intellectual products out of data infrastructure.
[38] The repository that universities & national R&D agencies and so on. It is managed mainly in universities in Japan.
[39] Policy for the management and utilization of research data will be developed in national R&D agencies until fiscal 2020. As for the plan, a system will be introduced into the funding agencies' and ministry's competitive research funding programs, for the researchers in publicly funded projects to manage the research data appropriately until the solicitation of the project proposals of FY 2021.

national R&D agencies.

- Promoting the development of the repository to store and release research data and the development of policies or plans to manage and utilize research data, considering the characteristics of research data, and securing the machine-readability and interoperability of the research data by being mounted to data infrastructure and facilitating linkage with foreign data infrastructures.
- Considering the scheme to contribute toward raising the awareness of researchers in universities and national R&D agencies, conducting surveys and analyses on the situations and achievements of researchers or institutions, such as the universities or national R&D agencies.

① Necessity and importance of data infrastructure for open science for innovation

After arrival of the age of letterpress technology, which enables large-quantity printing, a more open intellectual infrastructure has been built up, and with it logistics and intellectual property systems have followed. As a result, many innovations have been created and have contributed to the development of human beings.

Science, which is supported by an intellectual infrastructure built over systems of large-quantity printing and logistics, has dramatically changed and progressed by the development of ICT into science that is supported by the cyberspace. As a result, Open Science--which enables all people in academia and industry and citizens themselves to utilize research data in cyberspace and creates knowledge all together--has made great progress. In response to these changes in society, it is required to redefine the policy or management of the research data and to develop a new system.

Therefore, it is necessary to construct data infrastructure for open sciences as social infrastructure to create innovation to develop research activities and industries.

② Recognition of the current situation

The discussion of the transformation of scientific research, led by utilizing research data through the use of ICT and the development of infrastructure for the new innovation has progressed globally.

For instance, in the US, all 22 federal government departments--which have the role as funding agencies--have already developed a plan to utilize the research results of governmental research institutions under the jurisdiction of the each department. The EU has progressed with the integration of existing data distribution infrastructure. Furthermore, discussions on the international standards of the distribution of the research data has made progress among researchers and other professionals.

Although the number of institutional repositories are most numerous[40] in Japan, the installation of research data other than research papers to the institutional repositories has not progressed. Today, the development of a system[41] is underway to develop a platform to manage, release and search large amounts of research data, utilizing the institutional repository. The development of data policy with characteristics of research fields and institutions considered has not made much progress; as of the end of 2017, only two[42] national R&D agencies have already established the data policy[43], which is necessary to manage and utilize the research data. As can be seen from this situation, the management and utilization of the research data has not seriously progressed in Japan.

Similarly, the introduction of a system, such as the requirement for submission of data management plan[44], that promotes the appropriate management and utilization of the research data in the research

[40] The number of institutional repositories at Japan 744, US 500, UK 255, Germany 244 to be continuously followed (surveyed by NII).
[41] The principal developer is NII.
[42] JAMSTEC, NIES
[43] Institution's policies about management and utilization of research data.
[44] Plan for management & utilization of research data formulated by researchers with competitive research grants.

projects funded by competitive research grants, is insufficient. Also, the awareness and the basic idea of the researchers is low about the management and utilization of research data.
Japan must accelerate the establishment of data policy or data management plan, so as not to lose the chance to utilize the research data preferentially for Japanese industry and win the chance for foreign industry, as a result of the progress of release of research data without considering open-and-closed strategies

③Future direction and major policies to be concretely implemented

We facilitate the development of a system mainly as an institutional repository and the development and management of the repository based on the international certification standards[45] so as to release the research data from the repository in Japan.
Additionally, we facilitate the development of the data policy or data management plan considering the open-and-closed strategies. Also, we facilitate the management and release of the research data based on these policies and plans and the security of machine-readability of the research data funded by public funds by being mounted to the data infrastructure.

Furthermore, we make efforts to contribute toward raising awareness and acquiring the basic knowledge for persons who engage in managing and sharing the research data, such as researchers and research administrators. We also survey and analyze the situations and achievements of researchers, the universities and national R&D agencies so as to consider a scheme to raise awareness among the researchers.

ⅰ）Development and deployment of the repository

[STI, MEXT]

- Developing a system to facilitate the management, release, and search of the research data utilizing institutional repositories and starting operation in fiscal 2020, which is mainly considered in MEXT.
- Considering the development of the system to link the paper published in the full text database[46] with the data granted the identifier[47] to manage and release.
- Formulation of the guideline by the CAO(STI) (including the requirements to achieve searchability, and secure the interoperability with foreign data infrastructures of, concerning the released data) to develop and manage the repository based on international certification standards, and promotion of the application of this guideline to the universities and national R&D agencies, among others.,

[45] It here indicate the certifying standards stipulated by international certifying institution, CTS（Core Trust Seal） established in September, 2017.
[46] Aggregation of the information, including not only bibliographic information but also full text of research paper to browse
[47] Internationally acceptable digital information which unmistakably identify the research results.

・Linkage with the “Cross Domain Data Exchange Platform” by promoting the participation of related institutes to the establishment of domain vocabulary.

ⅱ） Formulation of policies and plans for management and utilization of research data

[CAS, STI, FSC, MIC, MEXT, MHLW, MOE, MOD]

・Formulation of the guidelines by the CAO(STI) before June, 2018 to facilitate the development of data policy in the national R&D agencies.

・Formulation of data policy[48] in the national R&D agencies, considering the characteristics of research field, international environments, industrial development, and, if necessary, open-and-closed strategies.

・Introduction[49] of a system[50], such as requirement to submit the Data Management Plan, into the funding agencies' and ministry’s competitive research funding programs for the researchers in publicly funded projects to manage the research data appropriately, considering the purpose and target of each program.

・Facilitating the release of the research data generated in the publicly funded research on the basis of the data policy or data management plan, and securing the machine-readability of the research data generated in the publicly funded research.

iii) Personnel training and survey on the utilization of research data

[STI, MEXT]

・Promotion of the attendance of an advanced program, which enhances the expertise of the basic program[51]developed and released in fiscal 2017.

・Survey and analysis from fiscal 2019[52], on the situations and achievements of the utilization of research data, research data for open science, on the following points from fiscal 2019.

As for the national R & D agencies and universities:

- Progress on establishing data policies, deployment of the repositories, and good practices on the utilization of research data.

As for the researchers:

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[48] The number of formulating agencies stood at two at the end of 2017. Japan aims for all 24 national R&D agencies (except three research funding agencies, AMED, JST, NEDO) (including cases of formulating within the research center and department and such in agencies)

[49] Japan aims for all 14 ministries and their funding agencies to introduce the system into their competitive research funding programs until the solicitation of the project proposals of programs of fiscal 2021 budget, though the number of the ministries/funding agencies that have already introduced the system is only four at the beginning of fiscal 2018.

[50] Development of a Data Management Plan, release in the designated repository, clarification of the name of data-creator in the report, and so on.

[51] The program is mainly for research administrators in universities to learn basic knowledge of the management of the research data, which was developed by the “Japan Consortium for Open Access Repository (JPCORE).”

[52] Prior survey was conducted on 1400 experts of science and technology in the “Survey about release of the research data and open-access of research paper (published in December 2017).”

- Progress on dissemination of the publicly funded research data, and on the bottlenecks and promotional factors for the utilization of research data.

(3) Evidence Based Policy Making/Promotion of University Corporation Management

○ **Future visions to be pursued**

・Contribute to innovation and economic growth by conducting EBPM accurately.

・ Particularly, activate innovation by public and private by distributing government R&D investment ,which will prime that of private sector.

・Displaying its potential, improving its management thru EBMgt by national universities and R&D corporations[53].

○ **Objective**

・Constructing “Evidence System[54]” and starting utilization inside the Government-run by fiscal 2019 and the national university corporations and R&D corporations by fiscal 2020.

・Contributing to organizing the next basic plan based on evidence, using follow-up of the Fifth Basic Plan utilizing “evidence system analysis.

○ **Major issues towards accomplishment goal and future direction**

・It is insufficient in Japan and to use secondarily and machine reading in various forms and modes with much of evidential data scattered in the offices, ministries and agencies and collect continuously plus analyze from various angles as big data which could be evidence

・ Constructing of evidence system to collect scientific/technological innovation-related data necessary for policy planning and corporation management including those held by the Government, the national university corporations and R&D institutions, while connecting・linking the same on top of securing possibility of secondary usability and machine reading.

① **Necessity and importance of evidence based policy making on evidence in innovation**

It is imperative for the Government to propel EBPM in order to conduct the administration trusted by the people by maximizing the limited resources. In order to realize in particular, policies from basic research to international evolvement at a stretch, utilizing the data held by different relevant offices, ministries and agencies beyond institutional walls, it's important to build the STI policy. Additionally, so as to develop high-degree management of national university corporations/R&D institutions, it is necessary for such entities to grasp not only their current situations but their standing positions as

[53] Carried in Attachment No. 1 of "Act on Improving the Capacity, and the Efficient Promotion of Research and Development through Promotion of Research and Development System Reform is promulgated herein."(Act No.63 of 2008)

[54] System that accumulates scientific technology data (input (funds, trend of human resources), activity (activity of university and R&D agency), output (paper, patent), outcome data (social & economic trend), and enables policymakers and agency operators to analyze them easily.

compared with others based on evidence.

② Recognition of the current situation

In Europe and North America, initiatives to collect and analyze the data related.[55] to STI and to utilize such data for developing relevant policies have long been put in practice.

On the other hand, in Japan, such initiatives with EBPM[56]by the entire Government has just started.

Data are scattered among different offices, ministries and agencies, and the structure for collection and consolidation is in insufficient conditions. Additionally, many are in a variety of forms and modes unfit for machine-reading with lost values and abnormalities, without standardization of items and contents, in the condition of instant analysis.

③ Future direction and major policies to be concretely implemented

In the future, CAO(STI) will construct "Evidence System" for analysis by collection・putting in order of data, statistical information and such of scientific technological-related budgets. On top of that, for that purpose in order to make necessary data usable, secondary usage, machine readability, standardization of data will be propelled.

i) Construction of "Evidence System"

- The CAO(STI) will implement the measures as below in collaboration with other offices, ministries and agencies in order to construct bases for EBPM and EBMgt by fiscal 2020.

[All offices, ministries and agencies]

・Propelling to verify in an approach to usage within the inside of the Government within fiscal 2018 and then within national university corporations/research institutions within fiscal 2019 in relation to "Evidence System".

・Connecting scientific technological innovation-policies-related data[57] within 3 years.

・Study issues and counter measures in fiscal 2018 on data collection and utilization, more effective reflection of budget/operation status of scientific-related budget[58] in line with administrative business review sheet in order to grasp data collection and budget execution operation status.

・Study on budget businesses activating budget businesses and scientific technologies depending on not necessarily scientific technologies how to supplement/tally as part of STI policy propulsion

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55 Conducted STARMETRICS in the US from 2009, RISIS Project in Europe from 2014.

56 "the Declaration to Be the World's Most Advanced IT Nation / Basic Plan for the Advancement of Public and Private Sector Data Utilization " (approval by the Cabinet at May, 2017) and "Basic Policy on Economic and Fiscal Management and Reform 2017" (approval by the Cabinet at June, 2017)

57 Scientific Technology-related budget data, data of fiscal and human resource of national university・R&D agency, Scientific Technology-related Statistical Data and such.

58 Scientific Technological Promotion Expenses (expense in the general account whose primary purpose set for scientific promotion) and science technology relating portion of national university operating expense grant and private schools grant, expenses for tackling of new enterprising, empirical test in the real society, promotion of existing technologies in real society

towards the Society 5.0 realization within fiscal 2018.

ii) Enablement of data utilization

- We will implement the following policy measures in order to have data and public statistic utilized in national university corporations・R&D corporations which are the primary subjects of innovation

[All offices, ministries and agencies]

・Under the cooperation of all offices, ministries and agencies, CAO(STI) will construct the scheme to be the foundation to utilize the funds and personnel in fiscal 2018.

・CAO(STI) will formulate the guidelines and model system thru the consortium, comprising of national university corporations and R&D corporations and such in order to proceed with streamlining of related paperwork and system in order to invest in ERP and such by fiscal 2020.

・CAO(STI) will put in order related standards system, regulations and rules in liaison of the related Offices, ministries and agencies in association of the above in fiscal 2018.

・ Starting the usage of investigation slip info by administrative officers at onsite facilities[59] by propelling concentration to statistical center of investigation slips info concerning machine readability of public statistics[60] data in fiscal 2018.

[59] Facilities which have high infomation security adn nable handling temporarily confidential data.
[60] Statistics provided for in Article 2, paragraph (3) of the Statistics Act (Act no.53 of 2007)

CHAPTER 3: Knowledge Creation

For “Knowledge Creation”, it will be necessary to incessantly conduct R&D management innovation so as to proceed effectively and efficiently at maximum out of limited resources as reference of advanced instances and such in other countries to be raised to those of the world top level by strengthening shouldering responsibility in universities, research institutions and research human resource radically.

In the Fifth Basic Plan, diversity of human resources such as younger and female researchers at universities, public research institutions and such, training, participate actively, increase in number of highly cited papers, integrated promotion and such of the national university reform and research funds system renewal, powerful propulsion of SIP showing clearly exit strategy and further development and evolvement of ImPACT have been determined. In addition, in the comprehensive strategy 2017, it has become important to personnel training to aim at innovation in a way to change the society, promote management and personnel system of universities and such, reform of the basis expenses, diversification of sources of fund.

Glancing at the current status, in addition to high-quality research paper[61] produced by WPI, the case in which universities being granted with large-scale contribution from private companies, improvements are observed such as industry-academia collaboration[62] activities the COI Program aiming at innovation(s) to be begin with and patents permits etc. are on the increase[63] from universities. On the other hand, the investment from the industrial sector to universities and national research institutions stay at low level compared with foreign nations. Furthermore, the ratio of teachers and instructors aged 40 in all universities and under, coupled with international share of the top 10% most-often cited papers has been on the decrease since 1989.

Besides the above, in the world university ranking which students and industries use as reference indicator, that of Japan is observed on the decrease in tendency.[64] It has all been illustrated that in the NISTEP survey at the fixed points (targeted at researchers at universities and public institutions)[65], the environmental preparation for younger researchers, the number of younger researchers independently engaged in R&D, and the allocation of research money in universities are insufficient in either of these

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[61] The proportion of top 1% most-cited papers in total papersout of 5 centers is4.63%（average of 5 centers）, Rockefeller Univ. 6.24%, MIT 5.30%, California institute Univ. 4.40%, Harvard Univ. 4.39%, Stanford Univ. 4.14%（”Web of Science” Data（2007 to 2013）based, calculated by JSPS）

[62] Number of joint research with private companies and acceptance of research expenditure as below; 17,881 cases, 39 billion yen in 2013, 19,070 cases, 41.6 yen in 2014, 20,882cases, 46.7 billion yen, 23,021 cases, 52.6 billion yen in 2016 (MEXT “FY 2016 implementation status of industry-academia collaboration at university” (Feb.2018))

[63] FY2013：9,856 cases, FY2014：10,802 cases, FY2015：11,872 cases, FY2016：13,832 cases（MEXT ”FY 2016 implementation status of industry-academia collaboration at university”（February, 2018））.

[64] ”World University Rankings 2015-2016” by Times Higher Education of UK ：2 within 100th, 5 within 300th, , 16 within 600th, “World University Rankings 2018”：2 within 100th, 5 within 300th, 12 within 600th

[65] NISTEP “Analytical Report for NISTEP Expert Survey on Japanese S&T and Innovation System 2017(NISTEP TEITEN survey 2017)”” (Apr. 2018)

areas. In light of such situation, it is necessary for us to strengthen the governance based on presidential leadership, diversity the financial resources, creation of utilization opportunities of young researchers, enhancing mobility of personnel, reforming competitive research grants integrally, and responding to globalization and such.

(⇒"CHAPTER 3　①Creation of innovation ecosystem with university reform and such")

As for R&D, management methods toward creation of achievement in advanced countries in R&D have been remarkably advanced and it is necessary for R&D management in Japan to review and improve, through the advanced technologies and such introduction at all times. R&Ds in universities and such are generally divided into what aims at pursuit of truth, what aims at contribution to the socio-economic activities, and such. About the latter in particular, it is required to produce results by sharing exit strategy with various stakeholders involved in its process, keeping an eye on the social implementation from the developmental stage.

Out of the above, appearing is the result of strategic R&D in SIP of model cases for soliciting of the innovative creation towards realization of the Society 5.0. But not satisfying with these, as an opportunity to start SIP (the 2nd term) and aim at overseas deployment, it is necessary to re-think the strategies of global intellectual properties, international standardization and the system renewal.

In particular, by paradigm change of industrial structure centering on the ICT field, since the 1990s, the world trend is from enclosure of intellectual properties to that of open innovation while co-working and competition both by activating intellectual properties in and out of Japan doing business in open innovation rapidly is advancing, and it is necessary to construct open and close strategy.

Also, through the management method tried in SIP and strategy as applied for PRISM, cross-cutting deployment of the whole Government R&D is needed.

On one hand, there remains for drastic improvement involved in R&D accompany failure risk(s) , impacting much, if successful, in our county's system averting failure as evil, indispensable to daringly challenge new trials with no fear of failure in order to bear non-successive and disruptive innovations enabling to change of rules on one hand. As for the Government high-risk research innovative enterprises, today, other than ImPACT, NEDO-unbeaten challenge 2050[66] there are JST Mirai-Project[67] and such amidst advancing high-risk R&D, as Japan it is necessary to cope with betterment such as utilization of securing of management personnel, lessons ensured from failures the related offices, ministries and agencies with CSTI in center in order to spread and fix in the broad Government challenging R&D methods ImPACT has propelled by improving and strengthening in light of ImPACT

[66] Not listed on the existing line, projects for the purpose of contribution to exhaust reduction of greenhouses effective gas of circa 2050, future national project and the ways to getting ideas not dependent on the diffusion to the society.

[67] Research program aims the phase of recognition of implementation possibility in light of social and industrial needs, with technologically challenging aim, considering target (exit) that has economic and social impact, through utilization of promising result of JST Strategic Basic Research Programs and KAKENHI.

experiences in the final year of 2018.

It would be needed, additionally, taking forwardly failures, analyzing and evaluating causes to fundamentally transfer how to utilize them as assets as the next step.

(⇒CHAPTER 3　2. Promotion of Strategic R&D (SIP, PRISM, ImPACT)）

(1) Creation of Innovation Ecosystem with University Reform and such

○Future visions to be pursued

・Constructing innovation ecosystem to be the core of knowledge-intensive industries at sites throughout Japan.

<Improvement of Management Environment>

・The investable funds for education, research and personnel will increase by governance strengthening, by not only public funds, but also, strategic management enlargement of private strategy, and collaboration between industry and academia.

< Personnel mobility and younger members participation>

・As universities as whole, realization of balanced positioning of personnel including young, female and foreigners to enable to create each university's characteristics.

<Rising research productivity>

・Upon acquiring competitiveness, even more positioning and new regions at the right place along with increasing the challenging opportunities to excellent younger researchers not bound by age.

<Borderless challenge "Globalization, Large-scale collaboration between industry and academia ">

・Constructing the management structure to enable the full-fledged collaboration between industry and academia in the environment of international brain circulation.

○Objective

<Improvement of management environment>

Toward the construction of a system to allow the utilization of diverse views for strategic university management,

・By fiscal 2017 double[68] the number of research university[69] to appoint more than one outside directors compared to fiscal 2017.

Toward the formulation the management foundation to enable expanding outside funds such as private funds and contributions.

・By fiscal 2025 triple[70] investment amounts by private enterprises to the universities/national research institutions compared to fiscal 2014.

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[68] Fiscal 2017 result* 31 %.

[69] 16 national universities classified as type 3(excellent education-research type) in the differentiation of operating expenses grant in the third mid-term: Hokkaido Univ., Tohoku Univ., Tsukuba Univ., Chiba Univ., Tokyo Univ., Tokyo Univ. of Agricultural and Technology, Tokyo Institute of Technology, Hitotsubashi Univ., Kanazawa Univ., Nagoya Univ., Kyoto Univ., Osaka Univ., Kobe Univ., Okayama Univ., Hiroshima Univ., Kyushu Univ.)

[70] " Japan Revitalization Strategy 2016 towards the 4th Industrial Revolution" (Decided in the Cabinet in June, 2016) set. Research development expenses spent by industries in universities and national R&D agencies (2014): 115.1 billion yen in Japan (0.02 % against GDP), ("the Survey of Research and Development" by MIC(December, 2015) , Germany 484.8 billion yen(0.12% against GDP), U.S. 382.6 billion yen (against 0.02 %against GDP), China 1,166.2 billion yen (0.11 % against GDP) (OECD "Gross domestic expenditure on R-D by sector of performance and source of funds")

< Personnel mobility and young member participation>

In an effort of realization of the age construction to enable to participate,

- By fiscal 2020 increase the number of university teachers[71] under 40 in age by 10%[72] compared to fiscal 2013[73].
- By fiscal 2023 bring the proportion of full-time university faculty less than 40 years old to 30%[74].

＜Rising research productivity >

Towards realization of research productivity on a par with major nations in the world,

- While increasing the total number of papers increase the proportion of the top 10% most-often cited papers among the total number of papers to 10% and over [75] by fiscal 2020.
- While increasing the number of papers per one research university teacher and that of grand total, increase the proportion of top 10% most-often cited papers to no less than 12 %[76] by fiscal 2023.

Towards increasing of the ratio of younger researchers eligible to acquire research expenses.

- Having the ratio of young researchers which shares the adopted number in scientific expenses surpass 10 points and over[77] by fiscal 2023.

Toward establishment of opportunities for younger researchers through improving research environment,

- Surpassing the increase ratio[78] in science map participation regions surpass that of the entire world by 2023.
- Securing over 50 %[79] of time spent for research out of work activities of assistant professors.[80]

<Borderless challenge (Globalization, large-scale collaboration between industry and academia)>

Towards globalization of researchers and universities,

- In universities where globalization is thoroughly promoted[81], increasing the number of Japanese teachers with doctor's degree earned in a foreign university and with experiences of research and

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[71] Regular teachers (including those with tenure)
[72] Set in the Fifth Basic Plan. The proportions of young (under 40) teachers (2014): UK 29 %, France 29 %, China 45 %, Germany 55 %, (NISTEP "Japanese Science and Technology Indicators 2017" (August, 2017).
[73] 2013 yardstick: about 44,000 (about 25 %) (MEXT "school teachers' statistics investigation" (March, 2015)
[74] The proportion of teachers under 40 and less(FY 2017) : About 27% (About 8,900 persons) (survey by MEXT)
[75] Set in the Fifth Basic Plan. Calculated from 2013-2015 average (whole number counted): Japan 8.5 %, China 10:6 %, Germany15.1%, U.S. 15.2 %, UK 17.0 %(NISTEP "Scientific Research Benchmarking2017" (August, 2017)).
[76] Calculated from the average figure 2011-2013 : 10.3% (NISTEP "Japanese University Benchmarking Focus on Research papers 2015" (December, 2015) of which NISTEP gathered and calculated)
[77] Increase the proportion of young researchers in adaption thru allocating more to items centering on young researchers.
[78] Growth rate of participating domains of Science map from 2004 to 2014: entire world 1.3-fold, Japan 1.1-fold, U.S. 1.3-fold, UK 1.5-fold, Germany 1.4-fold, China 3.2-fold (CAO(STI) calculated based on NISTEP "Science Map 2014" (September, 2016).
[79] Research time ratio in 2012: 40.8 % (MEXT "Survey on Full Time Equivalent Data in Universities" (March, 2014)
[80] achieved by fulfillment of research assistant human resources quality and quantity and research assistance to young researchers, improving how better use research expenses.
[81] Universities adopted as type A of Top Global University Project(MEXT), for improving international applicability and competitiveness of Japanese higher education (13 universities)

educational activities by 30 % over[82] the fiscal 2017 yardstick by fiscal 2023 according to the characteristic of their respective fields. (use of joint degree, double degree encouraged)

・Increasing the number of courses to over 300[83] where students could finish courses in English only by fiscal 2023.

・Rising the increase rate of the number of internationally co-authored papers in the top 10% most-often cited papers to the levels of Europe and the US by fiscal 2023. [84]

Towards improving environment where holders of doctor degree(s) can be active.

・Hiring over 2,000[85] with doctor degree(s) in scientific and/or technological hired by the industry by fiscal 2023.

(Reference: Ranking)

・Putting 10 universities on the world's top-100 university ranking by fiscal 2023.[86] And aiming at putting the designated national university corporations within the above top-100 ranking. Also, as for research universities, aiming at upgrading on the list, field by field, utilizing the advantages and characteristics.

○Major issues towards accomplishment goal and future direction

・When it comes to construction of innovation ecosystem with research universities and national research institutions serving as a nucleus, there are "walls" in existence concerning university and such management environment, personnel affairs rigidity/aging, research productivity, borderless challenge (globalization, large-scale collaboration between industry and academia).

・Breaking these walls is required, together with improving drastically management environment at universities, facilitating utilization of younger researchers, human resources mobility improvement and realization of expanding of outside funds from industry-academia collaborations and such.

・These institutions need to be transferred to organizations capable of competing with the world in creating academic values and innovations, securing the basis for execution of strategic management responding to individuality and characteristics fields such as university missions as strong points.

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[82] 2017 result:1,331 persons (MEXT)

[83] The number of research departments where you could finish courses in English only FY2015: 247 research courses/3114 courses (national, public and private universities) (surveyed by MEXT).

[84] The change in internationally co-authored paper number among the top10%most-often cited papers (growth rate from 1998～2000 to 2013～2015) : Japan 2.1 fold, U.S. 2.7 fold, France 2.7 fold, Germany 2.9 fold, UK 3.1 fold, China 14.8 fold （CAO(STI) calculated based on "Science technology benchmarking 2017"）

[85] Hired Number of Persons in 2014: 1,257 Persons (Surveyed by MEXT).

[86] Set in " Japan Revitalization Strategy Japan is Back" (Decided in the Cabinet in June, 2013). Further, not targeting at being ranked in, but we must note that enhancement of research capability should be more important thru aiming at being ranked. The number of ranked universities by nation, for instance, Japan's universities are 89 being no. 3 following the US and UK (top 100 is only 2 in Japan out of all 1,102 schools ranked according to Times Higher Education of UK.

① Necessity and importance of university reform in innovation

It has been pointed out that measures of Japan to strengthen research capabilities relatively lagged behind amidst worldwide competition over innovation.

It is also necessary to give vitality to universities where epoch-making or, in other words, disruptive, science, innovation and technologies in order to realize sustainable growth in Japan by winning in the global competition. For that purpose, from an international viewpoint, it will be an urgent and inevitable issue to break “the wall” such as management environment, personnel affairs flexibility, research productivity and borderless challenge and such, and construct the innovation eco system.

In the environment where the social structure is rapidly altering in Japan and the basic research is directly connected with business and innovations, universities through reform will be strengthened than ever and by continuously providing human resources to the society bearing “knowledge” or the basis of yielding innovations, it will be expected to solve the social issues and yield continuity of vitality and growth of the society.

Moreover, it is important for the national research institutions common to national institutions bearing intermediary function between the industry and the academia to simultaneously continue their reform together with university reform according to characteristics of each institution.

② Recognition of the current situation

i) The wall of management environment

The national universities even after their incorporation are weak in their management bases in comparison to influential research universities in Europe and North America, since diversification of finances are not fully intended in operation dependence on the national coffers with scarce acquisition of private funds. Furthermore, with lack of managerial human resources, it is indispensable to adequately share and split management and education research in order to strengthen the management foundation and to improve their management environment of the national university corporations.

ii) Rigidity of personnel affairs and the wall of aging

In the reduction of operation grants, competitive research grants are on the rise, and so are those of the university operation, the extension of the mandatory retirement age has been in practice, reflecting the entire trend of the society together with restraint of new hiring of tenure-less posts in each university. As a result, amidst the increase of teachers, young teacher's ratio under 40, that of mid-career/senior teachers and those with tenure is also on the increase. So as to activate research environment, it is necessary to thoroughly treat them reflecting right-place, right-person positioning, irrespective of mobility of researcher's age and their achievement.

iii) The Wall of Research Productivity

In Japan the cost is high for one quality research paper in comparison to advanced countries in Europe and North America, hence lowering the research productivity.[87]

amidst increasing the number itself and that of frequently-quoted in Europe and North America plus China and Korea, etc. in Japan in the recent years, its relative position, and number have not been so bad, but staggering in participation number into internationally attention-catching research fields, it is also pointed out that the time of assistant professors in the health areas ratio allotted to research has been on the decrease as a result of an increase in time for education of students, clinical activities and such.

ⅳ） The wall of borderless challenge (Globalization and large-scale academic-industry collaboration）

In order to raise international acceptance in research, it is necessary to encourage human resource mobility across the borders and joint research, and activate R&D projects of universities and research institutions undertaken in collaboration with the industry.

Japan's share in the number of the top 10% most-often papers has been rapidly falling since around 2000 and our small number of internationally co-authored research papers in comparison to other nations is cited as a reason. Furthermore, there is an analysis that the researchers moving across borders and the quantity and quality of internationally co-authored research papers are co-related.[88]

On top of that, it is necessary to further promote industry-academia collaboration in order to advance the research at universities and national research institutions for developing innovations. Various promotion policies of the industry-academia-government collaboration such as the TLO Act[89] enactment have been put in place in our country up until now, and our country's industry-academia collaboration activities gradually have expanded. However, in comparison with overseas, the number of technological transfer cases and amounts of money are still insufficient[90] and even in joint researches of which many are undertaken based on personal relations between university teachers and such and researchers in industries, the structure to promote large-scale

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[87] " INTERNATIONAL COMPATATIVE PEFOMANCEOF TH UK RESEARCH BASE, 2016" (October, 2017). Note: in study of research productivity, it will be particularly necessary to note time lag between research expenses and paper production/publication. Especially in case of international comparison, variation among countries in calculation of research expenses and the number of researchers, characters of research and price variance between inside and outside of machines and equipment should be took into account..

[88] Caroline S. Wagner & Koen Jonkers, "Open countries have strong science.", Nature, No.7674, pp.32-33, 2017

[89] Act on the Promotion of Technology Transfer from Universities to Private Business Operators(Act No.52 of 1998)

[90] The number of licenses and revenue : Japan(case number continuously: 7,556 cases, new cases: 2,846 cases, revenue-causing case: 5,224 cases, revenue amount from license: about 4.3 billion yen, revenue amount per 1 case: 806 thousands yen), U.S.(case number continuously: 44,902 cases, new cases: 7,942 cases, revenue-causing case: 20,393 cases, revenue amount from license: about 2,520million US dollars, revenue amount per 1 case: 124 thousands US dollars)(Quoted from UNIITT University Technology Transfer Survey "University IP Annual Report 2016")

collaboration between industry-and academia on an academic organization vs. industrial organization basis is not sufficiently formed as noted in small amounts[91] received for research expense per case.

③ Future direction and major policies to be concretely implemented

In order to promote university reform, human resources mobility and young member's utilization promotion will be improved by achievement-based processing and introduction of annual salary, and management environment will be drastically improved by strengthening governance and the management basis. Furthermore, by human resources/research globalization and borderless challenge by collaboration between industry and academia promotion in addition to research productivity improvement, sustainable innovation creation will be promoted.

i) Improvement of management environment

・In order to force through the university reform and to construct the innovation ecosystem along with strengthening the governance based on university president leadership, the finance diversification and university linkage/reorganization and such, strengthening effective management base will be promoted.

[CAS, STI MIC, MEXT, MHLW, MAFF METI, MLIT, MOE, MOD]

<Promotion of university collaboration and reorganization>

・MEXT will proceed with examination of creation of "university cooperation promotion agency (tentative name)" outside of the framework of universities and such collaboration and function sharing facilitating in consideration not to rescue universities having managerially problems, together with enabling management of plural national university corporations under one single entity[92] by revising the National University Corporation Act[93] within fiscal 2019. (facilitating collaboration and re-organization of universities and such to effectively activate the limited resources in the society of 18-year old on the decrease)

<Formulating university governance code>

・The parties related to national university corporations will formulate the national university corporation code (change to the organization to enable to acquire and distribution of management resources under the leadership of the head of each university) within fiscal 2019 under cooperation of CAO(STI) and MEXT.

< Establishing what is tentatively called "Industry, Academia and Government Forum for University Reform Support (tentative name)">

・The university-related parties will strengthen and institutionalize the so-called "horizontal

[91] Scale of about 85% out of joint researches in fiscal 2016 was under 3 million yen. (Surveyed by MEXT)
[92] National University Corporation Act stipulates that one corporation manage only one university.
[93] Act no. 112 of 2003

collaboration" between the parties participating in university reform and management[94] within fiscal 2019 under cooperation of CAO(STI) and MEXT. (conducting exchanging opinions and creating an information sharing place, spreading good examples horizontally, training top management at each university and such)

・Additionally, promoting "IR of university version". (standardization of data base about university management and education and research, by visualizing university-owned seeds, promote university's public relations concerning its enchantment to industry)

<University function strengthening by national university corporation management reform promoting businesses and such>

・CAO(STI) and MEXT will, through national university management reform promotion project and other related projects, start assistance together with presidential expenses at discretion, conducting eager and forward-looking management reform with a sense of speed from fiscal 2018. (further promotion of university function strengthening by assisting the management reform by president leadership)

<Increase of the Number of Corporations to Hire Outside Board Members in National University Corporations >

・Stipulating through a revision in the Act Governing National University Corporations to be made in fiscal 2019 that in case of appointing more than one outside board member, such appointment be exempt from the legal number of directors specified.

<Diversification of Finances in National University>

・Indirect expenses related to competitive research grants and/or joint and entrusted research funds from the private sector will be clarified thorough introduction of jointly-usable financial accounting money and personnel salary system and they will be thoroughly introduced[95]. In addition, effective utilization of university assets will be promoted through accepting donations from industrial circles and such (including those, other than direct and indirect expenses, necessary for fulfilling and strengthening activities for industry-academia collaboration by consent from the industry) and through strategic facility management., etc..

＜Introduction of the system for acquirement of private funds and such[96]＞

・To national universities centering on research universities, according to securing private funds and such, studying within 2018 about incentive schemes distribution of the operating grants through evaluation, introduce experimentally in no time. (promoting dramatically acquirement

[94] The management (president, provost and such), outside director, outside　member of management council and such.

[95] In fiscal 2016 maximum 30% indirect expenses with public grant has been provided on a trial basis, and in fiscal 2018 it has been done in full-scale. With private grant effort will be made on indirect expenses of the industry-academia cooperation (joint and entrusted research).

[96] In response of Japanese universities' characteristics, the scheme operating together with the industry-academia collaboration (research, joint and entrusted), donation, asset utilization and such will be contemplated.

of private funds, strengthening the management bases, according to universities characteristics inviting private funds, and decreasing dependence on the management expenses grants)

ⅱ）Promotion of human resources mobility and creation of opportunities for young people

○ For creation of opportunities for younger researchers, promotion of human resources mobility, motivation of teachers and functional enhancement of national universities, advancing processing based on strict performance and introduction of annual salary system coupled with various effective and aggressive initiatives on personnel salary management reform

[STI, MEXT]

＜Promotion of personnel and salary management reform including expanding introduction of annual salary system＞

- National universities expand annual salary system with performance pay based on strict performance evaluation in stages, aiming at complete introduction of the system[97]. To this end, national universities introduce the system to all newly hiring teaching staff in principle, and boldly accelerate the introduction to tenured senior teachers.
- Additionally, national universities properly distribute the budget at discretion of president[98] etc. to young members of teaching staff in order to increase their motivation for research and education and to develop their capacity.
- Also, national universities promote hiring women, foreigners and persons from outside own university for diversity of teaching staff.
- MEXT, in consultation with CAO(STI), reflect progress in personnel and salary management reform to the evaluation concerning national universities operation grants functional enhancement re-distribution[99] and president expenses at discretion from fiscal 2019[100] in order to promote personnel and salary management reform[101] to begin with annual salary system.
- CAO(STI) and MEXT regularly inspect, publicize and improve as required status of personnel and salary management reform including effects on implementation of annual salary system and performance evaluation by FY 2021.

＜Improvement of senior teacher's mobility＞

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[97] The salary system of yearly basis with performance pay based on strict evaluation, including systems without installment/advance payment of retirement benefits. In the case of retirement benefits attached, it must would not necessarily be advantageous due prolonged tenure.
[98] In the fiscal 2018 budget, about 40 billion yen of national university operating expense grants was earmarked.
[99] Based on evaluation result, fund (so far, about 10 billion yen each year) from each national university corporation operating expense grant was re-distributed in the Third mid-term objective period (FY 2016-2021). Roughly 30 billion yen is transitioned from university "trunk expenses" to "function strengthening expenses" in three years to fiscal 2018.
[100] The personnel and salary management reform plan will be positioned in the mid-term plan of each national university corporation in the 4th term mid-term objective period (2022-2027) after inspecting progress in the personnel salary management reform including the introduction of the annual salary system in the national university corporation 3rd mid-term objective period latter-half (2019-2021).
[101] Includes improving mobility of senior teachers.

・The national universities will construct the scheme[102] not to be favorable only to prolongation of tenure in order to adjust the age construction, along with strict performance-based evaluation and introduction/promotion of the above-mentioned annual salary system to accelerate senior teacher's mobility at the national universities.

・CAO(STI) and MEXT regularly verify and evaluate the status of efforts by national universities mentioned above.

<Aggressive utilization of cross appointment system>

・The national universities will provide its incentives on salary teachers who will conduct cross appointment by flexibly utilizing the fund from private enterprises as important tool to acquire outside funds aggressively activating a cross appointment with private enterprises and overseas education research institutions.

iii) Improvement of research productivity

- We will build an environment where researchers could devote themselves with research by activating a variety of outside funds along with encouraging a challenging research which could liberate them from miscellaneous duties and personnel training.

[CAS, STI, FSC, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD]

<Taking a fresh new look on the whole at competitive research grants[103]>

・The related offices, ministries and agencies including MEXT will conduct comprehensive review of competitive research grants through such steps as promotion of allocating scientific technology grants to younger researchers and to challenging research on priority basis.

(a) In the Grants-in-Aid for Scientific Research (KAKENHI), MEXT will review the priority of its distribution, from large-scale projects to young researchers.

(b) In JST Strategic Basic Research Program, MEXT will set a strategic objective[104] under a broad and sustainable vision along with fulfilling challenging researches.

(c) In terms of exit-oriented projects for promoting the industry-academia collaboration and social・industrial needs, the related ministries and agencies will facilitate to coordinate with their related projects.

(d) The related ministries and agencies will examine to introduce and fulfillment schemes, stressing younger members training and support in each system (except (a) (b)) of competitive

[102] For instance, salary standard review reflects the study trends of reviewing of retirement allowance, introduction of fixed-term system and mandatory retirement age hike of government officials,.

[103] Research-related grant in revenue which universities and research institutions competitively garnered by public offerings by the ministries and agencies (including "competitive funds" stipulated by "the Third Science and Technology Basic Plan" (decided in the Cabinet in March 2006)).

[104] Under the vision showing the image of the society to be realized, set will be focused area contributing to opening of new interdisciplinary research areas .

research grants.[105]

(e) The related ministries and agencies will compile the conditions of voluntary-based research activities while young researchers are hired by competitive research grants.[106]

<Priority investment of resources and system reform toward research capability enhancement>

・MEXT to implement strategic investment/system renewal, joint utilization/research capability enhancement acceleration plan[107] strengthening of joint research structure about businesses with high-degree research productivity.

<Promotion of training younger researchers>

・MEXT is making the stage and streamlining of independent research environment for younger researchers to be able to tackle their research resolved and settled under competitive environment and build their carrier in preparation of implementation status of ”Leading Initiative for Excellent Young Researchers”.

＜Qualitative fulfillment of research administrator＞

・MEXT and the related organizations to initiate studies to facilitate the research and study concerning the structure design and trial towards construction of quality guarantee system on practical ability of research administrator[108] from fiscal 2019.

＜Training personnel with cross-cutting bird's eye view and originality>

・MEXT, to institutionalize “degree program beyond the framework of organizations”[109] from fiscal 2019 in order to implement flexible cross-department personnel training.

・MEXT will promote problem-solving-type personnel with originality, bird-eye view power and high-degree of expertise together with outside funds from industries in addition to emphasizing intra-university resources in “Program for inter-institutional, inter-sectorial collaboration on innovative doctoral education” comprising of high-degree education research program by collaborating with industries (strengthening of excellent graduate schools pulling innovations on educational research in Japan).

<Promotion of maintenance and share of research facilities, equipment etc. >

・MEXT will proceed with building the network in order to mutually make full use of research

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[105] Setting of research grant for young researchers, considering proposals as added factor from young researchers at evaluation process.

[106] Clarify conditions that should be required when postdoctoral researchers hired by governmental project research themes not included in that project in the universities they belong to and y and standard of improvement of usability of competitive research grants.

[107] In details, in addition to combination of (a) and (b), expand Research Fellowship for Young Scientists which contributes to research capability improvement and construction of researcher network, strengthen function of Inter-University Research Institute for creation of new research domain and interdisciplinary merging and innovation promote reform based on evaluation of joint usage/research centers in universities and create international joint usage/research centers.

[108] Assume enhancement of research capability and fullfillment of research environment.

[109] Expected flexibly forming inter-departmental curriculum by assembling the resource of university departments, etc., improve management of faculty and promote curriculum innovation.

facilities in the near neighborhood, proceeding with streamlining and mutual use the advanced research facilities, equipment and device of universities and research institutions (full use of R&D investment effects, supporting partnership between industry, academia, and government)

< Understanding the actual situation and analysis of research sites >

・MEXT to conduct the systematic grasp analysis on effects to research results (number of research papers etc.) from fiscal 2019 by studying their research environment and characteristics (including hours, funds, structure, management). (grasping and diffusing of characteristics of research environment with successful results).

iv) Borderless challenges (Globalization, Large-scale collaboration between industry and academia)

- Promoting thorough globalization and collaboration between industry, academia, and government both in terms of human resources and research beyond the borders of the countries and the domains of industry, academia, and government in order to continuously create innovations based on wide-ranging knowledge, viewpoints and inspirations and such.

[STI, MIC, MOFA, MEXT, MHLW, MAFF, METI, MLIT, MOJ, MOE]

<Promotion of researcher's transborder challenge>

・MEXT through utilization of the Joint-Degree[110], Double-Degree[111] will promote training researchers with international view points and sending them overseas[112] and ensure international human resources mobility through improving their employment improvement. (taking in world's knowledge and promoting researches internationally acceptable based on global view point and inspirations)

<Strengthening of collaboration with overseas enterprises in order to win global competitions>

・The Cabinet Office (STA) will consider the direction of issues and solutions and develop guidelines related to collaboration with foreign enterprises during fiscal 2019 regarding obtainment of funds from overseas that contributes to an increase in funds obtained from overseas or collaborative research between Japanese universities/national R&D agency and foreign enterprises, international competitiveness is strengthened in Japan).

＜Promotion of open innovation>

・MEXT will promote streamlining of open innovation institution[113] aiming at intensive

[110] Presenting one single degree jointly by the involved plural universities when students finish joint education programs set up by linked universities

[111] collaborating universities give each degree to students, when students finish equal degree level education programs in each university y, and meet each graduation requirements.

[112] clarify directions of and solution enhancement of international human resources mobility and increase the number of doctors by promoting joint degree and double degree with foreign universities.

[113] structure building and organize excellent researchers inter-disciplinarily and inter-departmentally to facilitate genuine industry-academia collaboration like "organization" vs "organization" large-scale joint research

management of large-scale joint research deeply related to industry's business strategy (strengthening the structure for industry and academia collaboration management at universities)

<Maximization of measures effects by collaboration with the industry>

- METI and MEXT will promote visualization of technical seeds possessed by universities through, for example, reinforcing the fact book for comparing initiatives in industry-academia-government collaboration at universities across Japan in light of “Guidelines for Enhancement of Joint Research through Industry-Academia-Government Collaboration” in fiscal 2018.
- The Industry will aggressively hire doctor's degree holders through the consortium with the universities by sharing its needs, issues, know-how, and cooperating in personnel training of students in doctor's degrees via scholarship and industrial-academia joint research.
- MEXT will promote effective technologies transfer of research results in order to strengthen the network among universities, industry and TLO through initiatives towards formation of innovation management hub (tentative name) from fiscal 2019.

(2) Strategic R&D (SIP, PRISM, ImPACT)

○ Future visions to be pursued

・To realize sustainable innovation creation under definite management, with R&D of various economic・social for issues solution and defiantly challenging R&D working as both wheels of a car driven in exquisite balance.

○ Objective

In light of the global benchmark etc., by setting R&D objectives cast backward from the industrial and social positions, aiming at accelerating innovation creation by strategically devising R&D.

<SIP>

・To realize social implementation early in the world norm and under SIP-type management[114] and strict PDCA without waiting for the project conclusion.

<PRISM>

・Through PRISM implementation, leading R&D of the entire government to "Target Regions"[115] while cross-cutting spreading the SIP-type management in the entire government.

<ImPACT>

・Spreading and entrenching the ImPACT R&D method[116] in the entire government R&D sites and producing world pioneering, innovative research results one after another.

○ Major issues towards accomplishment goal and future direction

・There are various issues about SIP and ImPACT which both began in fiscal 2014 such as "institutional problems and issues towards social implementation, "Necessity to expose problems (SIP)" and "insufficient supporting structure for PM and insufficient heeding of outside opinions (ImPACT)" are the examples.

・In light of these issues and points, improvement and strengthening of R&D method of ImPACT to enable bold challenges even allowing failures, we will proceed with R&D which will spurn out non-continuous innovations in the entire government, continuously and stably by studying schemes which will promote R&D selectively and intensively under more aggressive concept.

・Also, while contemplating the necessary improvements about SIP (the 2nd term), we will strongly promote R&D along with PRISM established in fiscal 2018.

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[114] The management method equipped with features of arrangement for PD, clear goal setting and detailed progress management, construction of the integral industrial-academic-government collaboration system, etc.

[115] The region expected of contribution to optimization of government expenditure by private investment inducement effects and utilizing R&D result. Proceeding the study by "Committee on Target Areas for Funds to Promote Public and Private Investment in Science, Technology and Innovation", the 3 regions to be practiced in fiscal 2018（(1) Cyber space platform technologies（AI//IoT/Big data）,(2) Physical space platform technologies（Sensor/ Actuator/Processing device/Robotics/Light /Quantum）,(3) Construction and infrastructure maintenance technologies/ Natural disaster prevention　and disaster reduction technologies）were set..

[116] Mode to propel challenging R&D stressing unconventional unique conception・idea, economic and social impact.

① Necessity and importance of strategic R&D in innovation

Today when economy and society has highly developed the issues we face have also complicated and in order to solve those through technological breakthrough, not only spurn out seeds technology, but needed will be technical development set on practical and social implementation in order to adequately pass the benefits to the society, including the systematic exit.

On the other hand, it will be important to concurrently proceed with high-risk and high-impact R&D towards future industrial creations and social changes since these nonsequential and disruptive innovation sort of most recent socio-economic problems not necessarily arise from the R&Ds alone. in order to connect these with seamless innovation's creations, tackling strategically will be necessitated and important to spread and fix in the whole government structure as R&D method taken in by CAO(STI).

② Recognition of the current situation

In Japan, towards realization of "the world most innovation-friendly country", the result will be bearing fruit about control tower SIP and ImPACT, already-started back in fiscal 2014.

In SIP, for instance, as basis needed for automatic driving along with making high-degree three-dimensional map developed SIP4D and MP-PAWR etc., as actual and empirical evidence in the 2016 Kumamoto Earthquake and the 2017 Northern Kyushu torrential rain as business and MP-PAWR expected are qualitative torrential rain forecast in short hours and social issues solving, industrial competitive power strengthening results conducive to economic revival in a big way, numerously gained up until now.

Also, in ImPACT, development of new version of super computers capable of initiatives problems at the world fastest speed, thought to be unsolvable flexibly in realistic hours with the conventional computers and research results have started to appear to be able to bring out renewal in the future industrial and society.

On the other hand, in both programs, various systematic improvements are recommended by the outside specialists in their interim evaluation, system verification.

For instance, on SIP,

(a) Towards “strengthening industrial competitiveness, new business creation and social implementation”, systematic problems and challenges should be identified and initiatives should be implemented to use of them for policy making and system change.

(b) For R&D peer review by specialists should be conducted on progress status, so as to guarantee the quality of R&D.

(c) As for R&D nearing social implementation, it was pointed out that funds from the private

sector be sought, among other things.

Also, as for ImPACT, the below are pointed out,

(a) In the program making and the implementation process thereafter, assistance structure towards PM and opinions and evaluations from the outside such as the industrial circles should be given more weight.

b) In progress control of the programs and PM evaluation, outside specialist technical evaluation will be indispensable so as to gain suitable results for innovative creation of non-continuous and disruptive nature.

In the future, in light of these points, it will be necessary to tackle with so in an effort to spread and entrench the R&D modes adopted by CAO(STI) in the whole government.

Furthermore, PRISM, based on "Public-Private Investment Expansion Initiative of STI" has been in progress since fiscal 2018 so as to have SIP-type management which is appreciated by the industry cross-cutting unfolded in the Government and expand R&D investment from the private sector.

③ Future direction and major policies to be concretely implemented

i) SIP

○SIP (the 2nd term)[117] in light of issues clarified in consideration of conducted peer review by experts while improving, facilitate 12 research issues[118] strongly under the 10 requirements[119] should be satisfied introducing of matching fund factors and clarification of exit strategy for realization of Society 5.0, IP strategy, international standardization and regulatory reform and introducing factor of matching fund. In that occasion, aimed will be maximization of the outcomes, in order to be more adequately executed, the improvements will be incessantly contemplated.

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[117] front-load spending started by the Supplementary Budget for Fiscal 2017

[118] (1)Cyberspace Basis Technology "Cyberspace Technology using AI and Big-data", (2)Physical-space Basis Technology "Digital processing for physical-space region", (3) Security (cyber physical security) "Cyber-physical security for IoT society"),(4) Autonomous Driving "Automated Driving System (system and service) " , (5)Materials Development Basis""Materials Integration" for Revolutionary Design System of Structural Materials", (6)Light/Quantum Technology Basis "Photon, Quantum Technology for Society 5.0", (7)Bio/Agriculture "Smart Biotechnology for Industry and Agriculture", (8)Energy/Environment "Energy System for Decarbonation", (9)Disaster Prevention/Mitigation "Strengthening of national resilience against disaster", (10) Health/Medicine "AI Hospital System for Medical Diagnosis and Treatment", (11) Logistics (land & sea transportation) "Smart Logistics Service", (12)Ocean "Developing innovative technologies for exploration of deep sea resources"(

[119] (1)Aiming at the Society 5.0 realization, and (2)emphasizing needed for productivity revolution , (3)not only simply R&D but bringing the social change, (4)important area for the Japanese economy to social issues solving and Japanese economy・industrial competitive power, (5)clear exit strategy for practical application, commercialization and social implementation (clear for business making contents in 5 years), (6)intellectual properties , international standardization, system's exit strategy restraints reform, (7)tackling with across-area indispensable of inter-governmental linkage, (8)promotes focused, end-to-end R&D, from basic research to practical application and commercialization, (9)proceeding "cooperative regions" from "competitive regions" separating clearly (having open and closed strategy), (10) construction of the industry-academic-government collaboration structure, R&D outcomes actualization・making business by participating industries and matching funds factors built-in.

[CAS, STI, Space, Ocean, NPA, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE] MOD]

ⅱ）PRISM

○ In fiscal 2018, additional budget will be allotted on 3 target regions expected to contributions to optimization of government expenditure by private investment inducement effects and utilizing R&D result. (Cyber space platform technologies, Physical space platform technologies, Construction and infrastructure maintenance technologies/ Natural disaster prevention and reduction technologies). Incidentally, at the time of allocation, in line with these principal strategies, the field where Japan owns high-quality real space information, initiatives to establish data linkage bases regarding fields with social issue field[120] and initiatives contributing to training advanced IT human resources through R&D should be high on the priority list.

Moreover, by integrally operating with SIP, and consolidating R&D projects of different government offices and agencies under PRISM, implementation system of R&D through collaboration between industry, academia and government/intra government should be constructed.

[STI, NPA, MIC, MEXT, MHLW, MAFF, METI, MLIT]

ⅲ）ImPACT

○Evaluation of the existing 16 research issues[121] to be closed in fiscal 2018 will be conducted and whatever may be possible will be put in business and actualization without delay. Moreover, in light of the system approval result done in fiscal 2017, ImPACT R&D modes be improves and strengthened, allowing failures, daring challenges possible thus fixating in the related Government Offices, ministries and agencies and while reviewing the related policy measures, near turning point of ImPACT tackling, under more aggressive concept the Government in a body will continuously and stably proceed with R&D (moonshot-type R&D system) to spurn out innovations.

[STI, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD]

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120 Agriculture, health, medical and nursing, construction, disaster prevention and reduction etc.

121 (1) "ultra-thin membrane possibility & realization of strong/tough polymer possibility", (２) "new value creation by serendipity's planned creation", (3) "realization of the safe・security longevity society by ubiquitous・power laser", (4) "ultimate eco usable with non-charging for long" "equipment realization", (5) "heavy-nursing zero realizing innovative cybernic system, (6) "Material Industrial Revolution by Super high-function structural protein", (7) " Tough Robotics Challenge", (8) "big deduction・new material revolution material industrial revolution high-level nuclear disposal resources possibility", (9) "ultra-swift multi-sensing system of ultra-small quantity materials", (10) "by innovative visualization technology"(11) "Visualization of the brain information and realization of active life by control", (12) "Realization of advanced knowledge social infrastructure", (13) " Small-size radar satellite system capable on demand observation", (14) "Artificial cell reactor to realize new bio manufacturing and rich and safety society, (15) "The Industrial Revolution curve out by bionic humanoid", (16) "Super big data platform to decrease social risks"

CHAPTER 4: Social Implementation of Knowledge

It will not be easy to implement “created knowledge” to our society. It is necessary not only to reform the site of the university that is responsible for the frontier of knowledge creation and promote R&D that contributes to realizing the Society 5.0 as mentioned in the previous chapters, but also to review all the government's projects and systems to make them more innovative with the government’s own initiatives. In other words, it is required for all the industries, academias and governments to change their behavior.

In the Fifth Basic Plan, the importance of integration and collaboration of related measures and establishment of a system are mentioned, which support for human resource development, establishment, commercialization, and growth, together with industries, academias, and governments. Furthermore, it is pointed out that the creation of the market is a major issue for SMEs and startups when they start their business and the public sector should expand the opportunities to procure the products using new technology. Additionally, in the Comprehensive Strategy 2017, the importance of promoting the creation of university-originated startups and national research institution-originated startups was emphasized.

As a result of this, it is true that the bright sign is appearing in the environment surrounding the knowledge social implementation, following the path written in the Fifth Basic Plan. For instance, the number of university-originated startup companies[122] as exemplified in the road to the Fifth Basic Plan has been on the rise[123] since 2012 and awareness among students has gradually going up[124]. Moreover, the number of unlisted startups whose cooperate value exceed one billion dollars (Unicorn) or 10 billion yens are 22 in total in Japan as announced in a survey report.[125]

However, at present or the middle of the Fifth Basic Plan, its social implementation is still in midway. Focusing on the situation of startups in Japan, compared with other countries, the opening ratio is still low and VC investment amounts and fund formation amounts too at digits below. These facts show that the environment for startups in Japan hasn't improved yet as contemplated in the Fifth Basic Plan. It is necessary to construct startups ecosystems which is suitable for Japan while nurturing budding sprouts by analyzing strengths and weaknesses of Japan, learning without reserve that other nations in the world have been gaining remarkable results in the variety of starting environments.

(⇒CHAPTER 4: 1.Startup)

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122 Universities indicate those of national, public & private (including junior colleges), national, public and private KOSENs, inter-university research institutes. University-originated startups indicate those starting businesses based on patents teachers, employees or students invented, and those starting businesses established by teachers and employees.

123 The number of university-originated startups are 51 (FY2012), 127(FY20160) (MEXT “the implementation status of collaboration between industry and academia at universities”) (February, 2018)

124 The ratio of students wishing to start businesses, while student 2.6%（1982）, 3.8%（1997）, 4.2%（2012）(The Small and Medium Enterprise Agency “2017 White Paper on Small and Medium Enterprises”)

125 NIKKEI “Next UNICORN survey” (November, 2017) Those of enterprise value were presumed by NIKKEI

On the other hand, innovation promotion policy the Government itself has just got under way and the trial to innovate the Government projects themselves through the initiative called “Science Technology Innovation Conversion” to analyze all existing government projects and introduce advanced technologies has been undertaken since fiscal 2018.

The Government research investment sharing 20% more or less out of all the R&D amounts in Japan, one single case alone far surpasses the investment scale of the private sector combined, hence influencing greatly our country's entire economic activities, since the government has a large investment digits off scale from that of the private sector.

Accordingly, the policies will be studied to facilitate to enable to innovate those as far as possible by reviewing from the Government projects to procurement, system, restraints by re-recognizing the role to fulfill own budget of the Government each office. The whole inspection would improve the administrative investment efficiency and, as a result, in our government, will tackle over recognizing policy meaning to open the path leading to the growth strategy.

Innovation in the government projects/systems and mentioned here Japan must face tackling, advanced only with un-solved issues directly facing population decrease by effectively utilizing the limited financial resources. It will be thought hereafter to lead to contribute to the world to demonstrate our precedents to countries facing with similar status such as maturity, financial restraints of the economic society.

(⇒CHAPTER 4: 2. Promotion of innovation in the Government projects and system)

(1) Startups

○Future visions to be pursued

・Realizing the society which the result of R&D to be implemented more easily, by building Japanese-style startup ecosystem with strengths of Japan, such as excellent human resources and technologies of major companies and universities.

○Objective

Creating the environment concerning establishment of R&D startups in Japan on a par with the U.S. or China at the world highest level.

＜Startup awareness＞

・Doubling the number of university-originated startups and public research institution-originated startups from the fiscal 2016 result. [126]

＜Fund＞

・Doubling startup investment amount to the world highest level[127] against nominal GDP ratio.

＜Growth＞

・Creating 20 unlisted startups (Unicorn) [128] or listed ones[129] with their corporate value or market capitalization reaching over 1 billion dollars by 2023.

○Major issues towards accomplishment goal and future direction

・In various reports, their causes are pointed out such as the lack of cooperation among the government agencies, lack of entrepreneurs, and so on. However, they haven't been solved yet and the ecosystem to establish R&D startups as the leaders of innovation is still insufficient.

・In order to support entrepreneurs and startups speedy and consistently among training, establishment, industrialization, and growth, invest efficiently, and maximize investment effectiveness, the government agencies, public-private funds, private VCs and overseas VCs mutually collaborate in some policies.

・Providing such support as commendation (award-type R&D support) to technologies or imagination overturning the existing common sense together with cross-cutting, open and flexible deregulation.

・Creating Japanese-style R&D startups ecosystem through the reduction of risks of startup companies and new business, by promoting equal cooperation and collaboration between major

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[126] The number of accumulated establishment of university-originated startups (2016): 2,533(MEXT "the implementation status of collaboration between industry and academia at universities") (February, 2018), calculated at CAO(STI)). The number of accumulated establishment of national R&D agency-originated startups (2016): 207 (CAO "Survey concerning independent administration corporations science and technology activities (March, 2018)).

[127] Nominal GDP ratio of startup investment (2016) : Japan 0.028%, U.S. 0.37%, China 0.18%(VEC "Venture White Paper 2017" (November, 2017) based and calculated by CAO(STI))

[128] The number of Unicorn: U.S. 114, China 62 (CB Insights end of February, 2018 data)

[129] Targeted at companies not established or those established within 10 years at the beginning of FY2018.

companies /universities and startup companies and flexible human mobility and through utilizing data linkage bases for realizing the Society 5.0.

① Necessity and importance of startup in innovation

Because of the accelerating advance in technologies and the fundamental change in the role sharing between the industries, universities, research institutes and the government agencies, it has become more difficult for the industries to do business and social implementation of technologies alone as in the past. Under such circumstances, it is considered to be effective for the social implementation that the major companies and universities try to cooperate with R&D startups who have excellent technologies and conceptions and aim to create a new value.

Therefore, it is very important for stimulating innovation to make it easier to establish R&D startups and promote the cooperation between R&D startups and major companies/ universities.

② Recognition of the current situation

In Japan, it has long been pointed out that the result of excellent research done by major corporations and universities have not been connected to social implementation and innovation. On the other hand, the government agencies in Japan have taken some policies for supporting R&D startups, such as entrepreneurship education, commendation, financial support, and support for commercialization, because the R&D startups who aim rapidly to create the new value would be the leaders of innovation .

But, compared with other countries, it is hard to say[130] that circumstances for startup in Japan are positive. And also, the investment amount by VCs[131] and the fund formation amount[132] are not enough. Therefore, the ecosystem to establish R&D startups dose not function yet. On the other hand, in other countries, startups ecosystem which makes use of their own regional characteristics has been rapidly developing, not only as the copy of Silicon Valley style.

As an issue of government agencies' initiatives, it is pointed out that the information about technology seeds are closed in different institutes and/or support projects, and the lacking of the system to dig up the technology seeds horizontally.

Additionally, it is hard for applicants to grasp the detail of each institutes and/or support projects comprehensively because different institutes are offering support projects independently and there are no unified window among them.

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130 Entry rates (2015): Japan5.2%, Europe and America 10% more or less (The Small and Medium Enterprise Agency “2017 Medium & Small Industries White Paper Glimpse” (April of 2017)).
Ratio of people who are uninterested in establishment (2012): Japan 77.3%, Europe and America 30%, more or less (The Small and Medium Enterprise Agency ”2017 Medium & Small Industries White Paper Glimpse” (April 2017)).
Total Entrepreneurship Activity (index) (2016): Japan 5.30, U.S. 12.63, Chiba 10.29, Europe 5.78 (CAO “Survey on Independent Administration Corporation” (March 2017).

131 Venture Investment Amount (2016): Japan 152.9 billion yen, U.S. 7519.2 billion yen, China 215.6 billion yen, Europe 535.3 billion yen (VEC ”Venture White Paper 2017” (Nov. of 2017)).

132 Fund Formation Amount (2016): Japan 235.8 yen, U.S. 4528.3 billion yen, China 877.4 billion yen, Europe 775.7 billion yen VEC “Venture White Paper2017” (Nov. of 2017).

Focusing on the support projects, many of them are specialized in research and technical development, lacking the perspective of social implementation. It is required to fulfill the demand side policies by changing the role of R&D from the seeds-driven[133] style to the needs-driven[134] style and being aware of the platform-type thinking, customer's needs, and social implementation. Also, though the existing support projects are premised on “being success”, it is necessary to be conscious of the importance of disruptive innovation without being afraid of failure for the future.

From the point of view of the environment for supporting R&D startups, lacking in policies for globalization and the existing legal restraints which cannot be adapting the changes in social and industrial construction are the hindrances for innovation.

Furthermore, promotion of the policies about mobility of human resource is necessary because of lack of policies centered on human resources.

In Japan, there are excellent human resources and technologies in the major companies and universities, and abundant financial resources in the industries. Furthermore, the social infrastructures such as ICT have been well developed. Therefore, it might be possible to support R&D startups by using technology seeds which have been developed in the project of governmental agencies as the innovation sources, and by using the advanced technologies in the government as the priming. It is required to create the Japanese-style R&D type startups ecosystem by using these strengths of Japan and reducing the risks associated with establishment and new business.

② Future direction and major policies to be concretely implemented

In order to encourage innovation with the implementation of excellent result of R&D by promoting the establishment of R&D startups and supporting their growth strongly, the government will conduct some policies as below for the future.

ⅰ）Cooperation between industries, government agencies, public-private funds and so on

-In order to construct and maximize the result of investment by supporting training of entrepreneur, establishment, commercialization, and growth speedy and consistently, enhancing the cooperation between government agencies (particularly, funding agencies[135] and startups supporting agencies[136]) and public-private funds[137] within 1 to 2 years.

[CAS, STI, MIC, MOF, MEXT, MHLW, MAFF, METI, MLIT]

・In order to enhance the R&D startups support by promoting digging up technology seeds, training of entrepreneurs, grant for R&D, support for commercialization, support for patent acquiring and so on integrally, promoting cooperation between funding agencies and startups supporting agencies

[133] The way of R&D exploring the needs which are suitable for a certain technology seeds.
[134] The way of R&D exploring the technological issues for resolving a certain needs.
[135] Implying those functioning to distribute funds (subsidy, etc.) destined to R&D out of public institutions. In particular, here, it implies institutions who distribute funds towards R&D.
[136] public organizations that don't distribute funds to R&D but assist startup companies throughother means.
[137] governmental funds invested by the Japanese Government and the private based on the national policies.

by through mutual sharing of information by support with execution of cooperation agreements among funds-allocation organizations and those of startup supporters.

・Network construction with overseas VC etc. and implementation of R&D subsidy linkage with funding agencies and private VC, etc.

・Intend and maximization of investment effects thru enhancement of business judgment power Industry Competitiveness Enhancement Act revision[138], enhancement of cognoscente power, investment efficiency and investment effects efficiency, maximization revenue construction enhancement., etc. to improve the revenue construction, etc.

・Activating the programs and networks of overseas offices such as JETRO, promoting of transmission and mutualization of information. Also, conducting intensive support programs by public and private sectors to the certified startups toward global deployment and training at overseas institutions by students and younger researchers.

・R&D startups projects by facilitating procurement of the advanced technological products in public procurement.

ⅱ） Improvement of circumstances for generating Moonshots[139]

- Setting the future figure as starting point, within 2 to 3 years, public and private sectors should consider the construction of the platform which accept the difficult but challenging concept which may realize the big impact without fear about failures.

[CAS, STI, MIC, MEXT, METI]

・Setting needs-driven and challenging theme(s), studies conducted to promote support of such award-type R&D with commendation

・Reviewing of the restraints and legal system in accordance of technologies and innovation (sand box system[140] of regulation utilized, cross-cutting, open and flexible reviewing of regulations, national strategic special zone utilized).

ⅲ） Construction of Japanese-style of R&D startups ecosystems.

Other than utilizing the data exchange platform towards the realization of the Society 5.0, our country's strengths of the major corporations and universities abundant with excellent human resources, technologies and regional characteristics construct the Japanese-style R&D startups ecosystems between the major corporations, universities and startup companies to spur the mobility of human resource within 2 to 3 years in sight so as to equal cooperation, collaboration and flexible moving of human resources.

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[138] Act No. 98 of 2013

[139] grandiose objectives or challenges which are hard to realize but may bring large effects by its realization.

[140] The process to verify and pursue speedily more rational modes of regulations on new technology and business model Under certain conditions the social experimental verifications are conducted in environment where targeted regulations are not applied.

[STI, MEXT, MHLW, METI]

・Constructing environments to be for seeds technology easily be evolved in businesses activating the data exchange platform towards realization of the Society 5.0.

・Reviewing of Japan's unique single-track carrier path and mobilization of human resources (introduction of job-based[141], wage, revision of retirement benefits, consider of introduction of annual salary system, auxiliary dual work facilitation, re-hiring the retired employees recommended)

・Making and strengthening initiatives to contribute to facilitating such as spin-out[142] and strengthening of partnership between major corporations and universities and startups.

・Accelerating creation and growth of startups from universities and national research and development agencies by allowing more national research and development agencies to invest in such startups and by allowing universities and national research and development agencies to receive share and share option from such startups as a return for supports for them

[141] The employment mode where duty, working hours, working place are limited.
[142] Make one partial portion of existing corporation and organization separate and independent.

(2) Promotion of Innovation in the Government Projects/Systems

○ Future visions to be pursued

・Building schemes where innovations are constantly created under the government projects/systems and such with these projects/systems and such compared with and checked against cases of other countries, building system(s) conducive to aggressive utilization of new technologies to encourage innovation, and reforming regulations which constitute impeding factors for such movement, among other things.

・Through the government initiatives towards its productivity enhancement, development/introduction and investment expansion in the private sector will be induced.

○ Objective

＜Aggressive utilization of New Technologies＞

・In order to attain the new policy objectives upon the implementation of its businesses, aggressively introduce the new technologies (the world economic forum “government procurement of advanced technology products” of Global Competitiveness Index to enhance to the world top level by 2030[143]).

＜Promotion of R&D Investment＞

・The Government R&D investment objective (1% of GDP ratio (in the Fifth Basic Plan duration's GDP nominal growth rate. Through these government tackling towards productivity enhancements and such in trial computed based on “trial computation concerning the medium-long term Economic Finance” (submitted to Council on Economic and Fiscal Policy on July 22, 2015) at the time of formulating of the Fifth Basic Plan, the total would be about 26 trillion yen)) and the public-private R&D objective amount was realized (against GDP rate of 4% or over[144]).[145]

Achievement of the government R&D investment objective (1% of GDP- when trial-computed on the assumption that the nominal GDP growth rate in the Fifth Basic Plan to be based on the economic revelation case shown in “the Trial computation of the medium to long-term economic and fiscal policies” (submitted to Council on Economic and Fiscal Policy on June 22, 2015) of the time of the Plan formation, the total amount of such investment would be about 26 trillion yen) and the public/private R&D investment objective (no less than 4% of GDP).

＜Realization of the world’s most innovation-friendly country ＞

・By reviewing at the Government businesses and systems, drastically improving the innovation's environment (improve to be within third among the advanced nations before 2020 in the World Bank's

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143 23rd in the World Economic Forum “The Global Competitiveness Report 2017~2018”(September, 2017)

144 In light of the Fifth Basic Plan, securing the consistency with “Economy/Finance Renewal Plan” in "Economic Finance Operation and Renewal Basic Policy" make governmental R&D investment 1% against GDP, and total R&D investment by public and private over 4% against GDP. The industrial circles have announced that they aim to make R&D investment by private companies to 3% against GDP and make effort to increase investment in response of the attainment of R&D investment by the government.

145 The country which invests the most in the advanced countries is Korea (2015 government R&D investment (against GDP): 1%, private R&D investment (against GDP): 4.23 %).

business environment ranking[146])

＜Top productivity growth rate attained among world's advanced Nations＞

・Doubling Japan's productivity[147] growth rate in 2020 (the annual growth ratio to be increased to 2% from the median rate of 0.9 % for 5 years ended 2015).

○ Major Issues Towards Accomplishment Goal and Future Direction

・Innovation possibility in the Government projects and systems will be shown the direction where the country should proceed, and large change of the society will be expected though the grasp of seeds/needs technology and the system's analysis are insufficient, and not utilize potential sufficiently.

・ Strengthening functions and such of CSTI, the control tower of STI policies, to collect and analyze information[148] and relevant the relevant offices, ministries and agencies making concerted efforts for promoting innovation in the government projects/systems.

① Necessity and importance of innovation in the government projects and systems and such

The Government projects have largely contributed to creation of innovations such as the development of the Internet led by the US government, realization of the Government-led large-scale projects including energy-saving society of the world's highest level, implementation of the energy saving low[149] in Japan. Moreover, innovations have not necessarily been brought about by technological innovations, but sometimes by un-used existing technologies, process improvement, in combination with regulation reforms.

For this, it is necessary to promote innovation in aggressive utilization of the new technologies including advanced technologies in the Government projects, and there is a need for regulation reform, streamlining to accelerate creation of innovations, obstructive factors, and innovations in the Government projects/systems.

The Government will make initiatives toward creating innovations with the limited resources at most its projects and system and such, and our country called advance country with unsettled challenges can be a model toward the world.

② Recognition of the current situation

Looking abroad, innovations are being created as never seen before, activating big data and AI technologies and as part of such creation, there are cases of the governments, ahead of others, constructing innovation basis of their own. In Singapore, for example, the Government has aggressively been facilitating the introduction of the advanced technologies, hoisting "the smart nation

[146] Analyzing 10 items such as financing environment and taxation system and compile ranking annually. Japan stands24th out of OECD 35 nations 2018.
[147] real GDP per capita and per hour.
[148] technological seeds/needs and regulations of domestic and foreign.
[149] Act on Rationalizing Energy Use (Act No.49 of 1979)

concept”[150] using AI technologies and IoT since 2014. A different instance in the U.S., activating excellent technologies which small and medium startup companies own in order to strengthen commercialization of R&D results by the federal government, the government has adopted the SBIR system since the 1980s to be part of innovation. [151]

Amid this situation, in Japan, based on the ”Promotion of Society 5.0 and the achievement of the Government R&D investment objective”（Decided by CSTI in April, 2017）, it has been tackled with expansion of the government R&D investment, starting with the budget for fiscal 2018 under the “STI Convention” existent government projects introducing science, technology and innovation factors[152] centering on CSTI.[153]

For example, in the MLIT, it has been deepening its initiatives with i-Construction in an effort to enhance productivity in public works, advanced technologies aggressively and development of new technologies such as those of AI, expansion of ICT detailed types of construction and raising efficiency at construction sites.

Additionally, in COI program, in the conduct of R&D, building the structure came together industry, academia and government including local public agency, the sampling of the technical needs which need for the future social image will been conducted.

Furthermore, in the vulnerability assessment of the national strengthening policies with the Government offices tackling horizontally intended for large-scale natural disasters, it is required to analyze what process might lead to “the worst case” caused by natural disasters and identify current challenges. Through tackling like these coping with administrative technical needs, acquire promoting diffusion and social implementation and such utilized by environmental of R&D and public procurement and such the Government projects.

It is necessary to promote diffusion and social implementation and such of R&D results utilizing these government projects including R&D and procurement programs toward responding to technical

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150 Official individual certification, elevation and automation of public transportation, livability and maintenance of security in cities by positioned censors have been done.

151 About 200 billion yen per year research/development assistance was conducted to small-and-medium and startup companies in fiscal 2016 and the federal government assisted commercialization in procurements and inviting venture capital. .

152 introduction of technologies which aren't used amply in a domain but expected to improve the effect and efficiency of the works by introducing them.

153 ”Promotion of Society 5.0 and the Achievement of the Government R&D Investment Objective”(Decided by CSTI in April, 2017)(reference1)
CAO estimation based on a certain assumption.
Against GDP in fiscal 2020: 600 trillion yen * 1% = 6 trillion yen (initial budget, revises budget, local autonomies portion)
Out of it, the initial 4.4 trillion yen, supplementary: 1.1 trillion yen (largest in the past 10 years)
Local 0.5 trillion yen (the same level as fiscal 2017)
Scientific Technologically-related budget Initially 3.5 trillion yen
Difference of 0.9 trillion yen
As the budget pertaining 191.5 billion yen for innovation transfer in fiscal 2018 and 252.1 billion yen, totally in the total scientific technologies-related budget, 252.1 billion yen increase of 60 billion yen
(60.6 -billion yen increase except innovation transfer) are secured.

needs of the administrative bodies identified through the relevant initiatives.

Furthermore, in addition to initiatives of innovation in these government projects initiatives for innovation in systems, are in progress in each government office. For example, in the MHLW, it will be expected of facilitation of private R&D investment expansion in order to early realize putting into actual use of high-priced pharmaceuticals/medical equipment necessary in clinics and hospitals on the assumption of through safety and effectiveness in before/after marketing.

As in the foregoing, innovation in each government office is in progress in the government projects and systems, while further proceeding with analysis and evaluation of the current initiatives, it is necessary to accelerate the innovation, sharing issues to be horizontally coped among the government offices.

③ Future direction and major policies to be completely implemented

Such will be proceeded as new technologically aggressive utilization, innovation-creating system improvement, regulations reform and such, to be their negative factors in the government projects. On these occasions, in CSTI innovation will be led by functions strengthening as “think tank” acting as center of the government, such as suggesting and such concerning new seeds/needs technology in and out the country, information assembly and analysis of innovative initiatives system improvement and regulations reform and such.

In addition of the above, the national evolvement of created excellent examples will be taken care of, along with introduction of aggressive innovation in initiatives of assistance of the local autonomies from the viewpoint of contributing to the regional issue-solving and utilization and such so as to allow innovation initiatives permeating to local autonomous bodies in the central government.

Incidentally, CSTI in promoting these innovations, will collaborate with the MOF in order to receive a high priority in the budget compilation process.

- CSTI will lead in the government businesses, system and such in proposing the renewing businesses, system and such of each government office by integrating and analyzing information on innovation.

[STI]

- Each government office will promote innovation in government-related matters including projects and systems in collaboration with CSTI by studying responses when innovation-associated proposal is received from the same.

[All Government Offices]

- Regarding public procurement including public works projects that have begun pioneering approaches in particular, CAO(STI) will develop guidelines[154] for the relevant offices, ministries and

[154] Include initiatives to introduce advanced technology to public works projects by MLIT, and effective cases of

agencies during fiscal 2018 to promote introduction of advanced technology or utilization of SMEs / venture enterprises not only in some but in all the relevant offices, ministries and agencies. After fiscal 2019, the government entities will actively take action based on the guidelines.

[All Government Offices]

utilization of SMEs / venture enterprises referring to the SBIR system in the United States.

CHAPTER 5: Global Deployment of Knowledge

"Global deployment of knowledge" has interactive policy inducements: it not only leads innovation in Japan by fusing with the world knowledge but also deploys Japan's innovation to the world. It will be, thus, Japan's urgent policy subject to encourage domestic innovation as well as create the environment that attracts world knowledge and lead global deployment of knowledge to nation's economic growth.

Promotion of international collaborative R&D, open science, IP strategy and international standardization as the platform to realize Society 5.0, correspondence to the global issues and acceleration of the world development through the contribution to SDGs, presentation of Japan's STI initiatives at international occasions such as G7, and comprehensive promotion of STI diplomacy have been committed in the 5th Basic Plan and Comprehensive Strategy 2017.

It will be indispensable to integrate policies related to the "Global deployment of knowledge" with heretofore described "Source of knowledge", "Creation of knowledge" and "Social implementation of knowledge" to respond to the current situation.

Regarding the current status of "source of knowledge", we have been working on Japan-Europe mutual certification concerning private information protection and construction of CBPR[155] system in APEC, to secure the position to be able to systematically stand as international information hub. However, the giant platformer like the U.S. and China are linking a vast data exchange across the borders, advancing official data exchange system linkage in the U.S., Canada and Mexico, even Europe intending to build the inter-regional linkage bases, and pursuing compatibility with the North America at the same time. Looking the situation in Japan, initiative are still underway to build the domestic data exchange platform such as the entire designing of data exchange platform toward realization of the Society 5.0, and it's urgent to build the global cooperation. In open science, too, the data policy formulating is not advancing, and on the research data management and utilization, there exists a great concern about present situation where discussions related to the matter has been progressing under the Europe and the U.S. leadership.

As for "Knowledge Creation" in the super global universities[156] as a whole there seems to be progress witnessed as an increase of the number of courses to be able to attend classes in foreign language class(s)[157] in the number and graduate only in foreign language (s) on the increase accepted foreign students in the number.[158]. However, for example, the number of internationally co-authored research

[155] system that certify tackling personal information protection across the borders by industries and such as as suitable with APEC privacy principle.
[156] 37 universities supported by Top Global University Project
[157] In comparison to before the "Top Global University Project",the number of classes by foreign languages has increased about 1.7-fold (fiscal 2013: 19,533 subjects), fiscal 2016: 32,846 subjects). The courses you can graduate by foreign languages alone, an increase of 221 courses to 73 courses were established (JSPB Top Global University Creation Supporting Program Committee "Summary of Top Global University Creation Supporting Project Mid-term Evaluation Results" (Feburuary, 2018)
[158] Roughly 1.4 fold increase (FY 2013: 49,618 people, FY 2016: 69,119 people) (JSPS Top Global University Project committee "Top Global University Project Mid-term Evaluation Result")' (February, 2018).

papers[159] and such lags behind the U.S., UK, and Germany. Also, the number of Chinese students going overseas to receive high-degree education has rapidly increased[160] and the number of internationally co-authored research papers from China[161] which was smaller than that of our country in the 1990s, has doubled in 2010s. As for U.S. doctorate earners, while the number of Chinese students has increased to well over 5,000 on one hand, our country's number has been on the extreme decrease[162]. Taken this alone, global deployment of universities and research institutions in Japan must be severely evaluated.

In the context of "Social implementation of knowledge", Japan's internal direct investment will be on the steady increase and such and to small-and-medium-sized startup companies aiming at global deployment, it will offer necessary knowledge, know-how, network and such acquiring support and such [163]in order to strengthen the linkage. However, as mentioned previously, though the direct investment is increasing, its balance (GDP ratio) is still a few % (UK roughly 50 %, US, France, Germany about 30 %)[164] hence, there's a fear that our country's startup ecosystems is not yet fully connected with the world.

Pursuantly, arrear of nation's globalization is the biggest weakness of its STI ecosystem; thus, conceptual change and enhancement of initiatives, in accordance with the global benchmarks in the relevant fields, are indispensable.

（⇒Reference each chapter）

In the meanwhile, there's a possibility for Japan to make drastic changes in its current situation in STI as a consequence of the devoted discussions on SDGs in the world, With the prospect that there is a high affinity between a concept of Society 5.0 and 17 goals of SDGs in terms of aiming at creating human-centric sustainable society, Japan can present not only its global contributions with its STI but also world-leading policy package, as a developed country facing challenges, by connecting the conceptual platform of SDGs and Society 5.0.

To achieve goals of SDGs, it is necessary to promote the win-win development in both developed and developing countries with nation's STI policy, instead of its one-sided ODAs. From that perspective, Japan has supported countries mainly in South East Asia to achieve their tremendous economic growths in the same approach. Furthermore, in consideration of accomplishments in EPA with Europe as well as TPP in Asia-Pacific region, Japan has been securing a position as the intermediator in the

[159] Japan 23,214 cases, U.S. 136,652 cases, UK 59,291 cases, Germany 54,779 cases (2013-15)(NISTEP "Benchmark of Scientific Research 2017" (August 2017))
[160] 151,055 people (1998), 434,040 people (2007), 847,259 people (2017)(UNESCO UIS)
[161] Japan: 23,214 cases, China: 61,087 cases (2013-15), (NISTEP "Benchmark of Scientific Research 2017" (August 2017))
[162] China: 4,448 persons (2006), 5,534 persons (2016), Japan: 271 persons (2006), 166 persons (2016) (National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates. "Table 26. Doctorates awarded for the top 10 countries of origin of temporary visa holders earning doctorates at U.S. colleges and universities, by country or economy of citizenship and field: 2006–16")
[163] Supported by " Global startup ecosystem strengthening of partnership project" conducted by METI
[164] Inside direct investment balance against GDP ratio (2015 end): Japan 4.7 %, UK 51.1 %, U.S. 31.1%, France 31.9 %, Germany 33.4 % (METI "The White Paper on International Economy and Trade 2017" (June, 2017))

international economic community with these policies. In 2019 when the first high-level review on SDGs at the UN High Level Political Forum and G20 Summit, which will be co-chaired by Japan, is to be held, Japan will accelerate its activities towards SDGs.

Furthermore, it will be important for Japan to investigate how the international standardization should be for the purpose of disseminating Society 5.0 as the nation's initiative to the global society.

(1) Promotion of Science, Technology and Innovation for Achieving SDGs (STI for SDGs)

〇Future visions to be pursued

・Utilizing Japan's STI, necessary for realizing the Society 5.0, to undertake the world's top-level actions towards the achievement of 17 goals[165] of SGDs, set by the United Nations.

・Leading the world "STI for SDGs" activities by deploying Japan's STI globally.

〇Objective

・Utilizing Japan's STI to achieve 17 goals of SDGs by 2030 and continue its initiatives thereafter to set an example to the world.

・Formulating "STI for SDGs Roadmap" ahead of the world and share it among global society for supporting other countries to formulate their roadmaps.

・ Promoting the formulation of platform, where nation's STI (seeds) and relevant domestic/international needs are to be matched, so that private companies and so forth can independently make the global contribution by utilizing STI and lead the formulation of sustainable societies even after 2030.

〇Major issues towards accomplishment goal and future direction

・It is a global common awareness that STI plays a prominent role for achieving SDGs, but its framework is yet to be built.

・Nation's activities for contributing SDGs with its STI are still not systematized.

・"STI for SDGs Roadmap" is to be formulated by mid-2019 as the world-leading SDGs plan and disseminated to the world at such occasions as G20 Summit, TICAD7.

・SDGs-related objectives are to be visualized in the governmental plans and strategies when newly-formulated or revised to present detailed steps towards achieving SDGs.

・With the idea of nation's private companies, and such to operate it independently, study on the potentialities of platform for matching nation's STI and such (seeds) and relevant needs are to be conducted.

① Necessity and Importance of Innovation for the achievement of SDGs

The 2015 UN General Assembly formally adopted SDGs as its motto "No one will be left behind" for actualizing sustainable, diverse and inclusive society.

UN has recognized the importance of STI for achieving 17 goals by 2030 and clarified the central role of STI in SDGs. There are many objectives that can be achieved with STI in 169 targets under 17

[165] Hoisted 17 Objectives of (1)Poverty, (2)Famine, (3)Health, (4)Education, (5)Gender, (6)Water & Health, (7)Energy, (8)Economic Growth & Employment, (9)Infrastructure, Industrialization, Innovation, (10)Inequality, (11)Sustainable Cities, (12)Sustainable Production & Consumption, (13)Climate Change (14) Ocean Resources, (15)Land Resources, (16)Peace, (17)Implementation Means

goals[166], thus, it can be said that STI is indispensable for achieving SDGs.

② Recognition of the current situation

In the international society, "STI for SDGs" is being discussed at UN STI Forum, started in 2016 and since held annually. High Level Review Meeting is held at the UN High Level Political Forum every 4 years, and reviews and revisions of activities toward SDGs are conducted.

On the occasion of High Level Review Meeting in 2019, the first meeting after the adaptation of SDGs, there are great expectations on Japan, as a developed country facing challenges and country aiming at actualizing the sustainable society, from the global society.

Three main pillars, (a) promotion of Society 5.0, (b) regional revitalization, (c) empowerment of next generations and female, were set up as the nation's distinctive SDGs model at a meeting of the SDGs Promotion Headquarters in December 2017, and discussions on "STI for SDGs" was accelerated with an instruction to deploy initiatives under the public and private collaborations, formulate STI for SDGs roadmap, etc. by Prime Minister. CSTI established the "STI for SDGs Taskforce" (hereinafter referred to as "taskforce") in January, 2018, and started discussing concerning formulation of "STI for SDGs Roadmap" and "STI for SDGs Platform."

The importance of "STI for SDGs Roadmap" has been emphasized at U.N. STI Forum, etc.; however, its specific initiatives have been just begun. The statistical information, necessary to formulate roadmap and reviewing its progress, has not yet been organized enough either domestically or internationally.. By taking into account such circumstances, the taskforce has started to deliberate on the fundamental concept of roadmap by drawing the connections between existing governmental plans and strategies and 17 goals of SDGs.

A tentative roadmap with its concept and signification was shared among relevant international organizations and countries at "Expert Group Meeting on STI Roadmaps for SDGs", co-hosted by UN and government of Japan in May 2018 in Tokyo. Japan has already been taking a lead role in this respect but needs to accelerate its initiatives to be the world's top SDGs accomplished country. Japan also needs to investigate the whole concept of platform for connecting between country's STI seeds and domestic/international needs for contributing to the achievement of global SDGs.

③ Future direction and major policies to be concretely implemented

"STI for SDGs Roadmap" is to be formulated as Japan's action plan for accomplishing the world's top-level SDGs and presented to the world at G20 Summit, TICAD7, etc.

Moreover, contents related of SDGs in the government plans and strategies to be newly formulated

[166] For instance, Agricultural Productivity Enhancement (Target 2.4), Youth Death Rate Decrease by Prevention & Treatment (ditto 3.6), Water-related ecological system Protection & Recovery (ditto 6.6), Recoverable Energies Ratio Increase in bounds & hounds, (ditto 7.2), Comprehensive Disaster Risk Management & Implementation (ditto 11b), Sustainable Management & Effective Usage Fulfillment of Natural Resources (ditto 12.2) and such.

and/or revised should be visualized so that the nation's comprehensive initiatives towards the achievement of SDGs are pledged through including specific steps and objectives in such undertaking. Furthermore, with the idea of nation's private companies and so on to operate it independently, examination on the potentiality of platform, which matches nation's STI seeds and domestic/international needs, should be conducted.

Since SDGs is a concept that includes the wide range of aspects of economic society, integration among diverse knowledge, whether humanities or sciences, as well as consideration on heretofore 3 pillars, should be enforced for implementing the effective domestic initiatives and global contributions.

ⅰ）Formulation and Implementation of roadmap

○CAO(STI), as the control tower, will formulate "STI for SDGs Roadmap", clarifying steps toward achievement of SDGs, with relevant ministries and agencies, steadily implement "STI for SDGs" measures, and contribute to the global SDGs.

[All Ministries & Agencies]

・Formulate "STI for SDGs Roadmap" by the mid-2019.

・Contribute to the acceleration of domestic programs/projects by enhancing the statistical information for the progress management, setting up a country-specific targets and/or indicators as needed, analyzing each governmental program/project, and examining how the sophisticated progress management should be.

・Present necessary elements for formulating roadmaps to the global society and support other countries for the formulation of roadmaps through the global network that Japan has fostered till now.

ⅱ）Reflection on governmental plans and strategies

○SDGs-related matters should be visualized in the governmental plans and strategies when newly-formulated or revised to present detailed steps toward achieving SDGs.[167]

[All Ministries & Agencies]

・Each ministries and agencies to (a) clarify the gaps between existing plans and strategies and directions toward the achievement of SDGs, (b) include detailed activities and indicators that can contribute to achieve SDGs into their plans and strategies, and (c) implement the progress follow-ups.

・CAO(STI) to grasp the progress status of all ministries and agencies and increase effectiveness by collaborating with each ministries and agencies as necessary.

ⅲ）Study of platform towards the global deployment of STI

[167] For instance, SDG's way of thinking at "the Fifth Basic Environmental Plan" (approval by the Cabinet in April 2018) will be activated, from the viewpoint of solving regional issues included in "regional circular symbiotic sphere" creation.

○ Examination on the potentiality of platform for matching intellectual asset, such as technical solutions, with domestic/international needs will be conducted.

[All Ministries and Agencies]

・With CAO(STI) and the IP Headquarter playing a central role as well as with the close collaboration with ministries, potentialities of platform for matching intellectual asset, such as technical solution examined, on the assumption that private companies and such will operate it independently in the future.

・Collect international needs with the collaboration among CAO(STI), MOFA, MEXT, METI and such and utilization of their existing international networks.

CHAPTER 6: Major Fields to Be Enhanced

In the 5th Basic Plan and Comprehensive Strategy 2017, it was decided that we would handle these issues in light of linkage with the related government offices and each strategy headquarter and the utilization of SIP (the 1st term)[168] and such along with the platform construction toward the Society 5.0 realization, energy, resources and food stable procurement, healthy longevity society formation, national and people's safety and security securing, toward independent development, sustainable growth and regional society's self-reliant development.

As for platform building toward realization of the Society 5.0, utilizing SIP (the 1st term), data base construction for geology-leaning, environment-leaning and such has been studied, and R&D and such for technology of AI and that of robotics and such undertaken. In the future, about cyber and basic physical space technologies it is necessary to be earnestly handled as mutual bases technology. In particular, about rapidly-developing AI technologies, fight aspect seeking the scarce human resources is staging on, effective measures will be urgently carried out.

As for energy, resources and food-securing technologies, energy platform building, hydrogen and energy carrier technologies, agricultural production technologies and such, activating SIP (the 1st term), we have handled R&D and social implementation. Furthermore, for sustainable society realization under health/medical headquarters, toward healthy longevity society formation, pharmaceuticals creation, medical equipment development, order-made genome medicine and such, in road traffic field SIP (the 1st term) to be activating, various development and proof involved in automatic driving system has been in progress. On the other hand, the policy inclination to electric vehicles are rapidly evolving circling around environmental energies after “Paris Agreement”, about autonomous driving, involving the gigantic IT industries, competition has been severely contested. Also, rapidly extending is data-driven agriculture, the related scientific innovation policy, too, is re-studied.

As for safety and security technologies, R&D and social implementation, utilizing SIP (the 1st term) has been in progress toward infrastructure maintenance and the measures against natural disasters. On the other hand, amid ever-increasing severity of our country’s security environment, our county's measures around safety and security technologies policies, too, strengthening being even more sought after.

As for the global-scale issues, we've proceeded with development of earth environment information platform development, highly-developed utilization of satellite data in the space field, strengthening

[168] 11 issues to be handled in SIP (the first term) : (1) Innovative combustion technology, (2) Next generation power electronics, (3) ”Structural materials for innovation”, (4) Energy carriers, (5) Next-generation oceanic resources investigative technology, (6) Automatic driving system, (7) Infrastructure maintenance management & renewal & management technology, (8) Resilient disaster prevention & disaster reduction strengthening , (9) Securing of cyber security at important infrastructure and such, (10) Next-generation agriculture, forestry & fisheries creation technologies, (11) Innovative design production technology.

of oceanic information in the ocean field gathering and acquisition in the frontier development. Continuously, heightening the ocean resources investigation technologies and streamlining satellite data platform are steadily needed.

Furthermore, as recent advancement in disruptive innovation of development in the light and quantum fields and bio-technology is dazzling, it is necessary to drastically strengthen R&D of the former, and formulate the national strategy emphasizing our country's strength for the latter. Furthermore, in the distribution field, together with electronic commerce transactions development, gigantic export-import businesses in mind, the measures will be urgently coped with towards ever-active distribution process progression.

In overall consideration of these circumstances in SIP (the 2nd term) in the newly starting PRISM, cyber/physical space bases technology, the related security, autonomous driving, integrated type material development system, light/quantum technologies bases, smart bio industry and agriculture bases technology, construction of energy system, enhancement of national resilience, AI hospital, smart distribution services and the innovative ocean resources investigation technology to be handled with.

Particularly, the strategy for the five fields of AI technology, biotechnology, environmental energy, safety and security and agriculture should be reviewed, and the direction set in line with the world trends. [169]

[169] In this chapter, it will be described on five fields: “AI technology field” which lacks national action plan despite national strategy has formulated, "biotechnology field" national strategy of which has not been formulate, “environmental energy field” and “safety and security field” necessary to urgently in the recent rapidly-changing international situation to be coped with, and additionally “agricultural field” where possibility high latently in world deployment as national strength..

(1) AI Technology

○ Future visions to be pursued

・Realizing supply of the needs-met things and services, health care to keep people from getting sick, free and safe movement[170] through having everyone acquire “IT literacy[171]“, which is “reading, writing and arithmetic” of today and utilizing human-friendly AI technology

・Creating high-degree new employment and services through ensuring cyber security, social acceptance of AI technology and its utilization in all types of fields from industry to life.

○ Objectives

＜Establishment of Human Resources Basis＞

・Establishing of the structure to enable training and hiring of several thousands of Advanced IT human resource[172] and several hundreds of thousands of IT human resource [173]annually by 2025. (the size of training measures set by the related government offices in fiscal 2018)

・Having all the students complete the elementary and secondary education to acquire the IT literacy by 2032.

＜Promoting Strategic Technology Development＞

・Realizing social implementation of AI technology by 2022, with the use of the field-by field data exchange platform in the fields where Japan has high-quality real space information.

・Realizing the detailed applied objectives, area by area, in fiscal 2018 set in applied robotics technologies with AI technology.

・clarifying the AI bases technology[174] overcoming the weaknesses in the present AI technology more its objectives set in each R&D before the mid-2018 will be realized.

＜Formulating Human-centered AI Social Discipline to be Presented for International Discussions＞

・Leading the international discussion along with raising the domestic social acceptance of AI technologies.

○ Major Issues Towards Accomplishment Goal and Future Direction

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170 Excerpt from the social image to be aimed at shown in the fields with overriding priority depicted in “productivity” “health, medicine & nursing” “movement in space” in AI technology strategic conference “AI technology Strategy” (March, 2017)

171 Quality and ability needed for utilizing AI such as arithmetic and mathematics to enable to apply and understand adequately the basic programming and data.

172 Human resources bearing high-tech industries such as big data, I o T, AI. Nurturing 6-7 thousands in number of persons are needed, based on a estimate by CAO (STI) from hearing the related ministiries.

173 The IT human resources ratio out of the number of the employed is Japan 1.8%, U.S. 3% (IPA “IT Human Resources White Paper” (April 2017). Needed will be about the 7 billion additional nurturing to be on a par with the U.S. By the estimate by CAO (STI), 10 thousands must be nurtured each year.

174 For instance, AI technologies learning from the small quality data and explaining causal relationship which cannot be explained bythe current deep learning.

・From R&D to social implementation lag behind U.S. and China, to break the present situation, (A)resolve of the lack of human resources at all levels from the top to the general public, (B) strategic R&D and such apart from selfish everything me-ism, (C) The key being the improvement of social acceptance of AI technology.

・Together incomparably-sized personnel training, reform of personnel and salary system renewal for mobility-enhancing.

・For social implementation of AI technology activating the cross-domain exchange platform in various fields from industry to life, the applied development combined with robotics technology, and the consequent of weakness of present AI technologies, the basic R&D programs should be strongly promoted with concerted industry-academia-government efforts.

・Formulating the human-centered AI social discipline in order to raise the social acceptance of AI technology.

・Formulating the action plan to strengthen more actualized the strategy of AI technology in mid-2018.

① Necessity and importance of AI Technology in innovation

The AI technologies will largely and fundamentally change the existing societal structure, and in the near future, bearing the majority brain workers to help expected, thus altering shouldering most of regular-form labor largely the working modes and business model.

In Japan where small number of death of the aged has been met, overcoming of the issues stemming from the labor shortage realized and everyone enjoying a vivid and bountiful life to lead the industrial competitiveness strengthening by combining the technologies our country can show its strengths and those of AI technology to support the declining labor force, AI technology contributing to productivity enhancement will be needed.

② Recognition of the current situation

Dramatic advancement by utilization of AI technologies in a few years of the recent age has encompassed the vast data in the Net and has been led by the IT industries in the U.S. which the industries of China and the U.S, have succeeded today in hegemony competition, and our country circumstantially lags behind in the presented number of research papers and introduction into businesses in comparison to the U.S. and China.

On the other hand, there are voices heard that victory or defeat is yet decided as the competition such as the data collection at the sites where the gigantic platformer has just started.

Under such situation, in Japan, in the strategy meeting of AI technology established in the Government, and its roadmap toward industrialization, it will handle the issues centering around the three primary fields of “productivity”, ”health, medicine and nursing” and ”movement in space” in linkage with the public and the private sectors.

On the other hand, in human resources, the strength power of the AI advance nations have been stronger even more amidst winning the over fierce cut-throat competition of the human resources on a world-scale such as buying them in the still green in international academic meetings.

However, in Japan, with lack of understanding toward AI technologies and IT, personnel and payroll system and such-originated low-keyed mobility being seen as a problem, and it has been surmised[175] to be roughly 50,000 persons in advanced IT persons in the advanced IT human resources, roughly 300,000 persons in the general IT human resources in 2020. Against these situations, in relevant government offices, while support to personnel training and such top-level human resources usable at once at AI3[176] center at universities being done, the training objectives to be met in future are not yet conducted in many cases yet unmet on the expected scale.

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[175] METI ”Research Results on New Trend and Future Estimate of IT Human Resources” (June, 2016). IT human resources was estimated in the median scenario.

[176] NICT's Brain Info Communications Integration Center (CiNet) and Universal Communications Research Institute (UCRI) Intelligence Integrated Research Center, RIKEN (AIP), Artificial Intelligence Research Center, AIST (AIRC).

Furthermore, to the nationals in general, the IT literacy as user, has been needed in addition to creatively play his/her part with the basic powers have been asked even more such as the basic learning ability, issue-setting and communication ability such as human being, and those of academic, assignment-setting and communications required as human being. In order to drastically improve the competitiveness of our country's industries and accelerate utilization of the AI technologies even more in the society, it will be required of many human resources capable of understanding the AI technologies bearing more of actual duties and thus will be requested to reform the personnel and payment system and such, bound by the conventional concepts.

As for R&D and that of technologies, our country catching up with China and the U.S. going ahead of the U.S. on AI technologies usage and having our competitiveness over them, throwing away the idea of building all by ourselves by incorporating the advanced excellent technologies and assembling all the excellent knowledge in the industry, academia and government in various fields from industry to life complementing our own weaknesses and it is necessary for us to swiftly proceed with social implementation of these technologies.

Moreover, it will be discussed in G-7, European and North American industries and the domestic private organizations and such expected of extensively bringing plenty of social economic benefits to us humans on one hand but being concerned about bringing various risks on the other hand, hence restraining them so that improving the social acceptance toward AI.

③ Future direction and major policies to be completely implemented

From (a) the top to the general at all levels[177] human resources and personnel・salary system renewal facilitation for mobility enhancement on an unbelievable scale in future, (b) as the three emphasized fields[178] as nucleus away from the selfish me-ism, strategic technologies development facilitation in cooperation of AI advanced nations, (c) formulating human-centered AI society principle will be conducted.

Coupled with, in order to materialize and strengthen and practice these initiatives more in detail, “AI technology strategy action plan” will be formulated in the mid-2018.

ⅰ）Human resources training and utilization on unbelievable scale

○ It will be re-reviewed (likewise, if additions and such are necessitated in future) depending on situational change(s) about IT human resources measures of the related offices upon grasping the present nurturing-capable scale at each level to be attained before 2025 to be set in fiscal 2018. Upon reviewing toward realization of the nurturing scale to be attained, the entire government will handle

[177] In advanced IT human resources”top talented persons and capable persons of pioneering”, “independence (having special ability, high-degree analysis and persons of problem-solving ability on his/her initiative)”, “apprentice (persons with basic ability on the advanced on the advanced IT (AI, IoT, Big data)”, general IT human resources (persons with general IT basic ability except the advanced) & the populous in general.

[178] The three fields shown in the “AI technology Strategy”, “productivity”, “health, medicine and nursing”, “movement in space”.

the matters by centralizing/strengthening and such the resources more in policies expected of more results and evolving effective policies boldly plus creating or abolishing policy(s) low in personnel training or unknown.

[STI, MIC, MEXT, MHLW, KETI, MLIT]

○ Recurrent education for adults of society of research expansion opportunity(s) on the part of promising young researchers and from practical education to numerical and data science, together with quantity and quality science at universities, and ferment IT literacy as grounding comparable to "reading, writing, arithmetic" to all students, Major personnel training policies as below;

[STI, MIC, MEXT, MHLW, METI, MLIT]

＜Advanced IT human resource（Top and leader Level）[179]＞

・Utilization of SIP/PRISM and such[180] in top-level personnel training thru R&D.

・Support to the numerical and data science in detail on elementary and middle education stages toward numerical top human resources[181].

・Tobitate! Study Abroad Initiative (Future Technology Human Resources Framework Quota)[182] has started the follow-up (conducting an industry-involving workshop and such)

・Develop and Evolvement of education program(s) and such as data science intended for high-degree human resources such as doctor-course students and doctorate earners.

（a）Developing data-related personnel training program(s) in cooperation with the four stronghold universities[183] and other institutions.

（b）Formulating in fiscal 2018 the evolvement plans for other institution(s).

＜Advanced IT human resource（independent master-level）[184]＞

・Expansion of AI-related recurrent education opportunities (expansion of the 4th industrial revolution skills learning course[185])

・Training of human resources capable of offering solution(s) suitable to individual businesses in the infrastructure fields. (development and diffusion of recurrent education programs)

＜Advanced IT human resource（apprentice ship-level）[186]＞

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179 Until 2025 tens-hundreds a year (ideal human resources training size surmised at each level) .

180 Personnel training thru research projects in RIKEN etc. and NEDO projects, expansion of research expenses to younger researchers in JST projects, expansion of IT human resources digging and training projects of unbeaten IT human resources at IPA.

181 Detailed in light of existing support policies such as Super Science High Schools, Junior Doctors Training Private Schools, International Science Olympiad and such.

182 Future industrial fields inseparable in overseas study support system corporated by public-private, AI, Big data and such, (6 fields of future technologies) for university students and high-school students overseas study support.

183 Tokyo Medical and Dental University, The University of Electro-Communications, Osaka University, Waseda University.

184 Annually a few or several thousand size before 2025. (idealistic personnel training size presumed from each level)

185 Approved by the METI for adults in IT & data fields specialty and practicability high in education and training courses. As the first time approval are 23 courses including data science fields (16 business operators). (January, 2018)

186 Tens of thousands a year size (idealistic personnel training size, assumed from each level.)

・Study of expansion measures for AI-related-licensing examination/qualification examination[187] which the private organization(s) and such hold.

・development and spread practical education(PBL) program to information-leaning students (department and research course) linked with the industry.

（a） Review of the training scale of expansion measures, including diffusion to other universities from education program at stronghold universities[188] within fiscal 2018.

・Strengthening of data science education thru engineering-leaning education reform

（a） Enforcing by flexing the capacity setting・teacher formation for engineering-leaning department and major by revision of the university establishment standards to facilitate the introduction of major and minor system within fiscal 2018 (utilization and positioning of information-leaning teachers in other subject(s) and major(s), availability for all students to major the data science).

（b） Pioneering development of model/core/curriculum toward introduction of the data science education in all engineering fields.

（c） Formulating the spread measures of (b) to other universities in fiscal 2018.

＜General IT Human Resources[189]＞

・Development and diffusion of standard curriculum and such of numerical/data science education for all students.

（a） Starting the standard curriculum and such in linkage of the six stronghold universities[190] and other universities.

（b） Sharing the education materials and such from the six stronghold universities to others.[191]

（c） Formulating expansion measures of nurturing size including the above within 2018.

・Add to set question(s) concerning advanced IT in ”IT Passport examination[192]” [193]

・Raise of the benefit rate of general education training benefits[194] intended for IT literacy earning in order to acquire the basic IT literacy.

・Study the development and enforcement of vocational training for learning of basic IT literacy[195].

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187 NPOs practice inspection and qualification examination to certify knowledge and ability on AI technologies like machine learning and deep learning etc.

188 Targeted for information-learning students: Tohoku University, University of Tsukuba, Nagoya University, Osaka University. Targeted for the general adults: Nagoya University, The University of Kitakyushu, Toyo University, Waseda University, Institute of Information Security.

189 Hundreds of thousands a year size by 2025 (idealistic personnel training size assumed the each level).

190 Hokkaido University, The University of Tokyo, Shiga University, Kyoto University, Osaka University and Kyushu University.

191 Consider study in The Open University of Japan and MOOC, activating on-line course when the real lecture is difficult..

192 National examination to certify the basic knowledge concerning IT that all working people and students who use IT must know.

193 Formulate “IT literacy standard” (tentative) as a "scale" to show knowledge around AI, IoT, data that should be learned and expand examination.

194 Current benefit ratio is 20% of education and training expenses (the upper limit 100,000 yen).

195 Vocational training here means official system that provides vocational skill and knowledge to job applicants who get employment insurance (unemployment insurance).

＜General nations＞

・Such abilities will be nurtured as to the bases for study of problem finding and problem solving and such by abilities of language and informatization (including programming style thinking) by the new government curriculum guidelines. (to be practiced in fiscal 2020)

（a） Putting how the evaluation should be in details within fiscal 2018 on objective attainment s decided in the new Government Curriculum Guidelines.

（b） The gained results will be reflected in the policies as required, grasping study situation after implementation of the new Government Curriculum Guidelines by utilizing various types of investigation and such in and out of the nation.

・Assign one ICT assisting personnel to help a teacher lecture per four schools by fiscal 2022.

・Start the subject re-organization of subjects for university entrance examination uniform tests including setting an information subject in response of the new Government Guidelines in fiscal 2018.

・The “Regional ICT Club” will be evolved on trial basis as an opportunity to learn in a promising manner on the part of pupils and students as an impetus of start of the new Guidelines.

- “The degree program overriding organizational framework” will be systematically positioned in order the human resources to be conducted horizontally overriding departments. By this, incorporating horizontally numerical/data science education in the existing department(s), research course(s) and such, it will be tactically promoted of education initiatives to answer to the social needs[196] in implementing department-crossing education program(s) among humanities and social science-leaning departments.

[STI, MEXT]

- The follow-up investigation will be done afterward of course-learners in private industries[197] course-participants and qualification earners[198] request of aggressive hiring of high-degree foreigners

[STI, METI]

ⅱ） Promotion of Strategic Technology Development and such

- The basic/fundamental R&D will be forcibly promoted with the industrial-academia-government combined in a body to overcome the weaknesses of present AI technologies in the combined fields of applied development, combined with robot technologies and such, AI technologies social implementation activating data exchange platform[199] in the field of quality actual space in Japan in social issues fields (agriculture, health/medicine/nursing, construction, disaster prevention/disaster

[196] Approach of “degree program exceeds faculties” in university reform. (refer to p.32)
[197] Trainee of AI-related education programs by universities, graduated schools and on-line education.
[198] Participants of AI-related education programs and qualified people in AI-related qualifications.
[199] CHAPTER 2 (1) the data exchange platform towards realization of the Society 5.0 (p.12) in reference.

mitigation, manufacturing, etc.) to be solved in the viewpoints to proceed R&D in combination of AI technologies and data/on-the site hard ware or strengths of Japan.

[CAS, STI, Space, MIC, MEXT, MHLW, MAFF. METI, MLIT, MOE]

＜Social implementation＞

・Realizing social implementation ahead of others in the world, utilizing the cross-domain exchange platform without being bound by selfish everything me-ism.

（a） Starting developing the human interaction basis technologies[200] to enable high-degree intelligent communications between physical data exchange platform and computers/machines and to lighten and make efficient human chores.

（b） Starting constructing of smart food chain system to enable production customization and to make distribution effective to match consumption.[201]

（c） Starting utilizing AI technologies to contribute the productivity improvement at low cost in nautical/oceanic fields, Port and bay distribution, and construction/maintenance management.[202]

（d） Starting constructing AI technologies and such intended for multi-language voice translation to enable productivity and services improve in tourism field etc.[203]

（e） Starting constructing AI hospital(s)[204] to enhance medical services by constructing the most suitable medical model.

（f） Starting utilizing AI technologies to research in interface standardization and such concerning image data collection in the said technological field where our country owns strengths in health medical technologies[205]

（g） Starting developing of disaster information sharing and support system[206] to strengthen response capabilities in disaster and disaster reduction fields.

＜Application development＞

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[200] Research for social implementation in 2022 is considered in SIP (the Second term) cyber space basis technology "Big Data/AI-used Cyberspace Basis Technology"

[201] Research for social implementation in 2022 is considered in SIP (the Second term) bio and agriculture "Smart Bio-industry and Agricultural Basis Technologies".

[202] Promote construction productivity by 20% until fiscal 2025 through propelling i-Construction in construction and maintenance field. Formulate within fiscal 2018, objective and process in detail towards realization of "AI terminal" in port and bay distribution field. Aim at realization of automatically-driven ships before 2025 by propelling maritime productivity revolution (i-Shipping & j-Ocean) in maritime and ocean fields

[203] By facilitating the tackling of "translation bank" to amass the translation data in various fields, utilization of deep learning, one of AI technology translation accuracy's improvements and such. Take advantage of Tokyo Olympic & Paralympic Games, social implementation of multi-language will be aimed at by 2020. Moreover, strengthening the partnership among the relevant ministries and facilitating ICT multi-language utilization promotion in various fields.

[204] In health-medicine during SIP (the 2nd term) "high-degree diagnosis & processing system" being studied shll be the contents toward social implementation in 2022.

[205] Diagnostic imaging support, Drug development, Surgery support.

[206] Studying the contents of R&D being scheduled toward the social implementation of 2022 in SIP (the 2nd term) prevention & mitigation of disaster "enhancement of the national resilience (disaster prevention & disaster)".

・Strategically promoting applied development in combination of robotics technologies and those of AI[207] which our country has strengths as industry-academia-public united in a body by clarifying in fiscal 2018.

＜Basics and basic R&D＞

・Strategically promoting innovative computing technologies[208] such as brain type compatible with AI quantum and such by setting the objectives in detail as industry-academia-public united in a body along with clarifying AI basis technologies conquering today's technological weaknesses such as AI, learning from quality small data by the mid-2018.

ⅲ）Ethics and Social acceptance

- Formulate “Human-centered AI Social Discipline” to be the basic discipline for sharing social implementation in better shape AI technology in fiscal 2018[209], our country leading the international discussions such function as G-7, OECD etc.

[STI, MIC, MEXT, MHLW, METI, MLIT]

ⅳ）Formulation of “Artificial Intelligence Technology Strategic Action Plan”

- In order to strengthen artificial intelligence technologies strategy in detail, it will formulate including the above, policies ”AI technology strategic action plan” in the mid-2018.

[STI, MIC, MEXT, MHLW, MAFF, METI, MLIT]

[207] For instance, a combination of industrial robots, endoscopes, material development and regenerative medicine with AI and such.
[208] For instance, computing technology changed information processing qualitatively for quantum, analog, approximation, brain-molfic, and high efficiency computing technology and such linkage with technology layers.
[209] Formulating while referencing tackling of MIC “AI network social facilitation council”, Japan Business Federation, Future Industrial Science and Technology Committee “AI utilization principle task force” and such.

(2) Biotechnology

〇Future visions to be pursued

・In agriculture, industry and health/medicine fields, promoting the new market (bioeconomy) and employment suited to the development of the world bio-industry market, and contributing to transferring the new industrial structure, realization of sustainable society, forming health and longevity society and solving world-scale issues such as SDGs.

・Realizing a society in which not only researchers but the public can understand biotechnology and bioethics and make adequate judgments and selections

〇Objective

・Development of a strategy toward promoting innovation by biotechnology (the new strategy for biotechnology) that contains concrete goals such as expansion of the market size aimed in the 2019 summer

・Accelerating ”Data-driven” [210] technology development and social implementation to the world standard, and achieving new objectives to be included in the new strategy for biotechnology

〇Major issues towards achieving goals and future direction

・A national strategy coping with recent situational change and focused on biotechnology is lacking and selection of fields in which our country could have advantages and “data-driven” R&D and social implementation are insufficient.

・In future, developing the new strategy for biotechnology aimed in the 2019 summer, collaborating with studying toward development of the next “health and medicine strategy”, on the bases of the analysis of past strategies in more detail.

・For the time being, to accelerate “data-driven” and social implementation speedily, starting ahead of others R&D focused on the fields in which our country has advantages and improvement of an environmental for biotechnology.

①Necessity and importance of innovation in biotechnology

Biotechnology can contribute greatly to formation of health and longevity society through improving the people’s health, stable food supply, development of a wide range of industries utilizing biological systems and realizing the sustainable society.

OECD expects the market biotechnologies can greatly contribute to (bioeconomy) will expand to about 1.6 trillion dollars (200 trillion yen) in 2030[211].

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[210] Initiatives spurning new value, such as solving various problems by analyzing gained data.

[211] Biotechnologies have contributed 1% or less of GDP out of OECD member nations on and assumption in the mid 2000’s.

Furthermore, expectation to biotechnology is ever heightened toward the realization of sustainable economy and society amidst the largely changing global situations represented by such international consensus for SDGs as COP-21.

② Recognition of the current situation

Turning our attention to the world, so as to facilitate industry promotion and solution of the social issues, parts of such regions as Europe and North America have developed new strategies, introducing the concept of bioeconomy and strengthened it. Among them, the U.S. is leading the world in all the fields of (a) elaboration and sharpening[212], (b) diversification and complication[213], (c) integration and systematization[214] which are in the trend of technological innovation in the recent biotechnology field[215].

With dramatic advancement of IT and AI technologies, "data-driven" R&D and social implementation based on "inductive" thinking rather than "deductive" thinking is being introduced in the world, and thus we need to rapidly strengthen our response to such change. Looking at our country, we developed "Outline of biotechnology strategy" in 2002, and many of 200 action plans in the strategy have been executed. Moreover, based on the situation change after developing of the strategy, in order to further strengthen our country's biotechnologies, we developed "Dream BT Japan" in 2008 and has promoted development and creation of new industries by practical application of excellent basic research results, social acceptance and R&D of genetically-modified crops, biomass utilization and others.

So far, certain results have been obtained, for example, together with development of regenerative medicine technologies to various diseases using iPS cells in progress, development of new materials that utilize biological functions such as artificial spider silk and agricultural product varieties containing functional ingredients in higher concentration; however, expected results have not sufficiently obtained on the whole.

Its factors appear as follows:

（a） The follow-up has been insufficient after "Dream BT Japan" was developed, and thus we have not been able to deal with the changes in world trends and social situations,

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[212] Life has been quite exquisitely observed, operating technology (genome editing technology, cryo electronic microscope technology and such).

[213] Not only model biology, technologies applicable to various biological species, that of to enable praticiole-individual complicated leaning to analyze (Homo in vitro experimental technology (organoid technology, organ chip technology and such), micro-organism（micro biome analyzing technology and such）.

[214] Individualizing various phenomenon by integrating and analyzing big data Technology to forecast technology (big data analyzing technology and such).

[215] The U.S. has formulated "National Bioeconomy Blueprint" (2012), "Federal Activities Report on the Bioeconomy (2016), Europe has formulated "Innovative for Sustainable Growth: A Bioeconomy for Europe" (2012). In China, there is no strata by specialized in the bio field but as a part of "Scientific Technologies Innovation" is being handled.

（b） We have not prioritized the field where our country has advantages by analyzing our standing position in the world,

（c） Interdisciplinary integrated research has not been progressed with such fields as data science (for example, human resource development[216] has not caught up on dramatic progress in digital technology),

（d） Concerning biotech start-ups conducting technology development, whereas the initial fundraising environment has been arranged, the continual fundraising environment including the time after listing has not been improved.

（e） Although the CRISPR DNA sequence of CRISPR/Cas9 representing genome editing technology was once found by our country, even if we had such an achievement that could lead to innovative basic technology, only a few have reached to technology developmental stage,

（f） Although we have made efforts on the public understanding of the knowledge concerning the safety of genetically-modified crops and foods, the public has not recognized their necessity and value, and social implementation such as cultivation of them in the country has not been progressed.

On the other hand, Japan has many advantages as follows:

（a） Accumulation of plentiful biological resources and Japanese food, the basis of world-class health and longevity,

（b） Promising seeds of basic technologies competitive to proceeding patents of other countries,

（c） Breeding and cultivation techniques producing high-quality and high value-added crops such as paddy rice and fruits,

（d） Manufacturing technologies using microbial function such as fermentation,

（e） Technologies to convert biomass to useful compounds and materials, and others.

Utilizing these advantages, there is plenty of possibility to win the competition with the world by “data-driven” technology development and social implementation integrated with digital technology. However, regarding “data-driven” technology development and social implementation, in order to maximize advantages of our country, the analysis from a viewpoint of what kind of data needs to be collected and how to utilize it has not been sufficiently conducted, and thus we need to start dealing with this immediately.

Moreover, whereas the genome editing technologies recently developed can alter genetic information with great accuracy, they have different characteristics with existing genetic engineering technologies, such as genetic modification without insertion of exogenous gene(s), and thus treatment of these technologies on the legal systems need to be reasonably clarified. Furthermore,

[216] Bioinformatician and such (specialist in the integrated region of information science and life science).

concerning these advanced technologies, we need to provide accurate information to the public and promote technology development and social implementation.

③ Future Direction and Major Policies to be concretely implemented

From now on, upon more closely analyzing the past strategies and such, we will develop the new strategy for biotechnology that involves both of medical and non-medical fields aimed in the 2019 summer.[217]

On the other hand, to rapidly accelerate “data-driven” technology development and social implementation, as steps for the moment, we will make the following improvement of an environmental for biotechnology and technical development and social implementation using the analysis by “inductive” thinking etc., targeting for the field in which our country’s strengths will be maximized.

ⅰ）”Data-driven” technology development and social implementation and improvement of an environment to accelerate them

- Together with the basic technological development underlining “data-driven” technology development centered on SIP（the 2nd term） as core projects, we will conduct technological development and social implementation in each industry to which biotechnology is applied.

[CAS, STI, MEXT, MAFF, METI, MOE]

＜Development of basic technologies＞

・Development and sophistication of analysis techniques for big data such as plant and microbial multiomics[218] information and such, biological function design technology[219], genome editing technology of which our country has promising seeds, long-chain DNA synthesis technology, etc.

＜Innovation in agriculture, forestry and fisheries＞

・Establishment of ”smart breeding” (preparing big data such as omics information and characteristics evaluation data and conducting “genomic selection[220]” which has improved prediction accuracy of genetic performance by AI analysis) spurring to meet the needs of varieties in short term than previously.

・Development and actualization of new agricultural materials to increase productivity, quality and environmental tolerance of crops (conducting inclusive data acquisition and analysis and such in complex plant-microbe symbiotic systems)

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[217] Incorporating high affinity items to be specialized in linkage with health & medical strategy to be revised before the fiscal 2019 end.

[218] Information of various substances having biology-owned genes, gene transcripts, protein, and metabolite and such.

[219] Indicating technologies in regions of system biology, composed biology, metabolism engineering in detail, rational genome & metabolism designing technology to induct to give or take out the necessary based on big data such as multi omics information and such.

[220] Selection mode in prediction of genetic performance of individuals based on individual difference of many DNA arrangements on genome

＜Creation of innovative new materials and products＞

・Development of technologies to manufacture new useful compounds and such that are hard to synthesize chemically by "smart cell[221]" of which functions are designed based on the analysis of big data such as genome information and which regulates expression of function by genome editing technology, long-chain DNA synthesis technology and such.

・Developing production technologies for useful substances and materials using biological function and biomass and optimization of production conditions by acquiring various data concerning mass production processes and AI analyses.

・Development and commercialization of new biological function-integrated devices and such that can measure immeasurable and ultra-small amount of chemicals by integration of excellent biological function, electronics technologies, AI technologies and such.

＜Health enhancement with foods＞

・Developing a new system that designs a diet to maintain and enhance health according to individual health conditions and lifestyles (data regarding diet and health collected, analyzed and otherwise processed).

・Developing new foods in order to enhance health using microbiome[222] (exhaustive microbiome data of common people and such collected, analyzed and otherwise processed)

○Conducting improvement of an environment for biotechnology such as human resource development, increasing data availability, development of research centers, etc., emphasizing the interdisciplinary integration and the cooperation with the industry.

[STI, MEXT, MHLW, MAFF, METI]

＜Human resource development for interdisciplinary integration with data sciences[223]＞

・Developing program(s)[224] for human resource development in response to needs from the industry (conducting courses easy-to-be taken by the general adults such as e-learning).

・Starting to study the use of recurrent education-related policies[225] by the Government in fiscal 2018 toward smooth offering and expansion of the program for human resource development.

＜Improvement of data usage environment＞

・Enhancing data and function in response to not only academic use but the needs from industry concerning the databases of national research centers (machine readability for AI analysis, clustering[226] annotation[227] API implementation and such useful for development in the industry).

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[221] Biological genes regulated of appearance of functions, of which are highly designed.
[222] Assemblage of microorganisms living in specific environment.
[223] Study of special field about data analysis. Mainly, leading out or its processing method meaningful information of any kind, rules and relevancy.
[224] Starting bioinformatics education program development from fiscal 2018.
[225] For example, thinkable are acquiring the 4th industrial revolution skills learning support course approval system.
[226] The method of automatically sorting the data.
[227] Giving the related in information as reference to certain data.

・Considering a system that promotes the use of data from the industry in the industry, academia and the government aimed in fiscal 2018.

＜Development of joint academic-industrial research centers for interdisciplinary integration ＞

・Development of joint academic-industrial research centers to accelerate interdisciplinary integration between biotechnology and data science and social implementation.

ⅱ）Promotion of systemic measures and such for early social implementation of obtained achievements made

- Taking systemic measures for early social implementation of obtained achievements, supporting biotech start-ups, and promoting public understanding of biotechnology.

[STI, CAA, MHLW, MAFF, METI, MOE]

＜Systemic measures and such＞

・Clarification of handling of organism(s) obtained using genome editing technologies on the Cartagena Act[228] and of initiatives agricultural produce and fishery products and such obtained using genome editing technologies on the Food Sanitation Act[229] aimed in 2018 and promotion of actions toward international harmonization.

・Creation of a labeling system concerning usefulness and environmental performance of products using biological function and biomass.

・Reflecting scientific evidences accumulated with a progress of R&D on the health enhancement by foods in “Foods with Health Claims System”[230], including utilization of agricultural, forestry and fishery products and foods obtained using biotechnology, on an assumption ensuring safety of food adequately based on the thought "a balanced diet leads to a healthy body", and international standardization of the labeling for functional foods and component analytical methods

・Promoting fundraising at stock markets for biotech start-ups which needs a large amount of fund over a long period of time (developing investment guidance and reviewing the listing standard and delisting standard at the stock market(s) and such)

＜Promoting public understanding＞

・Developing risk communications based on scientific viewpoints[231] (strengthening of information provision about public's benefits).

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[228] Act on the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms. (Act No. 97 of 2003)

[229] Act No. 233 of 1947.

[230] For example, study the evolution method for perishable food according to characteristics in “Foods with Function Claims system” and the probability of expansion of indicatable health complaints in “food for specified health use” and “foods with function claims”.

[231] Exchanging information and opinions mutually among related such as consumers, business operator and administrative institutions.

(3)Environment and Energy[232]

○ Future visions to be pursued

- To realize the world's most advanced energy management system[233] compatible with building a data exchange platform required for realizing Society 5.0
- Contributing to the enhancement of our industrial competitiveness, climate change measures and energy security through deploying both at home and abroad our world-leading technologies for creating energy[234] and storing energy including their infrastructure
- Realizing the world's first hydrogen society through building an international supply chain for such objectives as converting renewable energies into hydrogen and importing the latter via overseas infrastructure deployed by our country.
- Achieving the "2-degree goal"[235] as stipulated in the Paris Agreement through promoting the above and other necessary initiatives

○ Objective

< Energy management system >

- Setting up a base for data linkage in this field and a framework for new energy management system within a period of three years (course to be set in fiscal 2018)

< Creating energy and storing energy>

- Realizing globally competitive power unit costs of renewable energies[236] for deploying our technologies abroad (specific goals to be established in fiscal 2018)

< Hydrogen>

- Realizing the world's first hydrogen society
  - 2050 introduction quantity of hydrogen to be 5~10 million tons +α, 2030 introduction quantity of ammonia to be three million tons
  - hydrogen power generation cost to be made substantially equal to that of fossil fuel in 2050

○ Major Issues Towards Goal Accomplishment and Future Direction

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[232] Integrated Innovation Strategy 2017 set forth and promoted the seven "Priority initiatives" -"a" through "g". Of these, regarding "a"- Structuring an energy platform, "b"- Stable supply of clean energy and reduction of its cost, and "c"-Stabilization of energy use through means including the utilization of new technologies and batteries toward realizing a hydrogen society in particular, goals to be achieved with proper understanding of our position in the global expansion and measures for achieving such goals have not been clearly defined and we are yet to become internationally competitive. Therefore, we will continue to work on these initiatives in this Strategy under the items of energy management system, creating energy/ storing energy and hydrogen.

[233] It is a system to optimally utilize energy between the networks set up at regional or inter-regional levels irrespective of whether such energy is in the form of electricity, heat, chemical or other substances.

[234] To create energy through such renewable energy schemes as solar, wind and other sources as well as co-generation system

[235] To put the world on track to limiting the global warming of mean temperature to much less than 2 degree above pre-industrial levels

[236] Examples of benchmark goals: 2030 solar power generation cost ¥3.3/kWh (U.S.), 2030 ocean wind power generation cost ¥9.45/kWh (Europe), 2030 geothermal power generation cost ¥6.6/kWh (U.S.), 2030 ocean energy power generation cost ¥13.5/kWh (Europe).

- While our country is a leader in certain technological fields including energy saving, there are quite a few other technologies we have established our superiority in terms of their individual attributes, but we are yet to be successful in socially implementing/commercializing and marketing them overseas because goals to be achieved with proper understanding of our position in the global expansion and measures for achieving such goals have not been clearly defined.
- In order to build a world-leading energy management system, to deploy overseas our technologies for creating energy/storing energy and to materialize the world's first hydrogen society, we will establish goals with global perspectives and at the same time, we will set a course for achieving such goals and promote specific approaches comprehensively covering R&D programs through social implementation with collaboration between the relevant ministries and among industry, academia and government.

① Necessity and importance of innovation in the environmental energy field

In order to achieve the "2-degree goal" as set forth in the Paris Agreement, it is demanding to create and socially implement innovations which will not only drastically reduce greenhouse gas at home but also make the maximum contribution to reducing the global emission through developing entirely different technologies with disruptive innovations in addition to continued utilization of existing technologies.

Besides, in order for our country leading the world in renewable energy technologies to compete and beat Europe and China running ahead of us in terms of price competitiveness and supply records, and to capture the global market, we need to lower our costs through innovations and other available means, and at the same time to create value addition through maximizing our strengths.

② Recognition of the current situation

Drastic changes are taking place in the global energy supply and demand structure caused by such factors as increasing energy demand mainly in emerging countries, shale revolution and drastically reduced renewable energy costs. In particular, after the Paris Agreement was put into effect in November 2016, in line with the acceleration of a global trend toward "decarbonization[237]", the use of adjustable renewable energies has rapidly spread and in some Middle East countries, the solar power generation cost has been reduced to ¥3/kWh[238], lower than the natural gas cost. Along with such development, changes are noted in the power configuration where diversified types centered on adjustable renewable energies are on the rise in addition to the conventional centralized type, and digitalization of energy is also progressing at a rapid pace.

[237] It is to reduce carbon emission by decreasing the dependency on the use of fossil fuel and employing other available means toward equalizing artificial emission and sink-elimination of greenhouse gas of the world in the latter half of this century.
[238] IRENA "Renewable Power Generation Costs in 2017" (January, 2018)

Meanwhile, in China, a strategy is employed to transfer renewable energies from eccentrically located supply points to users through large-scale grids. The trend toward “decarbonization” is highly noticeable in the transportation sector, and “electrification” of motor vehicles on a global scale as led by EV is a big, rising tide.

In Japan, R&D programs in the environmental energy field have been promoted over many years with large amounts of national funds allocated and

while our country is a leader in certain technological fields including energy saving, there are quite a few other technologies for which we have established our superiority in terms of their individual attributes, but we are yet to be successful in socially implementing/commercializing and marketing them overseas.

Therefore, regarding our excellent technologies achieved via R&D programs in the environmental energy field, we need to further clarify how the roles should be shared and the responsibilities assumed between the relevant ministries for commercial viability and to strongly promote the Plan-Do-Check-Act (PDCA) cycle.

Furthermore, regarding energy/climate change diplomacy, we need to proactively support energy conversion initiatives of other countries through innovation and to lead economic growth and movement toward decarburization of the world, duly taking into account big changes in the global energy supply-demand structure and timely reviewing our infrastructure strategy.

③ Future Direction and Major Policies to be completely implemented

In order to build a world-leading energy management system, to deploy our technologies for creating energy/storing energy overseas and to materialize the world’s first hydrogen society, we will establish goals with global perspectives and at the same time, we will set a course for achieving such goals and promote specific approaches comprehensively covering R&D programs through social implementation with collaboration between the relevant ministries and among industry, academia and government.

Also, in order to realize the “2-degree goal”, other technologies designated as promising fields in “Energy, Environment Innovation Strategy” (decided at CSTI in April of 2016) and R&D programs including those to clarify/forecast the climate change will be continuously promoted.

i) Energy management system

○ In light of the introduction of power source with variable output and situation changes including technological progress of the world, we will set up a data exchange platform in the environmental energy compatible the cross-domain exchange platform toward realizing Society 5.0, and form a framework for new energy management system including the utilization of such data exchange

platform in a period of three years. In particular, we will promote a consistent approach for realizing the optimal design for the entire energy management system.

[CAS, STI, MIC, MEXT, MAFF, METI, MLIT, MOE)]

- The relevant ministries should cooperate with each other to set a course for achieving these goals in fiscal 2018.

ii) Creating energy and energy storage

○ We will establish goals for deploying our technologies of creating energy /storing energy overseas and at the same time set a course for achieving such goals in accord with the open and close strategy, and promote international standardization. Regarding technologies to utilize domestically abundant resources such as geothermal heat, we will promote R&D programs to disseminate such resources as base load power.

[MEXT, METI, MLIT, MOE]

-We will make sure to realize the 2030 energy mix[239] and to establish in fiscal 2018 such goals as reducing power generation costs of renewable energies to a globally competitive level for making such energies a major power source.[240]

- We will set a course to achieve these goals and make studies to revise the roadmap[241].

iii) Hydrogen

○In order to materialize a hydrogen society leading the world, we will set a course to achieve the goals of reducing hydrogen power generation costs and raising the introduction quantity of hydrogen through collaboration among the relevant offices, ministries and agencies. In particular, we will study developing an international hydrogen supply chain through the use of energy carrier and other available means, taking into account possibilities of realizing introduction potential, social implementation and other achievements.

[STI, MEXT METI, MLIT, MOE]

-We will set a course to achieve the goals and revise the roadmap.[242]

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[239] Long-term supply-demand outlook for energy (set forth by METI in July, 2015). Here, renewable energies are set to account for 22-24% of the 2030 power configuration.

[240] Examples of benchmark goals: 2030 solar power generation cost ¥3.3/kWh (U.S., Utility Scale) (US Department of Energy "Sunshot 2030" (November, 2016)); 2030 ocean wind power generation cost ¥9.45/kWh (Europe, fixed type) (European Commission "Transforming the European Energy System through INNOVATION" (September, 2015); 2030 geothermal power generation cost ¥6.6/kWh (U.S. System to ramp up thermal power generation) (US Department of Energy "2016-2020 STRATEGIC PLAN and Implementing Framework" (November, 2015)); 2030 ocean energy power generation cost ¥13.5/kWh (Europe, Tidal power generation) (European Commission "SET Plan – Declaration of Intent on Strategic Targets in the context of an Initiative for Global Leadership in Ocean Energy" (September, 2016)) (One dollar converted at ¥110. One Euro converted at ¥135)

[241] Development of roadmap for energy-related technologies

[242] Strategic Roadmap for Hydrogen and Fuel Cells

- From such innovative perception as placing the green ammonia consortium in the center and converting renewable energies of the world into ammonia for importation to Japan, we will initiate a study to deploy a CO2-free ammonia value chain.

iv) Implementation of R&D evaluation for achieving the goals

○In promoting R&D programs related to environment and energy, we will take into account such factors as social implementation and global deployment, and at the same time, we will evaluate commercial/business viability of results achieved in the past from the perspective of achieving innovation goals[243] for moving further to implement more vigorously the approach to activate the PDCA cycle.

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

- CAO(STI) will verify in fiscal 2018 evaluation methods of major projects related to environment and energy.

v) Promotion of energy/climate change diplomacy from the perspective of innovation

○Utilizing our country's broad technologies and experiences, and taking into account various needs of other countries, we will proactively support their energy conversion initiatives in terms of developing infrastructure and human resources, and lead economic growth and movement toward decarburization of the world. In particular, from the perspective of innovation, we will practice energy/climate change diplomacy which will work to contribute to enhancing our industrial competitiveness, dealing with climate change and improving energy security by means of assisting other countries' initiatives to achieve SDGs mainly with the use of low-carbon type infrastructure technologies including renewable energies and hydrogen.

[STI, MOF, METI, MOE]

vi) Reflection of the above in our plans and strategies

○In line with the above-mentioned directions, we will formulate environmental energy-related plans and strategies including the fifth basic energy plan and long-term, low-emission progress strategy.

[METI, MOE]

[243] Materialization of Society 5.0 - Requirements include R&D programs covering basic research through verification of commercial/business viability, strategy for intellectual properties /international standardization /regulation reform, distinction between zones of collaboration and zones of competition, collaboration among industry, academia and government, etc.

(4) Safety and Security

○ **Future visions to be pursued**

- Amid ever-increasing severity of our country's security environment, to realize, comprehensive security against a wide range of threats to people's lives and socioeconomic activities which include large-scale natural disasters, international terrors/crimes and attacks in such new zones as cyberspace
- Through the realization of comprehensive security, to unite our advanced scientific and technological capabilities by means of collaboration between the relevant ministries and among industry, academia and government for keeping our country's peace and ensuring the safety and security of its people
- Realizing a society where our superiority may be widely utilized for ensuring people's safety and security, while taking precautions not to have information of our scientific technologies leaked, moving ahead with social implementation of our advanced scientific technologies, and securing and maintaining our superiority in technology

○ **Objective**

< Know>

- Clarifying fields to promote, fields to supplement and fields to properly manage with an overview of our scientific technologies and from the standpoint of safety and security

< Develop>

- Focusing on fields clarified as such in the process of <Know> and strenuously developing scientific technologies which contribute to our safety and security through the allocation of budgets, human and other resources on a priority bases to these fields.

< Keep>

- Taking precautions to keep information related to scientific technologies for securing and maintaining our technological superiority and preventing our technological results from being improperly used to manufacture such products as weapons of mass destruction.

<Utilize>

- Ensuring the safety and security of our country and its citizens through executing social implementation of the results acquired via the above processes of <Know>, < Develop> and **<Keep>.**

○ **Major Issues Towards Accomplishment Goal and Future Direction**

- We need to broadly utilize our advanced scientific technologies for ensuring the safety and security of our country and its people.
- We will create innovation and ensure the safety and security of our country and its people while securing and maintaining our technological superiority through uniting our various advanced

scientific technologies and utilizing them for social implementation with concerted initiatives of the relevant ministries.

① Necessity and importance of innovation in safety and security fields

It is important to utilize our country's various advanced scientific and technological capabilities which make the bases for comprehensive security for ensuring the safety and security of our country and its people. Toward such end, it is necessary for the relevant offices, ministries and agencies to implement promotional programs of scientific technologies on a cross-sectional manner, to unite and broadly utilize our scientific and technological capabilities, to create innovations while securing and maintaining our technological superiority for safety and security.

② Recognition of the current situation

Amid ever-increasing severity of our country's security environment, people's lives and socioeconomic activities are faced with various threats which include large-scale natural disasters, international terrors/crimes and attacks in such new zones as cyberspace.

In order to maintain our country's peace and to ensure the people's safety and security against these threats, we need to broadly utilize our advanced scientific technologies for prevention and mitigation disasters and dealing with terrors and crimes as well as threats in various zones including cyberspace, space and ocean.

Also, regarding such scientific technologies, we need to take adequate precautions to prevent our technological results from being improperly used in connection with the manufacture of such products as weapons of mass destruction and acts of international terrors/crimes, for securing and maintaining our technological superiority and as international responsibilities to be assumed by a developed country.

③ Future Direction and Major Policies to be completely implemented

We will get a broad overview of scientific technologies, "know" those which contribute to safety and security, "develop" such technologies through concerted initiatives of the relevant ministries and collaboration among industry, academia and government, "keep" such technologies for securing and maintaining our superiority in these areas and for preventing such technologies from being used to manufacture such products as mass destructive weapons and "utilize" the results gained through such approaches for ensuring safety and security via social implementation.

i) Know

○We will overview our scientific technologies and from the standpoint of safety and security, find out our strengths and weaknesses and clarify fields to promote, fields to supplement and fields to properly manage.

[CAS, STI, Disaster, Space, Ocean, NPA, MIC, MOF, MEXT, MHLW, MAFF, METI, MLIT, MOD]

-Through concerted initiatives of the relevant ministries, and collaboration among industry, academia and government, we will enhance a system to overview and get a grasp from diverse standpoints domestic and overseas scientific technologies likely to be widely useful, and while acknowledging the necessity to keep track of technological levels of overseas and ensure our safety and security, we will identify fields to focus on and challenges, for example fields to promote.

-As it is imperative to investigate and analyze trends in scientific technologies from the standpoint of ensuring our safety and security, we will enhance relevant capabilities (function of think tank) of people including experts well versed in such fields.

-We will deploy a system to find out and identify early scientific technologies likely to be useful in the future and fields to be properly managed.

ii) Develop

○We will have the results of the process <to know> related to safety and security reflected in prioritized allocation of budgets and resources including humans, and at the same time, we will enhance a system to promote basic research of advanced scientific technologies as well as challenging and innovative R&D programs for intensively nurturing necessary technologies.

[CAS, STI, Disaster, Space, Ocean, NPA, MIC, MOF, MEXT, MHLW, MAFF, METI, MLIT, MOD]

○National research institutes playing an important role in developing scientific technologies, in view of their public status, should do so to contribute to prevention and mitigation of disasters as well as safety and security in various zones including space and ocean. The institutes' contributions should be made with their respective conditions taken into account and through proactive collaboration with other relevant ministries within the scope of the purposes of their foundation.

[CAS, STI, Disaster, Space, Ocean, NPA, MIC, MOF, MEXT, MHLW, MAFF, METI, MLIT, MOD]

- The relevant ministries and national research institutes should exchange information on scientific technologies which contribute to safety and security, and when needed, sign a collaboration agreement between them and take other necessary cooperative steps in joint research for efficiently and effectively promoting valid R&D programs against threats.

-Exchange of personnel and information between the relevant ministries and national research institutes should be augmented for deepening mutual understanding and expanding personal networking toward developing discerning human resources of scientific technologies.

○ In order to promote these approaches, it is quite important to foster understanding of society in general about safety and security in light of the diversity of scientific technologies, and therefore, the government should broadly publicize positive results of R&D programs and at the same time arrange an environment conducive for motivated R&D organizations to take part in these activities.

[CAS, STI, Disaster, Space, Ocean, NPA, MIC, MOF, MEXT, MHLW, MAFF, METI, MLIT, MOD]

iii) Keep

○From the standpoints of ensuring and maintaining our superiority in scientific technologies and preventing our technological results from being improperly used to manufacture such products as weapons of mass destruction, we will take precautions to block relevant technical information leaks. For making such precautions effective, it is necessary in the first place for each researcher to be aware of possibilities of such leaks, and for universities and corporations to which the researchers belong to take proper organizational measures and keep relevant information.

Also, when moving forward with these approaches, the parties concerned should ensure that the actions are compatible with the idea of open science to publicize R&D results and the policy to promote scientific technologies through joint research with overseas counterparts.

[CAS, STI, Disaster, Space, Ocean, NPA, MIC, MOJ, MOF, MEXT, MHLW, MAFF, METI, MLIT, MOD]

- Regarding technology information leaks to overseas or to such undesirable groups as international terrorists likely to cause safety and security concerns, which are brought about by increased transfers of researchers due to the globalization of research endeavors and business activities, corporate M&As, as well as cyberattacks and the like due partly to sophistication of telecommunications technologies, the relevant ministries should share information and cooperate in promoting coordinated measures.
-The government ministries should raise necessary awareness of the people and provide further assistance, and while taking steps to improve the effectiveness of such initiatives and to reduce burdens on universities and corporations, the ministries should encourage them to take initiatives and to deploy systems for observing laws and regulations, and properly managing information related to the technologies in their respective organizations.
-From the standpoint of security export control and the like, a close review should be made on government-sponsored R&D projects whose information should be properly managed and the number of projects subjected to requirements of such management and the like be expanded, taking into account characteristics of each project.
-Investigations and tests of technologies including measures against reverse engineering should be promoted to prevent technological leaks.

iv) Utilize

○Through the approaches “to know”, “to develop” and “to keep”, the government should make concerted initiatives to unite our various advanced technological capabilities and through “utilizing” such capabilities for social implementation, should ensure the safety and security of our country and its people while securing and maintaining technological superiority and continuing to create innovations.

[CAS, STI, Disaster, Space, Ocean, NPA, MIC, MOF, MEXT, MHLW, MAFF, METI, MLIT, MOD]

(5) Agriculture

○Future visions to be pursued

- Contributing to increasing productivity drastically and increasing income of farmers by having farmers practice innovative agriculture in which data is fully used[244] and smart agriculture technologies are introduced.
- Contributing to increasing the brand power of agriculture of our country and reducing food losses and wastes by deploying production bases[245] utilizing our smart agriculture technologies and systems to the Asia-Pacific and other regions.

○Objective

Creating innovations with the use of the achievements of SIP and other initiatives to realize future visions to be pursued even in such environment of drastic decrease in the labor force.

<Increasing productivity and raising added value through the entire value chain>

- Having virtually all farmers practice data-utilizing agriculture
- Reducing farmers' rice production cost by 40% compared with the 2011 national average cost[246] by 2023.
- Expanding the market size of "sixth-industry" vertical integration (from production into processing and distribution) to 10 trillion yen by 2020[247].

<Capturing the global market>

-Capturing a market of more than 100 billion yen by 2025 through deploying smart agriculture technologies domestically and internationally.
- Increasing the exports of agricultural, forestry and fishery products to 1 trillion yen by 2019 and based on the results, to establish a new goal of realizing exports totaling 5 trillion yen by 2030.[248]

○Major Issues to Achieve the Goals and Future Direction

- So far, our analyses of global trends and our strengths are have been insufficient, and targets and a viewpoint of global expansion have been unclear.
- We deploy not only agricultural, forestry and fishery products and foods but also smart agricultural technologies and systems domestically and internationally by improving an environment to accelerate technological development and social implementation and through promoting technology

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[244] Necessary data from production to processing, distribution and consumption.
[245] Smart agricultural technologies/systems to be introduced and "Michibiki", quasi-zenith satellite system to be proactively utilized
[246] 2011 crop was priced at ¥16,001/60kg (Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF)) (Farming management statistics survey (rice production cost statistics)
[247] In fiscal 2015, the figure stood at ¥5.5 trillion (Compiled at MAFF)
[248] In fiscal 2017, the figure stood at ¥807.1 billion (Compiled at MAFF based on "Trade Statistics" of MOF. Exports of agricultural products (excluding forestry and fishery products- expressed in billion dollars.) (FAOSTAT: 2013) had U.S. with 147.7 (first), The Netherlands with 90.9 (second), Germany with 84 (third) and Japan with 3.1 (60th)

development with clearly-defined targets and with an eye on the global market and developing a smart food chain system.

① Necessity and importance of innovation in the agriculture sector

With our society's declining population, whereas a sharp drop in the number of farmers and shrinkage of the domestic food market are inevitable, the global food market is expanding rapidly. Thus agriculture can be an industry with huge growth potential, if steps are taken to respond to the global food market and consumers' diverse needs and reforms that allow motivated farmers to maximize their ingenuity are promoted.

For our agriculture sector to move ahead in the current situation where a pinch and a chance co-exist, to become a winner in the global competition and to grow into a viable industry, it will be necessary to drastically boost its productivity and to realize innovations for enabling dynamic production, processing and distribution (export) tailored to satisfy demand (needs), in addition to continued promotion of farmland consolidation undertaken by the Farmland Intermediary Management Institution, agricultural reforms to lower prices of farming materials and other programs.

② Recognition of the current situation

Looking at the global expansion, it is noted that particularly in such developed countries as Europe and the U.S., data-aided agriculture (precision agriculture) utilizing such advanced technologies as drones and sensors is widely practiced.

Also, in Japan, with technologies for smart agriculture intended to boost productivity having been developed and our first Agricultural data exchange platform[249] set up having obtained remarkable achievements with the use of SIP and other means, our technological level is equivalent with that of Europe and the U.S. which practice precision agriculture. Besides, our country was the first in the world to develop two or more self-driving tractors moving collaboratively, which provides us with a world-leading technology.

If we are to become a winner in the global market and to move ahead of our competitors, it is important for us to accelerate technological development toward drastically boosting productivity and to steadily utilize the achievements for social implementation.

On the other hand, as we cannot differentiate ourselves from others with simply pursuing higher productivity, it is also important for us to practice agriculture which generates high quality and high added value through detailed cultivation management – a strength of ours. In particular, in

[249] ①Linkage between various systems provided by private corporations, etc. (to enable data linkage of various agricultural ICTs, agricultural machines, sensors, etc.), ② Function of sharing data (to enable data comparison and provision of services leading to higher productivity under certain rules), ③Data platform with the function to provide data (public data on soil, weather, market, etc. and various fare-paying data generated by private corporations may be accumulated and information useful for farmers (including paid information) may be offered.

cultivation of such diverse products as irrigated rice, vegetables (excluding tomato and bell pepper) and fruit as well as fields requiring diverse forms of agricultural management, for which precision agriculture is not widely practiced globally (blank areas), it will be possible for us to lead the world in technological development, and therefore we need to focus on such areas.

Furthermore, with our farming population continuing to age, we need to arrange an environment to prevent skilled farmers' sophisticated techniques and know-how, which enable production of high quality and high value-added products, from being leaked on one hand and to encourage their utilization on the other, and at the same time to visualize such assets with the use of AI technologies for making it possible for every farmer to practice the agriculture that incorporates our strengths without depending on their intuitions and experiences.

However, so far in technical development for agriculture, analyses of global trends and what our strengths are have been insufficient, and targets to focus on not clearly defined and steps for responding to global needs not adequately taken.

Also, partly due to the fact that the market size for the results of technical development for the agriculture sector is smaller than other industrial sectors, collaboration with the industry and initiatives to utilize such results for business has not been quite adequate. But as our labor shrinkage in the agriculture sector is more acute than in other industries, raising productivity in this field through the use of such advanced technologies as ICT and robotics has become an urgent requirement and now it is necessary to accelerate technological development and social implementation through collaboration with different fields and other industries.

③ Future Direction and Major Policies to be completely implemented

In the future, we will arrange an environment to accelerate technological development and social implementation through open innovation, collaboration among industry, academia and government as well as other means, taking note of the characteristics of agriculture, and at the same time develop smart agriculture technologies for a drastic increase in productivity targeting the blank areas of the world and the fields where our strengths can be maximized, and keeping an eye on the global market for such strengths.

Furthermore, we will develop a smart food chain system that enables raising farmers' income and reducing food losses and wastes by expanding the function of the agricultural data exchange platform to cover from production to processing, distribution and consumption and sharing information such as diversified domestic and global needs beyond the boundaries of industrial sectors, and developing a production/supply system that closely meets those needs.

Through such approaches, we will deploying not only agricultural, forestry and fishery products and foods but also smart agricultural technologies and systems domestically and internationally.

i) Clarification of targets and promotion of technological development and social implementation with an eye on the global expansion.

- Taking into account global trends, our strengths and challenges making the bottleneck, we will promote technological development with an eye on the global expansion[250], establish data-driven smart agricultural technologies and systems centered on the agricultural data exchange platform and deploy them domestically and internationally.

[CAS, STI, Space, MIC, MAFF, METI]

< Increasing productivity and raising added value through the entire value chain >

-Development of innovative technologies and systems for applying IoT and intelligence to machines and facilities (such as automated management technologies via automatic sensing of diverse data)

-Development of information platform that enables sharing and utilizing information from production, processing, distribution through consumption with the use of such tools as block chain technology

-Development of technologies to enable highly accurate production and demand forecasting as well as supply-demand matching (analyzing various data[251] obtained in a number of farmlands, consumption trends and related information utilizing AI and other technologies)

-Development of technologies to optimize distribution based on production-related information

< Capturing the global market>

-Development of automatic agricultural machines downsized and equipped with special functions which may be introduced in diverse regions[252]

-Development of technologies/systems to control agricultural machines and equipment precisely on the order of “centimeters” (utilizing the quasi-zenith satellite system in the Asia-Pacific and other regions)

ii) Arranging an environment to accelerate technological development and social implementation

- Taking into account the characteristics of agriculture, which is the basic industry of various regions, we will arrange an environment and develop an innovation ecosystem conducive to promoting open innovation and collaboration among the industry, academia and the government, promoting the entry of R&D-type start-ups, and encouraging farmers’ proactive participation in R&D, among other things.

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[250] Protection and utilization of intellectual properties (open and close strategy), boomerang effect, international standardization and others

[251] Cultivation data, weather data and others.

[252] Mountainous regions in Japan, Asia and other regions

[STI, MIC, MAFF, METI]

- Enhanced collaboration between R&D platforms[253] related to smart agriculture, development of producer-type human resources, holding of seminars/workshops that integrate knowledge and technologies of diverse fields

-Talent-spotting, development and utilization of private-sector consultants capable of accurately responding to technical requirements of forward-thinking farmers

-Systematic assembly and verification on a continuous bases of leading technical elements of smart agriculture from production to shipment

-Establishment of contract guidelines in 2018 for fairly defining the respective rights of use of farmers and data users in using farming data

-Development of communication tools to connect researchers and farmers utilizing AI and other available technologies

-Creation and development of AI, IoT service models that contribute to solution of challenges the agricultural sectors of different regions face

[253] Forum to accumulate and utilize "knowledge" (established at Industry-Academia-Government Collaboration Council)

(6) Other Important Fields

(a) Fields related to Cyberspace Technologies and to Physical Space Technologies

Amid the declining labor force, R&D for automation through the use of machines including robots is promoted but work which requires accumulated experience including operation and management of sophisticated machines, process planning, quality control and precise manual work cannot be automated, and human involvement remains essential. For this reason, in “Basic Cyberspace Technologies” and “Basic Physical Space Technologies” under SIP (the 2nd term), the bases for collection, analysis, coordination and utilization of data to assist and enhance human behaviors and cognitive capacities primarily in such fields as manufacturing industries, service industries and fields related to health, medicine and care as well as space mobility will be established. Also, developing IoT devices of extra-low electricity consumption and innovative down-sized, low-cost sensors which can be attached to such devices will be promoted in collaboration with PRISM for making IT technology-aided assistance available at workplaces.

(b) Cyber/Physical/Security fields

Amid the practice of connecting IoT devices in physical space with cyberspace via networks gaining popularity, cyberattacks increasing in number are becoming a threat to every industrial activity. In the U.S., for procurement of the Department of Defense, observation of criteria for cyber security measures[254] and similar requirements are applied to every unit of supply chain. Also, in Europe, a statement to the effect that the Cyber Security Acknowledgment System would be established was made in 2017 and it is likely that cyber security including the supply chains will be required in the future. As to our country, in “Security (Cyber/Physical Security) under SIP (the 2nd term), we will develop core technologies and take other necessary steps to enhance the cyber security of the entire supply chain including small and medium-sized enterprises.

(c) Autonomous Driving field

Through upgrading a map-development system covered under “autonomous driving system” and utilizing positive results of large-scale demonstration experiments under SIP (the 1st term), we will work to realize autonomous driving (SAE level 4) transportation service in limited areas by 2020 and to further promote relevant technological development and international standardization under SIP (the 2nd term) toward realizing full autonomous driving on highways (SAE level 4) by 2025.

(d) Fields of Manufacturing Industries/Value Creation

[254] NIST Special Publication 800-171.

We will newly construct a data platform for collecting, utilizing and cooperating manufacturing data among several companies to realize the “Connected Industries” in the fields of manufacturing industries and creating new values.

Due to our top-class international competitiveness, we have developed MI for the first time in the world in this field during “Structural Materials for Innovation (SM^4I)” of SIP (the 1st term).

We will improve MI which correspond to inverse problem such as design suitable materials and processes matching functions required in “materials development platform” during SIP (the 2nd term).

(e) Field of Basic light/Quantum Technologies

As the field of Basic light/Quantum Technologies is an innovative field which can make possible what was impossible with conventional technologies and bring about dramatic changes in society, proactive research activities are undertaken in the U.S., Europe and China.

In our country, in order to realize Society 5.0, we will develop “laser processing” which miniaturizes and upgrades devices to connect cyberspace and physical space, “optoelectronic information processing” which enables processing of explosively-increasing data, and “light/quantum communications” via quantum code which enables secure and reliable communications, with revolutionary light/quantum computing technologies[255] covered under SIP (the 2nd term). Through these projects, we will maintain and improve our international competitiveness in basic light/quantum technologies.

(f) Infrastructure Management field

So far, in “Infrastructure Maintenance, Renovation and Management” under SIP (the 1st term), we have worked to improve the level and reduce the costs of maintenance and management of infrastructure through preventative maintenance. In the future, we will accelerate disclosure of infrastructure data as well as open innovation including the involvement of IT startup companies and others and upgrade the infrastructure data platform to link data of the national government, local public organizations and private enterprises for boosting productivity via deepening of i-Construction and other means.

(g) Disaster Prevention/Mitigation field

In “Enhancement of Societal Resiliency against Natural Disasters” under SIP (the 1st term), we will establish a scheme to have disaster information shared between the relevant ministries through promoting collaboration between SIP4D and government systems, and develop technologies to

[255] research etc. for development of quantum gate type, quantum annealing type and quantum neural network type

forecast the run-up of tsunami, torrential rainfalls/ tornados as well as emergency communications network and other devices for social implementation. In “Preventing/Mitigating Disasters” under SIP (the 2nd term), at the time of large-scale disasters, we will have readiness and capabilities of local governments – the frontline to deal with such disasters – enhanced, have every citizen’s life protected through adequate evacuation procedures and have a society where an early reconstruction of broad-based economy may be realized, through developing and socially implementing leading-edge technologies with the use of satellites, AI, big data and other tools. Regarding our technologies to prevent/mitigate disasters including fire-fighting, it is important to accumulate disaster-related technologies through utilizing experiences of having dealt with disasters and contribute to preventing/mitigating disasters of the world through disseminating such technologies internationally. Also, regarding L-Alert advance system and G-space disaster prevention system for enhancement of local disaster prevention, we will work to have introduced in 15 prefectures and 100 regional public organizations by fiscal 2020 through verification tests to establish standard specification for L-Alert advance system as well as through educational and informative campaigns to disseminate and popularize the both.

(h) Health and Medical fields

In “Health and Medicine” under SIP (the 2nd term), we aim to offer sophisticated and advanced medical services through developing, establishing and socially implementing ““AI Hospital System” with the use of AI, IoT and big data technologies, and improve efficiency at medical institutions along with drastic reduction of the burdens on medical personnel such as doctors and nurses.

(i) Logistics field

In “Logistics (Land/Sea transportation)” under SIP (the 2nd term), we will work to lead the world in deploying the “Logistics/Trading Data Platform” to visualize movements of goods and product information and to boost productivity via optimizing the Entire Supply Chain running from production, storage, logistics, transportation through sales.

(j) Oceanic field

We will steadily promote such projects based on the Basic Plan for Ocean Policy[256] as development of AUV as part of Creating innovations with the use of the achievements of SIP and other initiatives to realize future visions to be pursued even in such environment of drastic decrease in the labor force.-enhancement of MDA, deploying an advanced information sharing system as well as R&D programs and other activities for frontier areas including deep seas and North-Pole regions. Also, regarding “Ocean” under SIP (the 2nd term), with the use of results of technologies to

[256] Approved by the Cabinet in May 2018

investigate marine resources of “Next-generation Technologies for Ocean Resource Exploration”, we will work to lead the world in developing and testing the application of these technologies in the water depth of 2,000 meters and over.

(k) Space field

It is expected that solutions to a number of challenges in such fields as agriculture, fishery and disaster prevention may be offered through capturing satellite data as part of big data and combining them with various other data, and we will steadily promote the projects based on the Basic Plan for Space Policy[257], which include improving infrastructure of various satellites, setting up satellite data platform for encouraging the use of satellite data owned by JAXA and other organizations for industrial purposes, and promoting G-space project via available means including the use of the G-space information center.

[257] Approved by the Cabinet in April 2016

List of Abbreviations

Abbreviation	Formal name
AI	Artificial Intelligence
AMED	Japan Agency for Medical R&D
APEC	Asia Pacific Economic Cooperation
API	Application Programming Interface
AUV	Autonomous Underwater Vehicle
C2C	Consumer to Consumer
CBPR system	Cross Border Privacy Rules system
COI program	Center of Innovation Program
COP 21	The 21st Session of the Conference of the Parties
CSTI	Council for Science, Technology and Innovation
DIAS	Data Integration and Analysis System
EBMgt	Evidence Based Management
EBPM	Evidence-based Policymaking
EPA	Economic Partnership Agreement
ERP	Enterprise Resource Planning
ESG	Environment, Social, Governance
EV	Electric Vehicle
FAO	Food and Agriculture Organization of the United Nations
ImPACT	Impulsing PAradigm Change through disruptive Technologies Program
IoT	Internet of Things
IPA	Information-technology Promotion Agency, Japan
IR	Investor Relations
IREN	International Renewable Energy Agency
IT General Strategy Office	Cabinet Secretariat, National Strategy office of Information and Communication Technology
IT General Strategy Headquarters	Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
JAXA	Japan Aerospace Exploration Agency
JETRO	Japan External Trade Organization
JOIC	Japan Open Innovation Council
JSPS	Japan Society for the Promotion of Science
JST	Japan Science and Technology Agency

MDA	Maritime Domain Awareness
MI	Materials Integration
MOOC	Massive Open Online Courses
MP－PAWR	Multi-Parameter Phased Array Weather Radar
NEDO	New Energy and Industrial Technology Development Organization
NICT	National Institute of Information and Communications Technology
NIEM	National Information Exchange Model
NIES	National Institute for Environmental Studies
NII	National Institute of Informatics
NISTEP	National Institute of Science and Technology Policy
OECD	Organization for Economic Co-operation and Development
PBL	Problem Based Learning
PD	Program Director
PM	Program Manager
PRISM	Public/Private R&D Investment Strategic Expansion PrograM
SAE	Society of Automotive Engineers
SBIR	Small Business Innovation Research
SDGs	Sustainable Development Goals
SEMIC	Semantic Interoperability Community
SIP	Cross-ministerial Strategic Innovation Promotion Program
SIP4D	Shared Information Platform for Disaster Management
TICAD7	The 7th Tokyo International Conference on African Development
TLO	Technology Licensing Organization
TPP Agreement	Trans-Pacific Partnership Agreement
UNITT	University Network for Innovation and Technology Transfer
VC	Venture Capital
VEC	Venture Enterprise Center
WPI	World Premier International Research Center Initiative
UN	The United Nations
national R&D Agency	National Research and Development Agency[258]

[258] National Research and Development Agency provided for in Article 2, paragraph (3) of the Act on General Rules for Incorporated Administrative Agencies (Act No. 103 of 1999)

Abbreviation	Formal name
AIST	National Institute of Advanced Industrial Science and Technology
IP Headquarters	Intellectual Property Strategy Headquarters
CAO（STI）	Cabinet Office, Director General for Science, Technology, and Innovation
RIKEN	Institute of Physical and Chemical Research

Especially the abbreviations of names of ministries used in "③Future Direction and Major Policies to be concretely implemented" are as follows.

Abbreviation	Formal name		
STI	Cabinet Office	Director General for Science, Technology and Innovation Policy	
Disaster		Director General for Disaster Management	
FSC		Food Safety Commission Secretariat	
IP		Intellectual Property Strategy Promotion Bureau	
Space		National Space Policy Secretariat	
Ocean		National Ocean Policy Secretariat	
NPA		National Public Safety Commission	National Police Agency
PPC		Personal Information Protection Commission	
CAA		Consumer Affairs Agency	
MIC	Ministry of Internal Affairs and Communications		
MOJ	Ministry of Justice		
MOFA	Ministry of Foreign Affairs		
MOF	Ministry of Finance		
MEXT	Ministry of Education, Culture, Sports, Science and Technology		
MHLW	Ministry of Health, Labor and Welfare		
MAFF	Ministry of Agriculture, Forestry and Fisheries		
METI	Ministry of Economy, Trade and Industry		
MLIT	Ministry of Land, Infrastructure, Transport and Tourism		
MOE	Ministry of the Environment		
MOD	Ministry of Defense		