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Article

The Dysfunction of Mission-Oriented Innovation Policy: Impeding the Accumulation of Scientific Knowledge in the Japanese Academic Sector

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Abstract: Since the Organisation for Economic Cooperation and Development presented its comprehensive Innovation Strategy in 2010, numerous countries have been updating their innovation policies. Subsequent to the promulgation, the innovation policies of Japan shifted the focus from discipline-specific to social issue-oriented approaches. This study investigates the response of the Japanese academic sector to this policy shift and the characteristics of the research projects associated with innovation policy by utilizing descriptive statistics from policy documents and the database of Grants-in-Aid for Scientific Research. The findings reveal that Japanese researchers have increasingly aligned their efforts with government-proposed research themes in recent years, with a notable shift toward short-term research projects. Moreover, Japanese universities are undergoing reforms that are transforming them into entrepreneurial institutions by altering incentive structures. Although these reforms may yield short-term research outcomes, they may not always address long-term societal needs. The narrowing focus on research themes could restrict the potential impact of research and impede the development of innovative solutions to societal challenges. From this viewpoint, assessing the relationship between government-proposed research themes and the research productivity of Japan is critical. Universities and public research institutions play a vital social role in broadening the foundational knowledge base through basic research, while private enterprises may lack the motivation to invest in research and development with low appropriability. These results may be beneficial for policymakers in reconsidering the division of labor in industry-academic collaboration in a knowledge-intensive economy.

Keywords: mission-oriented innovation policy; scientific knowledge; entrepreneurial university; academic sector; incentive structure



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1. Introduction

The Innovation Strategy 2010 of the Organisation for Economic Cooperation and Development (OECD) has increased the importance of the demand side of innovation policy. Although it emphasized that science remains an important component of innovation, the plan presented a systematic approach that includes not only supply-side policies focused on the development of specific technologies but also demand side ones, including economic and social issues and the broad range of actors that influence innovation (OECD 2010). In response to these trends, countries worldwide are developing mission-oriented innovation policies (MOIPs) that aim to create markets through the resolution of societal challenges in collaboration with various actors (Mazzucato 2016, 2018). Examples of MOIP include the Community Wealth Building program introduced in Preston, the United Kingdom, in 2015 (The Lancet Public Health 2023), policies affecting the demand and supply of Responsible Innovation in Health in Brazil and Canada (Lehoux et al. 2023), the Nutrient

Recycling policy in Finland (Nylén et al. 2023), and the Vision Zero initiative of Sweden as a mission-oriented innovation policy for traffic safety (Craens et al. 2022).

The innovation policy in Japan, which has been formulated every five years since 1996, is also transitioning toward a mission-oriented approach (Larrue 2021; Carraz and Harayama 2018). The Fourth Science and Technology Basic Plan (2011–2015) shifted the focus of the agenda from discipline-specific to social and environmental challenges after noting that the outcomes of science and technology (S&T) were not being effectively utilized for the creation of new industries, employment, national welfare, or the resolution of social issues (Cabinet Office 2011).

Policymakers of MOIPs argue that the government should not only fund but also play an active role in the formation of market directions and the creation of new markets (Maz-zucato 2014). Thus, the role of academia in bridging science and society to address social challenges and goals has attracted attention. However, debates over the approach of the government to evaluating university research remain active (Smith et al. 2011; Torrance 2020; Martin-Sardesai et al. 2017; Morrish 2020; Hudson and Williams 2016; Varghese and Martin 2014). Government interventions in academic institutions may have several potential consequences for their autonomy. For instance, if public and private funding bodies prioritize short-term results, then researchers may favor projects that yield quick outcomes, which may not always address long-term societal needs. Moreover, the lack of diversity in research themes could limit the potential impact of research and hinder the development of innovative solutions to societal challenges. Therefore, critically assessing the relationship between government-proposed research themes and research productivity is important.

The current study aims to explore the alignment between Japanese researchers and government research themes and their implications for potential societal impacts. Specifically, how did the academic sector in Japan respond to the shift in innovation policy? What are the characteristics of a research project for which researchers voluntarily apply? By seeking the answer to these research questions, this study proposes potential issues inherent in Japan's MOIPs within the academic sector.

For government-led MOIPs to successfully address complex social and economic challenges, cooperation and coordination with various nongovernment stakeholders are essential. In particular, ensuring effective coordination and communication across sectors presents a significant practical challenge (Sabel and Zeitlin 2008). This study focuses on the responses of universities to MOIPs among key actors in the national innovation system (NIS) in Japan. By presenting challenges faced in the process of establishing and achieving joint goals among multiple stakeholders, it intends to offer valuable insights for policy-makers and researchers.

The remainder of the paper is structured as follows: Section 2 reviews the previous literature on topics related to MOIPs and their intervention in academic freedom. Section 3 describes the Japanese context with regard to the transformation of innovation policy and university reform. Section 4 describes the materials and methods for data analysis. Section 5 provides an overview of the results derived from descriptive statistics. Section 6 features a discussion based on the fact finding. Finally, Section 7 concludes and presents implications.

2. Literature Review

2.1. Evolution of Innovation Policy

Innovation policy has evolved significantly over time, and such an evolution has been closely linked to the broad systemic understanding of innovation. In recent years, scholars in the field of innovation policy have discussed it in three phases (Diercks et al. 2019; Schot and Steinmueller 2018).

The first phase was the S&T policy, which occurred after World War II. Based on the idea of a linear model of innovation, the S&T policy was designed to promote scientific research and technological development and to strengthen the S&T base of the nation, which translates into economic and social benefits. Economic growth through the provi-

sion of new knowledge to the private sector and by addressing market failures and externalities justified policy interventions to disseminate science to society (Schot and Steinmueller 2018). The specifics of this policy include increasing investment in research and development (R&D), strengthening S&T education, promoting cooperation between public and private research institutions, and developing a legal and regulatory framework that promotes innovation (Diercks et al. 2019; Schot and Steinmueller 2018). These initiatives were institutionalized as key elements for enhancing the international competitiveness of the country and supporting sustainable economic growth.

The second phase is the NIS, which was conceptualized during the 1980s under the influence of neoliberal thought and whose policy agenda focused on economic goals. The NIS is generally defined as an entire system that consists of various organizations and institutions of actors involved in innovation activities in a country (e.g., firms, universities, and government agencies) and their interactions (Freeman 1987; Lundvall 1995; Nelson 1993). The major focus has expanded to peripheral areas, such as building cooperative R&D networks, facilitating knowledge dissemination and technology transfer, developing infrastructure to support innovation, strengthening linkages across regions and industries, and facilitating learning and knowledge spillovers in developing countries (Mowery 1998; Block and Keller 2009; Hall and Lerner 2010; Cooke 2005; Malerba 2004; Lundvall et al. 2006).

Since the 2000s, innovation policy has transitioned into the third phase, which is considered a paradigm change in innovation policy due to the diversification of policy issues. For example, it has been labeled MOIPs (Mazzucato 2016), a novel policy paradigm (Kemp and Mainguy 2011), and transformative innovation policy (Diercks et al. 2019; Schot and Steinmueller 2018) and positioned as broad social issue-oriented innovation policies. Thus, the policy agenda at this phase emphasizes a shift from economic to contemporary social and environmental issues such as the SDGs, which emphasize a distinction from previous innovation policies (Schot and Steinmueller 2018).

However, as Diercks et al. (2019) argued, this new policy paradigm does not entirely replace previous policy paradigms such as the S&T policy and innovation system policies. As demonstrated by the evolution of debates on the NIS, different countries exhibit varied performance with respect to innovation due to their diverse institutions. Formal and informal constraints, institutional complementarities, and path dependence operate within the NIS, which underlies the reason why innovation performance does not converge over the process of globalization (North 1990). Therefore, a historical perspective that focuses on institutional continuities and discontinuities is essential for the analysis of how institutional change leads to outcomes.

2.2. Mission-Oriented Innovation Policy

Innovation policy issues have diversified over time. The focus of policy agendas has shifted from the production of scientific and technological knowledge based on a linear model of innovation in the 1960s to one that is economic, social, and environmental, as the understanding of innovation has expanded (Diercks et al. 2019). MOIPs, advocated in conjunction with this paradigm shift in innovation policy, constitute a policy approach that establishes clear goals and measurable targets to address societal challenges and promote innovation. This approach aims to mobilize a wide range of actors, including governments, businesses, and communities, to work together to achieve specific goals (Mazzucato 2016, 2018). However, the exploration of the effectiveness and scalability of MOIP continues, along with the challenge of integrating these policies into a broad policy framework and overcoming administrative, legal, and governance barriers (The Lancet Public Health 2023; OECD 2023). The MOIP concept is applied to various contexts that promote transformative change and address complex social issues, such as economic development, sustainability, and health (Nylén et al. 2023; Kirchherr et al. 2023; Janssen et al. 2023).

MOIPs face several major problems. The first is the selection and definition of goals. In the mission-oriented approach, determining the mission to choose is critical. Mazzucato (2018) provides guidance on how governments and policymakers should set specific,

measurable, and achievable missions and how to incorporate these goals into the actual policy design. However, the selection and definition of specific goals are complex and typically require political and social consensus building. If goals are extremely broad and abstract, then identifying specific action plans and deliverables becomes difficult. Conversely, if goals are very narrow, then they may limit the potential for innovation. Furthermore, strong missions can lead to reduced technological diversity in the innovation system (Hekkert et al. 2020). The second is the direction of innovation. Mazzucato (2016) argues that governments should play an active role in the formation of market direction and the creation of new markets instead of merely serving as funders. This context denotes an entrepreneurial government. However, when determining the direction of innovation, governments need to consider the risk of government failure as well as market failure (Kärnä et al. 2023). Inappropriate goal setting and implementation plans can lead to wasted resources and inefficiencies. Thus, overcoming these problems and making MOIP successful will require ongoing evaluation and adjustment through a cumulative series of case studies on policy design and implementation.

2.3. Changing the Academic Sector

The trend in market co-creation by entrepreneurial states and various private sectors has led to increased demand and pressure on the academic sector from the economy and society. As a result, the academic sector is expected to support economic development, innovation, and social progress (Rostan 2010). Universities have been encouraged to develop new venture partnerships with the industry as an important driver of a knowledge-intensive economy (Olssen and Peters 2005; Godin and Gingras 2000). Furthermore, the interaction among industry, academia, and government (triple helix) has emphasized the role of universities as entrepreneurial universities, along with the government and industry, in technology transfer and the creation of knowledge-based startups (Etzkowitz and Leydesdorff 2000; Etzkowitz 2003; Lerman et al. 2021).

This trend is perceived as academic capitalism. In this context, a particular conception of the world was constructed in which knowledge is only valid if it is marketable, if researchers are entrepreneurs, and if higher education and research are in the service of global capitalism and neoliberal rationality (Bori and Block 2024). Moreover, public universities in the United States adopted the practices and norms of a business mindset that are more closely consistent with corporate goals and values instead of social institutions responsible for knowledge creation and dissemination (Spinrad et al. 2022).

The discussions on academic freedom and autonomy are related to the intervention of public institutions in the scholarly sciences, which leads to serious consequences for the creation, dissemination, and application of knowledge. By prioritizing marketable knowledge, recognizing researchers as entrepreneurs, and shifting toward subordinating higher education and research under global capitalism and neoliberal rationality, academic capitalism has severely affected the advancement of scientific knowledge and posed a major threat to the academic freedom of individual scholars (Walsh et al. 2007; Wieczorek and Muench 2023; Reichman 2022).

In addition, however, the prioritization of marketable knowledge under a strong mission can also hinder the accumulation of scientific knowledge. As Lin et al. (2010) point out, technological development that is dependent on innovation policies based on technological forecasts will not necessarily lead to national economic growth unless it is coordinated with basic research and the long-term economy (Lin et al. 2010). The reason is that basic research has high scientific value and knowledge spillover effects. Nevertheless, basic research explores the frontiers of knowledge; thus, the actual emergence of its results can take a long time. Therefore, examining the relationship between innovation policy and the accumulation of S&T is important. However, previous studies have provided insufficient discussion on this point. For this reason, the current study focuses on the behavior of researchers involved in research activities through their organizational incentives prior to patenting.

3. Japanese Innovation Contexts

The following text addresses the development of innovation policy in Japan using materials from the Cabinet Office and also describes the characteristics of university reforms at private and national universities.

3.1. Transition of the Science and Technology Basic Plan and Competitive Research Funds

The Basic Act on Science and Technology was enacted in 1995 (and revised in 2020) with the objective of improving S&T, economic, and social developments in Japan. Since 1996, the Science and Technology Basic Plan (Basic Plan) has been formulated and implemented every five years; the Sixth Basic Plan started in 2021 (Cabinet Office 2021). Figure 1 illustrates the shifts in the national initial budgets for the Basic Plan and competitive research funds and their fluctuation each year, which reflects consistent increases over time. Although the amount of competitive funds peaked under the Third Basic Plan, the ratio of the initial budgets has generally been 10%.

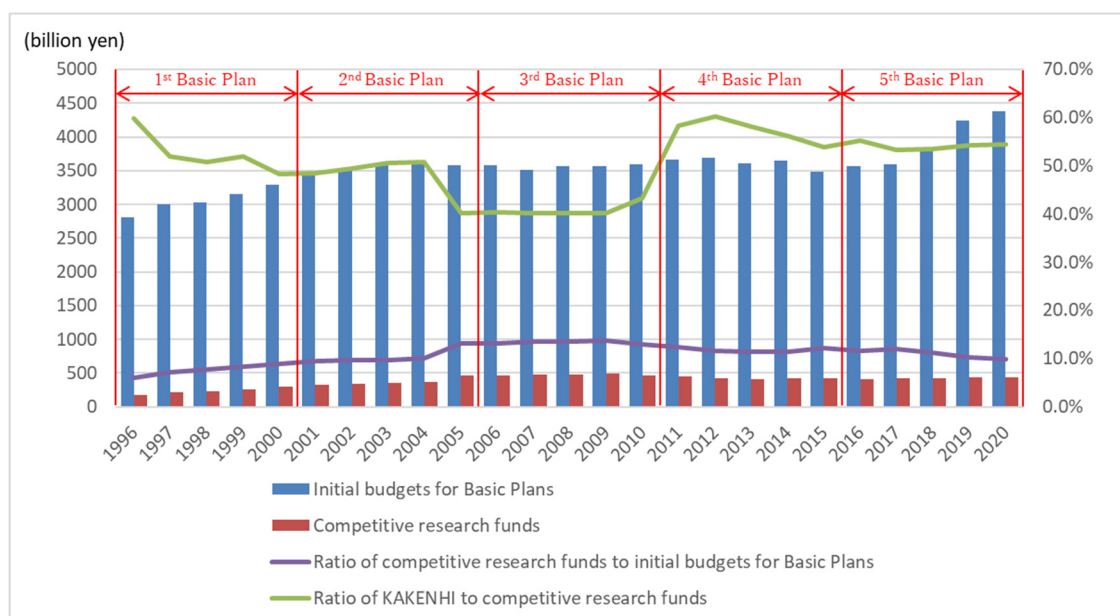


Figure 1. Shifts in science and technology budgets and competitive research funds between Basic Plans. (Source: Processed and created by the author based on the National Institute of Science and Technology Policy (NISTEP) and Ministry of Education, Culture, Sports, Science, and Technology (MEXT), “Digest of Japanese Science and Technology Indicators 2022” (NISTEP and MEXT 2022) and JSPS, “KAKENHI: New knowledge creation for the formation and inheritance of world-leading intellectual assets” (MEXT and JSPS 2021)).

Although several competitive research funds exist under the jurisdiction of ministries and agencies, the majority are short-lived. One of the major funds in Japan is KAKENHI, which was integrated into several research grants in 1965 with the aim of subsidizing creative and pioneering academic research that will contribute to the foundation of an affluent society. It is administered by the Japan Society for the Promotion of Science (MEXT and JSPS 2018). KAKENHI aims to fund all academic research, from basic to applied, in all fields, which accounts for approximately 50% of the total competitive research funds in Figure 1. This study examines the impacts of each Basic Plan with a focus on the Third and Fourth Basic Plans, on national research activities.

3.2. Transformation of S&T Basic Plans

The First Basic Plan (1996–2000) focused on the creation of intellectual assets through research by supporting 10,000 postdoctoral fellows and enhancing research in private uni-

versities, which comprise 80% of higher education in Japan. It also introduced measures for facilitating the transfer of university research to businesses and established technology licensing organizations (TLOs) to foster industry-academia collaboration. As such, TLOs play a central role as the driving force of the cycle of knowledge creation, which creates new industries that originate from universities and returns a part of the profits to researchers. In this manner, research funds are generated, and university research is further activated (METI 1998). The Second Plan (2001–2005) targeted specific areas in R&D, such as life sciences and nanotechnology. The Third Plan (2006–2010) expanded priorities to include energy and manufacturing, which promoted researcher mobility and gender diversity in research. The Fourth Plan (2011–2015) shifted the focus from academic disciplines to societal issues and emphasized green innovation and continued support for the tenure-track system. The Fifth Plan (2016–2020) aimed to promote innovation to address societal challenges and stressed the importance of collaboration among industry, academia, and government.

The innovation policy in Japan has long developed basic research capabilities that target key technologies that will drive future industrial growth. Until the Third Basic Plan, the national policy gradually expanded innovation efforts to incorporate diverse actors within industry-academia-government collaboration (Cabinet Office 2006a). The innovation policy then seemingly radically shifted to the mission-oriented approach since the Fourth Basic Plan (Larrue 2021; Diercks et al. 2019). Notably, however, each successive plan has consistently assumed that universities will play a central role in knowledge production for innovation, despite the diversification of the sites of knowledge production (Godin and Gingras 2000).

3.3. Japanese University Reforms

Since the 1990s, the environment for Japanese universities has significantly shifted. A report in 1991 highlighted the challenges posed by the declining youth population on university capacity, which had led to increased competition among universities, especially private ones, to attract students. This competition prompted schools to revamp faculties, admissions, and curricula (Morikawa 1994). In response, MEXT updated the University Establishment Standards to enable educational restructuring while maintaining control over the predominantly private higher education sector. The 2013 Comprehensive Support Program for Private University Reform aimed to stabilize finances and promote quality education by offering targeted subsidies for reformative efforts, which intensified grant competition among universities.

In 2004, the transformation of national universities into corporations (NUC) aimed to foster entrepreneurial activity, which enabled them to patent inventions and engage in dual employment. This reform resulted in increased patent applications and citations, which signifies success in enhancing the social impact of academic research (Motohashi et al. 2022). However, despite these reforms, MEXT retained significant control over universities and required them to align with policy agendas, especially in securing competitive external grants. A few critiques of the reform pointed to its negative impact on research infrastructure and activity due to the emphasis on external funding and competition (Yoshida 2007).

Recent reforms have likely shifted the focus of researchers toward short-term projects to secure funding, with an expected alignment with the keywords and trends of the Third and Fourth Basic Plans. This study aims to identify the trends in the responses of researchers to the keywords in the Third and Fourth Basic Plans by dividing them into five-year periods before, during, and after each plan.

4. Materials and Methods

4.1. Data Collection

Many methods can be used to achieve innovation policy objectives including economic growth, climate change prevention, improvement in population health (Fagerberg 2017), and

the relationship between patents and innovation (Jaffe 2000; Koléda 2008). However, the current study focuses on research grants. A number of studies have used research grants as data. Research grants influence the number of subsequent publications (Hottenrott and Lawson 2017; Jacob and Lefgren 2011). Furthermore, research grants also affect the number of patents (Munari et al. 2024). Considering these studies, a potential pathway for innovation policy could be “government direction → research project → paper/patent → economic and social outcomes”. This study focuses on the first step, “government direction → research project”, because the reaction of researchers strongly influences the outcomes.

We selected two major innovation initiatives in Japan, namely, the Basic Plan and KAKENHI, as the research object, because the first forms the basis of Japanese innovation policy, and the second is one of the most major competitive research funds in the academic sector in Japan. In particular, we analyzed the five-year periods before and after the Third (2006–2010) and Fourth (2011–2016) Basic Plans, because the focus of the policy agendas between the two plans has shifted from specific disciplines (e.g., life sciences and manufacturing technology) to issues (e.g., green innovation). For the Third Basic Plan, we captured the trends in keywords for policy issues across a total period of 15 years: 2001–2005 (before), 2006–2010 (during), and 2011–2015 (after); for the Fourth Basic Plan, a total period of 15 years: 2006–2010 (before), 2011–2015 (during), and 2016–2020 (after; Figure 2).

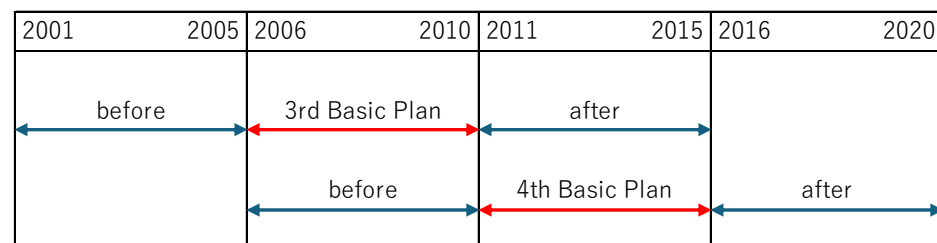


Figure 2. Data collection period for the Third and Fourth Basic Plans.

The first step of data collection is described below. The materials we used are those of the Third and Fourth Basic Plans published by the Cabinet Office. Supplementary materials for each priority area, such as life sciences, information and telecommunications, environmental sciences, and nanotechnology/materials, were prepared at the same time as the S&T Basic Plan was announced up to the Third Basic Plan. Therefore, we mainly extracted keywords from the supplementary materials, referring to Chapter 2 of the Third Basic Plan entitled “Strategic Priority Setting on S&T” of the Third Basic Plan (Cabinet Office 2006a, 2006b). As for the Fourth Basic Plan, supplementary materials are no longer produced. Therefore, we derived keywords from Chapter 2 of the Fourth Basic Plan, “Achieving Sustainable Growth and Social Development in the Future.” (Cabinet Office 2011).

We extracted the keywords using the following procedure: First, the first author derived the keywords from the source documents. Then, the second author checked the keywords against the source documents. We carefully discussed the items that did not match or needed interpretation and determined the keywords. The first type of keyword can be considered an as-is keyword. This is a case where the keywords are the same words as in the original documents (e.g., “nanomedical technology” and “hydrogen transportation technology” in the Third Basic Plan, “smart grid” and “nanocarbon materials” in the Fourth Basic Plan). The second type of keywords are slightly modified keywords. These are keywords whose content is clear but can be created by simply removing particles or rearranging the order of words (e.g., “technology to support software development” → “software development support technology” in the Third Basic Plan, and “making lighting more efficient” → “high efficiency lighting” in the Fourth Basic Plan). The third type of keywords, which constituted the primary focus of our discussion, are those that must be determined from the context. In this study, we refer to these as contextual reading keywords. For example, we derived “local industry revival” from the original text: “The Great East Japan Earthquake caused extensive damage to primary industries such as agriculture,

forestry, and fisheries, which are local industries, over a wide area along the coast of the Tohoku and Kanto regions. In light of this, the Basic Plan promotes R&D related to the investigation and improvement of contaminated soil and water quality, the restoration of marine ecosystems, the improvement of productivity and safety of agricultural, forestry and fishery products, as well as the use and application of the results of such R&D, with the objective of achieving the reconstruction, revitalization, and further growth of these industries” (Cabinet Office 2011). In this context, we could have extracted multiple synonyms, such as local industry reconstruction or local industry growth. However, we extracted only one keyword from each context to avoid biasing the data. In cases where the source text comprised multiple contexts, we extracted as many keywords as the number of contexts. Finally, 91 and 97 keywords were extracted from the Third and Fourth Basic Plans, respectively. Tables A1 and A2 provide a comprehensive list of sources and all extracted keywords. Figure 3 illustrates the percentages of as-is keywords, slightly modified keywords, and contextual reading keywords in the Third and Fourth Basic Plans. The figure demonstrates that the keywords discussed in depth by the authors account for approximately 4.1% of the keywords included in the Fourth Basic Plan.

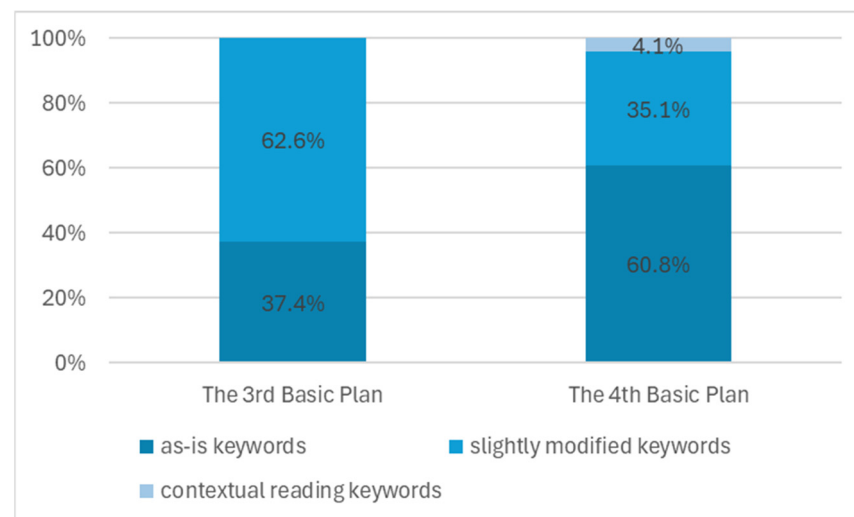


Figure 3. The percentages of extracted keywords by type in the Third and Fourth Basic Plans.

In the next step of the data collection, we extracted research projects from the KAKEN database that contained any of the keywords over the study period of the 15 years around the Third and Fourth Basic Plans. All data were collected in August 2022, and we searched for not only the titles and keywords of the research project but also summaries and full studies. The objective of this search was to capture data from research that mentioned the keywords, even if they were not the key topics of the research. Reports can also be searched in the KAKEN database. However, research projects whose keywords appear only in the reports were excluded from the sample in lieu of the abovementioned objective.

A few projects contained multiple keywords; however, we observed that not all of the keywords from the Third Basic Plan were incorporated into research. Specifically, researchers used all 97 keywords from the Fourth Basic Plan but failed to incorporate 15 out of 91 from the Third. We identified a total of 116,938 research projects that incorporated at least one of the keywords from either of the Basic Plans (Third: 42,456; Fourth: 74,482). Figure 4 presents the breakdown of the KAKENHI grants into five-year periods that reflect those from the Third and Fourth Basic Plans.

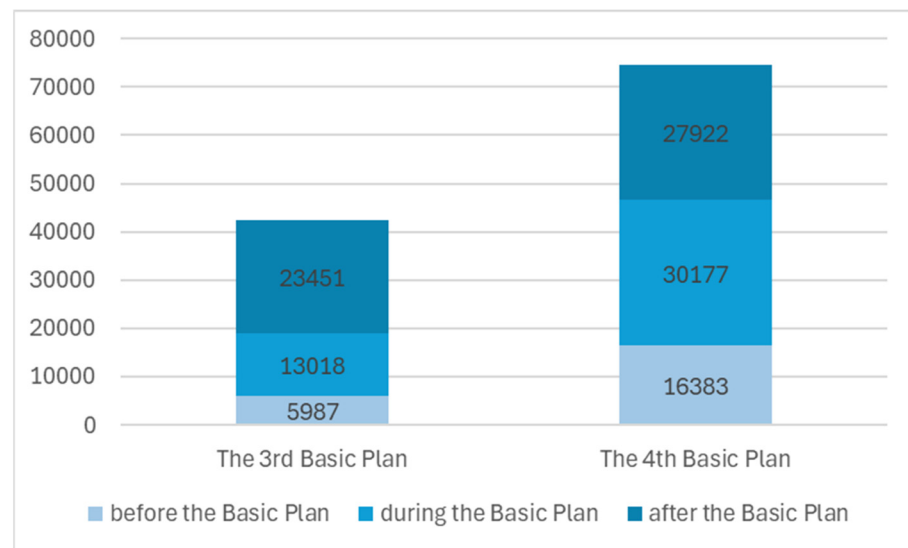


Figure 4. Number of KAKENHI projects for each five-year period.

4.2. Data Analysis

By comparing the number of projects adopted by KAKENHI during the Third and Fourth Basic Plan periods with those of the five years before and after the relevant Basic Plan period, we intended to elucidate the response of the Japanese academic sector toward the shift in innovation policy. First, we respectively compared the numbers of research projects before, during, and after the Third and Fourth Basic Plans by calculating the highest average number of KAKENHI projects during each five-year period to calculate the research volume per period. However, the average spanned 5 years and did not reflect individual peaks in the number of projects. Therefore, we identified the peak year for research projects related to the keywords that showed the highest average in each five-year period and organized the location of the research projects for each period. The abovementioned cross-tabulation of the research volume and peak year locations yielded a 3×3 matrix (Table 1).

Table 1. Cross-tabulation of the research volumes and peak years for KAKENHI projects.

	Peak in the Number of Projects		
	Five years before Basic Plan	Five years during Basic Plan	Five years after Basic Plan
	Five years before Basic Plan		
	Five years during Basic Plan		
	Five years after Basic Plan		

Second, by comparing periods with the peaks in the number of projects across the 15-year period, including the five-year period before and after each Basic Plan, we examined the degree of progress of the research projects. An S-shaped relationship between the amount of resources invested in technology and its consequent technological performance empirically represented technological progress (Foster 1986). In particular, technological progress was initially slow due to a lack of knowledge about the technology but progressed rapidly with the accumulation of knowledge. However, technology will eventually face its limits, and the pace of technological progress will slacken as large investments no longer produce the expected results. In other words, if KAKENHI-funded research projects have

advanced over the long-term, then the number of projects should have peaked after each Basic Plan period.

Based on the abovementioned discussion and expectations, if the government has mis-specified the research keywords of the Basic Plan, then many studies would be observed in the upper-left corner (before \times before). If the Basic Plan had set keywords for research that would only produce long-term outcomes, such as the basic sciences, then the research volume would be higher in the lower-right corner (after \times after). On the contrary, if researchers myopically responded to the keywords, then the research volume would settle in the middle (during \times during).

5. Results

5.1. Responses of Researchers to the Innovation Policy

To explore the responses of Japanese researchers to the transformation of Japanese innovation policy, we calculated descriptive statistics. The numbers on the vertical axes of Tables 2 and 3 indicate the number (percentage) of keywords in the Basic Plan and research projects adopted by KAKENHI within each period when the five-year average of KAKENHI-adopted projects related to the keywords was the highest over a total of 15 years, including the five years before and after the Basic Plan period. Simply put, if researchers agilely responded to the keywords in the policy agenda, then the number (percentage) of KAKENHI adoption should have been larger during the relevant period of the Basic Plan compared with those in the periods before and after.

Table 2. Responses of researchers to 76 out of the 91 keywords in the Third Basic Plan.

		Peaks in the Number of Projects		
Highest average number of projects		Before the Third (2001–2005)	During the Third (2006–2010)	After the Third (2011–2015)
		8 (10.5%)	21 (27.6%)	47 (61.8%)
		62 (0.1%)	4035 (9.5%)	38,359 (90.4%)
	Before the Third (2001–2005)	6 (7.9%)	0	0
	6 (7.9%)	32 (0.1%)		
	32 (0.1%)			
	During the Third (2006–2010)	1 (1.3%)	15 (19.7%)	2 (2.6%)
	18 (23.7%)	25 (0.1%)	521 (1.2%)	1673 (3.9%)
	2219 (5.2%)			
	After the Third (2011–2015)	1 (1.3%)	6 (7.9%)	45 (59.2%)
	52 (68.4%)	5 (0.0%)	3514 (8.3%)	36,686 (86.4%)
	40,205 (94.7%)			

Note: In the upper row, each cell presents the number of keywords in the Basic Plan and their percentages. The lower row represents the number of KAKENHI-adopted projects and their percentages.

Table 2 indicates that KAKENHI-adopted 40,205 research projects that pertained to 52 out of the 76 keywords in the five years after the Third Basic Plan period; that is, 68.4% of the total number of keywords and 94.7% of the total number of KAKENHI projects were highly concentrated in the five-year period after the Third Basic Plan. In other words, researchers did not always quickly respond to the keywords in the policy agenda within the period of the Third Basic Plan. In contrast, Table 3 implies that during the Fourth Basic Plan period, a convergence occurred between the keywords and KAKENHI research projects, which indicates that researchers responded more quickly to the keywords in the Fourth Basic Plan.

Table 3. Responses of researchers to 97 out of 97 keywords in the Fourth Basic Plan.

Highest average number of projects	Peaks in the Number of Projects			
		Before the Fourth (2006–2010)	During the Fourth (2011–2015)	After the Fourth (2016–2020)
		9 (9.3%)	49 (50.5%)	39 (40.2%)
		639 (0.9%)	16,311 (21.9%)	57,532 (77.2%)
	Before the Fourth (2006–2010)	5 (5.2%)	1 (1.0%)	1 (1.0%)
	7 (7.2%)	505 (0.7%)	21 (0.0%)	42 (0.1%)
	568 (0.8%)			
	During the Fourth (2011–2015)	3 (3.1%)	47 (48.5%)	22 (22.7%)
	72 (74.2%)	128 (0.2%)	16,248 (21.8%)	32,456 (43.6%)
	48,832 (65.6%)			
	After the Fourth (2016–2020)	1 (1.0%)	1 (1.0%)	16 (16.5%)
	18 (18.6%)	6 (0.0%)	42 (0.1%)	25,034 (33.6%)
	25,082 (33.7%)			

Note: In the upper row, each cell presents the number of keywords in the Basic Plan and their percentages. The lower row denotes the number of KAKENHI-adopted projects and their percentages.

If the outcomes of research conducted on a particular keyword in the Basic Plan are positive, then the research could continue over the long-term, such that the peak in the number of KAKENHI adoptions should occur after the relevant Basic Plan period. For instance, in the Third Basic Plan, 45 out of 76 keywords (e.g., “next-generation network technology”, “biomass utilization technology”, “innovative materials technology”, “hydrogen transportation technology”, and “X-ray free electron laser”) were continued in 36,686 (86.4%) KAKENHI projects even after the Third Basic Plan period (Table 2). This finding implies that progress in research related to discipline-specific keywords takes longer.

However, a certain degree of controversy exists regarding this part of the Fourth Basic Plan. Specifically, 47 out of 97 keywords (e.g., “medical care in disaster areas”, “medical institution networks”, “nursing care in disaster areas”, “advanced water treatment technology”, “information and communication technology in disaster areas”, “local industry revival”, and “highly insulated housing”) reached the peak number of KAKENHI adoption during the period, and 32,456 (43.6%) KAKENHI research projects related to 22 (22.7%) keywords (e.g., “imaging technology”, “renewable energy”, “nucleic acid medicine”, “telemedicine technology”, “power semiconductors”, “green sustainable chemistry”, and “hydrogen station”) were continued after the Fourth Basic Plan period (Table 3). We compared the aforementioned keywords that peaked during and after the Fourth Basic Plan period and found that those that peaked during the period were mainly related to the social issues at the time. Alternatively, those that peaked after the period were related to relatively general-purpose technologies. This trend suggests quicker outcomes from research based on keywords related to social issues than those based on specific fields. A potential reason is that the former is designed to be implemented as quickly as possible. Tables 2 and 3 demonstrate that researchers responded more quickly to research projects on policy issues during the Fourth Basic Plan period than those in the Third Basic Plan period. Moreover, the periods of individual research tended to be shorter during the Fourth Basic Plan period than those during the Third Basic Plan period. Thus, the study infers that the behavior of researchers who immediately responded to the keywords of the Fourth Basic Plan became increasingly myopic.

5.2. Progress of KAKENHI-Adopted Research Projects

Figures 5 and 6 illustrate the changes in the total numbers of KAKENHI adoption within the quadrants of during × during and after × after, which cover five years before

and after the relevant Basic Plan period based on Tables 2 and 3. In particular, we focused on the research trends in each quadrant, which indicated the rapid responses of researchers to the keywords and the progress of KAKENHI projects.

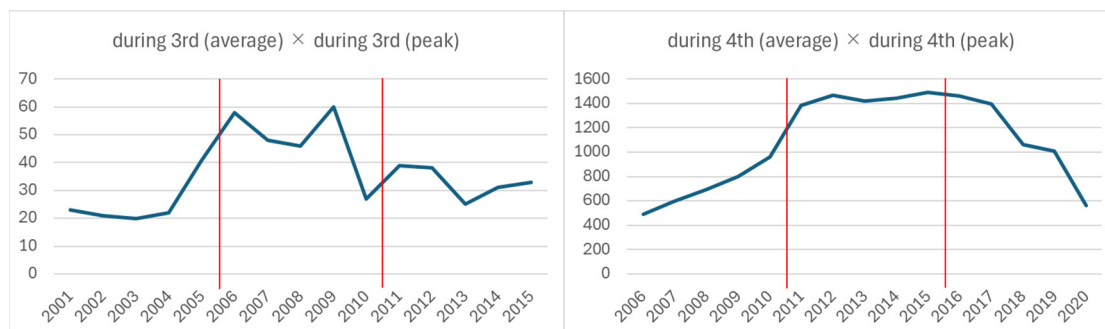


Figure 5. Trends in KAKENHI research projects related to the keywords in the Third and Fourth Basic Plans (during × during). Note: Left: Third Basic Plan; right: Fourth Basic Plan.

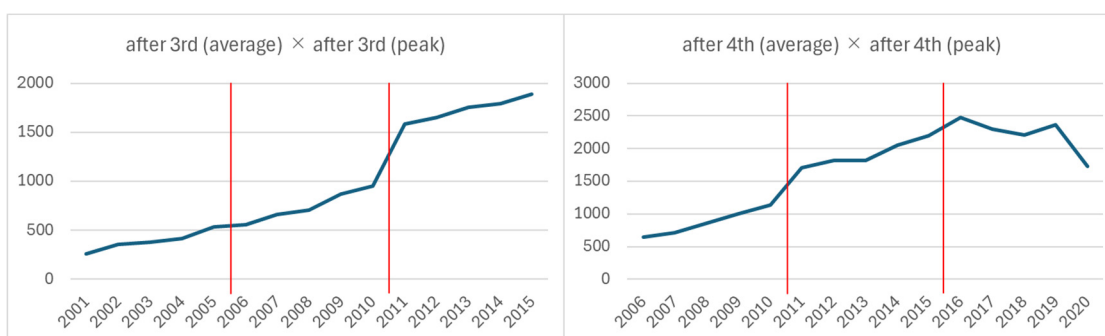


Figure 6. Trends in KAKENHI research projects related to the keywords in the Third and Fourth Basic Plans (after × after). Note: Left: Third Basic Plan; right: Fourth Basic Plan.

Figure 5 indicates the progress of research in which researchers rapidly reacted to the keywords during the relevant Basic Plan period and the number of KAKENHI-adopted projects that peaked during the same period. In the figure, the results for both Basic Plan periods denote an approximate inverted U-shape.

In contrast, Figure 6 presents a notable difference: more researchers reacted to the keywords after the relevant period, and the number of KAKENHI-adopted projects peaked after the relevant period. However, although the number of researchers that responded to the keywords of the Third Basic Plan continued to increase, the number of studies during the Fourth Basic Plan began to decrease. In other words, the number of KAKENHI-adopted projects in the Third Basic Plan, which stressed an academic field-specific approach, increased even after the period. However, the number of such projects during the Fourth Basic Plan, which prioritized the social issue-based approach, began to decline after the period. This result can be interpreted in two ways.

The first is that research projects related to academic field-specific keywords hold more potential for scientific research than for social implementation. In other words, researchers applied for research projects related to the Fourth Basic Plan in their application areas to obtain funding to continue basic research. As a result, they lost interest in projects related to social issues, which are oriented toward social implementation after achieving their objectives. The second interpretation is that research projects related to solving social problems are short-lived because they end with the development of practical knowledge. Hence, the speed of responses to policy challenges becomes significant.

6. Discussion

We analyzed the change in the focus of the Basic Plan of Japan, that is, from the academic field (Third Basic Plan) to solutions to social issues (Fourth Basic Plan) and ongoing university reforms toward entrepreneurship. We inferred from such changes in the environment surrounding the academic sector that recent university reforms have likely shifted the focus of researchers toward short-term projects to secure funding, with an expected alignment with keywords and trends from the Third and Fourth Basic Plans. We reasoned that although the increased mobility of human resources and the introduction of competition in the academic sector would lead to improved research performance, researchers would be more inclined to select research that would yield results in the short-term. Therefore, this study aimed to identify trends in the responses of researchers to the keywords in the Third and Fourth Basic Plans by dividing them into five-year periods before, during, and after each plan. The result of tracking the keywords of the Basic Plans in the KAKENHI-funded projects demonstrated that keywords in the Third Basic Plan exhibited a tendency to continue over the long-term after the plan, whereas those of the Fourth Basic Plan depicted short-term trends.

6.1. Contributions

This study draws on three contributions from previous research on MOIPs and academic capitalism. The first is the importance of long-term research at the frontier of knowledge. The study found that researchers increasingly tended to select research projects that would produce results in the short-term under the Fourth Basic Plan, which sought to address social issues. The shift toward entrepreneurial universities could devalue and hinder the production and accumulation of new knowledge as a public good. [Salter and Martin \(2001\)](#) explained the justification for the promotion of industry-academia collaboration as follows: profit-seeking companies lack the incentives to invest in nonmarketable basic research; therefore, universities are expected to be responsible for creating new knowledge as a public good ([Salter and Martin 2001](#)). However, the shift in R&D activities to applied research and projects designed for social implementation could discourage the accumulation of basic scientific knowledge through industry-academia collaboration, as evidenced by the short-term research progress under the Fourth Basic Plan. This finding suggests that policy intervention in academic freedom not only restricts the range of research choices but also hinders the accumulation of long-term research, as in the basic sciences. The current results are consistent with this argument.

The second is the importance of the impact of changes in the incentive structure on the behavioral changes of people. The results demonstrate that the agenda under the Fourth Basic Plan has promoted the transformation of higher institutions of education in Japan from primarily academic to entrepreneurial universities. The introduction of NUCs, expanded competitive research funds, and tenure-track systems have provided incentives—and consequently changed the behaviors of—the Japanese academic sector to select research with likely short-term outcomes ([Suzuki et al. 2021](#)). If these changes in the institutional incentive structure did not accompany the transformation of innovation policy, then researchers might have responded differently. Nevertheless, the Japanese academic sector has been responsive to changes in innovation policy due to these factors. This result indicates that the NIS not only poses institutional complementarities, such as changing innovation policies, but also provides incentives for scholars to change their behavior to obtain external research funding ([North 1990](#)).

The third is the path-dependent nature of the institutions. The Fourth Basic Plan shifted the focus of the policy agenda from academic discipline-specific to social issue-based approaches but retained the traditionally narrow understanding of the innovation process as deriving from technological revolutions driven by universities and companies. As [Larrue \(2021\)](#) pointed out, MOIPs in Japan need to be complemented with additional bottom-up, issue-based initiatives. The aim of the MOIPs in Japan since the Fourth Basic Plan has been to resolve the fragmentation among scientific knowledge, social issues,

and the lack of coordination across the innovation system of Japan to proactively address social challenges. However, the current scenario is that of a top-down MOIP built on a long history of goal-oriented policy interventions in Japan. This aspect demonstrates the diversity of MOIPs, which reflects the path-dependent nature of the institutions, including norms and practices that structure repetitive interactions among people (North 1990). The current results are supportive of the arguments of previous studies.

6.2. Limitations

This study has its limitations. The first is survivorship bias. The KAKEN database only displays research projects that were adopted. Thus, identifying the entire trend in the Japanese academic sector, including the number of rejected projects, is impossible. Therefore, another limitation is that the study only displays the characteristics of adopted research projects.

The second is consistency between the plans and results of KAKENHI, which amount to a large number of adopted KAKENHI projects per year. Researchers use catchy words as rhetoric in their applications to obtain research funding. However, the actual research content and results do not always match the keywords. Moreover, analyzing the consistency between the contents of the research plan and the results of the research is extremely difficult.

6.3. Future Research

This study has three future research directions. The first is to adopt a qualitative content analysis approach (Krippendorff 2004; Harwood and Garry 2003). This study aimed to examine the changes in the immediate responses of researchers to the policy change. In future research, we will create second-order constructs based on the keywords in this paper, using the criteria of research area, basic and applied research, and research topic, and analyze the speed of response for each second-order construct.

Second, we intend to determine the path dependence of changes in the transformative Japanese innovation system by examining not only the formal rules of the systems but also the roles of informal constraints and their complementarities across institutions (Hall and Soskice 2001; North 1990, 2005; Suzuki et al. 2021). For instance, we intend to explore the effect of public opinion as an informal constraint on innovation on policies and institutions.

We also aim to conduct a network analysis of collaborative research in the KAKENHI-adopted research projects examined in this paper. If solving social challenges entails diverse collaborations, then a possibility exists that the collaborative research network of the Fourth Basic Plan (social issue-based approach) is wider than that of the Third Basic Plan (academic field-specific approach). For this future research, we will use the KAKEN data on the researchers involved in each research project and their affiliated institutions, then compare the research communities in both Basic Plan periods.

7. Conclusions and Implications

This study aimed to explore the alignment between Japanese academics and the research agenda of the government and its implications for potential social impacts. Specifically, we investigated the responses of the Japanese academic sector to changes in innovation policy and the characteristics that can be observed in KAKENHI research projects that are consistent with the Basic Plan. This section concludes our findings on these research questions and poses potential issues inherent to MOIPs in Japan within the academic sector.

This study was conducted with descriptive statistics of a total of 188 keywords and 116,938 research projects extracted from policy documents (Basic Plan) and the KAKENHI database to investigate the responses of the Japanese academic sector to the shift in innovation policy and the characteristics of research projects related to the innovation policy. The findings reveal that Japanese scholars in recent years have become increasingly consistent with the research themes proposed by the government, especially in their focus on short-term research projects. Moreover, Japanese universities are in the process of transforming into entrepreneurial institutions by changing incentive structures. Although these series

of transformations may yield short-term research results, they do not necessarily address long-term social challenges. Moreover, policy intervention in research themes that target social implementation can not only narrow the focus of research projects but also impede the accumulation of research at the knowledge frontier. Thus, from a long-term perspective, the MOIPs may dysfunction, which may limit the potential impact of research and hinder the development of innovative solutions to societal challenges.

As a practical implication, the findings may help policymakers reconsider the division of labor between industry and academia in a knowledge-intensive economy. Although MOIPs advocate market co-creation by an entrepreneurial state and various private sectors, they will not lead to sustainable development of the innovation ecosystem if mistakes emerge in the establishment of the division of labor among universities and public research institutions, whose social role is to expand the fundamental knowledge pool of the nation.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. The 91 keywords and source text from the Third Basic Plan. (Source: The Third Science and Technology Basic Plan of Japan (Japanese) and Strategic Priority Setting on S&T in the Third Basic Plan (Japanese)).

No	Keywords (Japanese)	Keywords (English)	Original Text (Page)
1	3 R 消費 システム *	3R Consumption System *	環境分野：戦略3 環境研究で国民の暮らしを守る...中略...○製品のライフサイクル全般を的確に評価し3 Rに適した生産・消費システムを設計する科学技術<3 R実践のためのシステム分析・評価・設計技術> (pp. 140–41)
2	3 R 生産 システム *	3R Production System *	環境分野：戦略3 環境研究で国民の暮らしを守る...中略...○製品のライフサイクル全般を的確に評価し3 Rに適した生産・消費システムを設計する科学技術<3 R実践のためのシステム分析・評価・設計技術> (pp. 140–41)
3	F B R サイクル 技術 *	FBR Cycle Technology *	エネルギー分野：<戦略3：基幹エネルギーとしての原子力の推進>○長期的なエネルギーの安定供給を確保する高速増殖炉 (FBR) サイクル技術 (p. 231)
4	G T L 技術	GTL Technology	エネルギー分野：<戦略2：運輸部門を中心とした石油依存からの脱却>...中略...○石油に代わる自動車用新液体燃料 (GTL) の最先端製造技術 (p. 230)
5	I T E R 計画	ITER Project	エネルギー分野：<戦略3：基幹エネルギーとしての原子力の推進>...中略...○国際協力で拓く核融合エネルギー：I T E R 計画 (pp. 230–31)
6	X 線 自由電子レーザー	X-ray Free Electron Laser	ナノテクノロジー・材料分野：○『True Nano』や革新的材料技術によるイノベーションの創出を加速する推進基盤...中略...⑩ X線自由電子レーザーの開発・共用 (国家基幹技術) (pp. 190–91)
7	クリーンエネルギーコスト削減 材料技術 *	Clean Energy Cost Reduction Material Technology *	ナノテクノロジー・材料分野：○『True Nano』や革新的材料で困難な社会的課題を解決する科学技術。①クリーンなエネルギーの飛躍的なコスト削減を可能とする革新的材料技術 (p. 188)
8	コンテンツ 創造 技術	Content Creation Technology	情報通信分野：③すべての国民が I T の恩恵を実感できる社会の実現...中略...【戦略重点科学技術9】世界と感動を共有するコンテンツ創造及び情報活用技術 (pp. 67–68)
9	ストレージ 中核 技術	Storage Core Technology	情報通信分野：②革新的 I T 技術による産業の持続的な発展の実現...中略...【戦略重点科学技術4】世界トップを走り続けるためのディスプレイ・ストレージ・超高速デバイスの中核技術 (pp. 65–66)

Table A1. Cont.

No	Keywords (Japanese)	Keywords (English)	Original Text (Page)
10	セキュリティ 技術	Security Technology	情報通信分野：③すべての国民が I T の恩恵を実感できる社会の実現...中略... 【戦略重点科学技術 1 0】世界一安全・安心な I T 社会を実現する <u>セキュリティ技術</u> (pp. 67–69)
11	ソフトウェア開発 支援 技術	Software Development Support Technology	情報通信分野：②革新的 I T 技術による産業の持続的な発展の実現...中略... 【戦略重点科学技術 6】世界標準を目指す <u>ソフトウェアの開発支援技術</u> (pp. 65–66)
12	ディスプレイ 中核 技術	Display Core Technology	情報通信分野：②革新的 I T 技術による産業の持続的な発展の実現、...中略... 【戦略重点科学技術 4】世界トップを走り続けるための <u>ディスプレイ・ストレージ・超高速デバイスの中核技術</u> (pp. 67–69)
13	ディスプレイ部材 製造 技術*	Display Component Manufacturing Technology *	ものづくり技術分野：戦略重点科学技術（2）—資源・環境・人口制約を克服し、日本のフラッグシップとなる、ものづくりのプロセスイノベーション...中略... ○超フレキシブルディスプレイ部材や超ハイブリッド部材の製造技術、ガラス材料の高機能化のための超精密加工技術等の新たな高付加価値材料を生み出す製造技術や加工技術 (p. 263)
14	ナノ最先端 加工 技術	Nano Cutting-edge Processing Technology	ナノテクノロジー・材料分野：○『True Nano』や革新的材料技術によるイノベーションの創出を加速する推進基盤...中略... ⑨ <u>ナノ領域最先端計測・加工技術</u> (p. 190)
15	ナノ最先端 計測 技術	Leading-edge Nano Measurement Technology	ナノテクノロジー・材料分野：○『True Nano』や革新的材料技術によるイノベーションの創出を加速する推進基盤...中略... ⑨ <u>ナノ領域最先端計測・加工技術</u> (p. 190)
16	ナノテクノロジー 実用化	Practical Application of Nanotechnology	ナノテクノロジー・材料分野：○『True Nano』や革新的材料技術によるイノベーションの創出を加速する推進基盤...中略... ⑧ <u>イノベーション創出拠点におけるナノテクノロジー実用化の先導革新研究開発</u> (p. 190)
17	ナノテクノロジー 社会 受容	Social Acceptance of Nanotechnology	ナノテクノロジー・材料分野：○『True Nano』や革新的材料技術によるイノベーションの創出を加速する推進基盤。 ⑦ <u>ナノテクノロジーの社会受容</u> のための研究開発 (p. 190)
18	ナノバイオ 技術	Nano-biotechnology	ナノテクノロジー・材料分野：○『True Nano』で次世代のイノベーションを起こす科学技術...中略... ⑥ <u>超早期診断と低侵襲治療の実現と一体化を目指す先端のナノバイオ・医療技術</u> (pp. 189–90)
19	ナノ医療 技術	Nano Medical Technology	ナノテクノロジー・材料分野：○『True Nano』で次世代のイノベーションを起こす科学技術...中略... ⑥ <u>超早期診断と低侵襲治療の実現と一体化を目指す先端のナノバイオ・医療技術</u> (p. 208)
20	バイオマス 利用 技術	Biomass Utilization Technology	環境分野：戦略 2 我が国が環境分野で国際貢献を果たし、国際協力でリーダーシップをとる...中略... ○効率的にエネルギーを得るための地域に即した <u>バイオマス利用技術<草木質系バイオマスエネルギー利用技術></u> ＜持続可能型地域バイオマス利用システム技術＞ (p. 140)
21	ユビキタスネットワーク 利用 技術	Ubiquitous Network Utilization Technology	情報通信分野：③すべての国民が I T の恩恵を実感できる社会の実現...中略... 【戦略重点科学技術 8】人の能力を補い生活を支援する <u>ユビキタスネットワーク利用技術</u> (pp. 67–68)
22	ロボット 中核 技術	Robot Core Technology	情報通信分野：②革新的 I T 技術による産業の持続的な発展の実現...中略... 【戦略重点科学技術 5】世界に先駆けた家庭や街で生活に役立つ <u>ロボット中核技術</u> (pp. 65–66)
23	宇宙輸送 システム	Space Transportation Systems	フロンティア分野：（戦略重点科学技術）①信頼性の高い宇宙輸送システム、②衛星の高信頼性・高機能化技術、③海洋地球観測探査システム（うち、次世代海洋探査技術）、④外洋上プラットフォーム技術 (p. 318)
24	衛星 高機能化 技術	Satellite Functionalization Technology	フロンティア分野：（戦略重点科学技術）①信頼性の高い宇宙輸送システム、②衛星の高信頼性・高機能化技術、③海洋地球観測探査システム（うち、次世代海洋探査技術）、④外洋上プラットフォーム技術 (p. 318)
25	衛星 高信頼性 技術	Satellite High Reliability Technology	フロンティア分野：（戦略重点科学技術）①信頼性の高い宇宙輸送システム、②衛星の高信頼性・高機能化技術、③海洋地球観測探査システム（うち、次世代 海洋探査技術）、④外洋上プラットフォーム技術 (p. 318)
26	化学物質 リスク管理 技術	Chemical Risk Management Technology	環境分野：戦略 2 我が国が環境分野で国際貢献を果たし、国際協力でリーダーシップをとる...中略... ○新規の物質への対応と国際貢献により世界を先導する化学物質のリスク評価管理技術 ＜国際間協力の枠組に対応するリスク評価管理＞ ＜新規の物質・技術に対する予見的リスク評価管理＞ (p. 140)
27	化学物質 リスク管理 社会 普及	Chemicals Risk Management Society Dissemination	環境分野：戦略 3 環境研究で国民の暮らしを守る...中略... ○人文社会科学のアプローチにより化学物質リスク管理を社会的に普及する科学技術 ＜リスク管理に関わる人文社会科学＞ (pp. 140–41)
28	化学物質 リスク評価 技術	Chemicals Risk Assessment Technology	環境分野：戦略 2 我が国が環境分野で国際貢献を果たし、国際協力でリーダーシップをとる...中略... ○新規の物質への対応と国際貢献により世界を先導する化学物質のリスク評価管理技術 ＜国際間協力の枠組に対応するリスク評価管理＞ ＜新規の物質・技術に対する予見的リスク評価管理＞ (p. 140)
29	海洋地球 観測探査 システム	Ocean Earth Observation and Exploration System	フロンティア分野：（戦略重点科学技術）①信頼性の高い宇宙輸送システム、②衛星の高信頼性・高機能化技術、③海洋地球観測探査システム（うち、次世代海洋探査技術）、④外洋上プラットフォーム技術 (p. 318)
30	外洋上 プラットフォーム 技術*	Ocean-going Platform Technology *	フロンティア分野：（戦略重点科学技術）①信頼性の高い宇宙輸送システム、②衛星の高信頼性・高機能化技術、③海洋地球観測探査システム（うち、次世代海洋探査技術）、④外洋上プラットフォーム技術 (p. 318)

Table A1. Cont.

No	Keywords (Japanese)	Keywords (English)	Original Text (Page)
31	核融合 エネルギー	Nuclear Fusion Energy	エネルギー分野：＜戦略３：基幹エネルギーとしての原子力の推進＞...中略... ○国際協力で拓く核融合エネルギー： I T E R計画 (pp. 230–31)
32	革新 がん医療 技術	Innovative Cancer Treatment Technology	ライフサイエンス分野：③「標的治療等の革新的がん医療技術」 (p. 15)
33	革新 プロセス 技術	Innovative Process Technology	エネルギー分野：＜戦略１：世界一の省エネ国家としての更なる挑戦＞...中略... ○究極の省エネ工場を実現する革新的素材製造プロセス技術 (p. 230)
34	革新 材料 技術	Innovative Materials Technology	ナノテクノロジー・材料分野：○『True Nano』や革新的材料で困難な社会的課題を解決する科学技術...中略...④イノベーション創生の中核となる革新的材料技術 (pp. 188–89)
35	環境研究 人材 育成	Human Resource Development for Environmental Research	環境分野：戦略４環境科学技術を政策に反映するための人材育成○人文社会科学と融合する環境研究のための人材育成 (p. 141)
36	希少資源 代替材料 技術	Alternative Materials Technology for Rare Resources	ナノテクノロジー・材料分野：○『True Nano』や革新的材料で困難な社会的課題を解決する科学技術...中略...②資源問題解決の決定打となる希少資源・不足資源代替材料革新技術 (pp. 188–89)
37	気候変動 予測 技術	Climate Change Prediction Technology	環境分野：戦略１地球温暖化に立ち向かう...中略...○ポスト京都議定書に向けスーパーコンピュータを用いて21世紀の気候変動を正確に予測する科学技術＜気候モデルを用いた21世紀の気候変動予測＞ (p. 140)
38	航空機 国産 技術	Domestic Aircraft Production Technology	社会基盤分野：２．社会基盤の機能を適切に保持 再生し緊急課題に対応した社会を形成。○新たな社会に適応する交通・輸送システム新技術。交通・輸送予防安全新技術。新需要対応航空機国産技術 (p. 310)
39	高レベル 放射性廃棄物 地層処分 技術	Geological Disposal of High-Level Radioactive Waste	エネルギー分野：＜戦略３：基幹エネルギーとしての原子力の推進＞...中略... ○高レベル放射性廃棄物等の処分実現に不可欠な地層処分技術 (p. 230)
40	高機能 地震観測 技術	Advanced Earthquake Observation Technology	社会基盤分野：１．減災対策により世界一安全な国・日本を実現。○減災を目指した国土の監視・管理技術。高機能高精度地震観測技術。災害監視衛星利用技術。効果早期発現減災技術。国土保全総合管理技術。社会科学融合減災技術 (p. 310)
41	高性能 電力貯蔵 技術	High-Performance Power Storage Technology	エネルギー分野：＜戦略２：運輸部門を中心とした石油依存からの脱却＞...中略... ○電源や利用形態の制約を克服する高性能電力貯蔵技術 (p. 230)
42	高精度 地震観測 技術	High-Precision Seismic Observation Technology	社会基盤分野：１．減災対策により世界一安全な国・日本を実現。○減災を目指した国土の監視・管理技術。高機能高精度地震観測技術。災害監視衛星利用技術。効果早期発現減災技術。国土保全総合管理技術。社会科学融合減災技術 (p. 310)
43	高速増殖炉サイクル 技術*	Fast Breeder Reactor Cycle Technology *	エネルギー分野：＜戦略３：基幹エネルギーとしての原子力の推進＞...中略... ○長期的なエネルギーの安定供給を確保する高速増殖炉 (FBR) サイクル技術 (p. 230)
44	高度 I T 人材 育成	Advanced Information Technology Human Resource Development	情報通信分野：●継続的イノベーションを具現化するための科学技術の研究開発基盤の実現...中略...【戦略重点科学技術２】次世代を担う高度 I T 人材の育成 (pp. 64–65)
45	再興 感染症 技術	Reemerging Infectious Disease Technology	ライフサイエンス分野：④「新興・再興感染症克服科学技術」 (p. 15)
46	災害監視衛星 技術	Disaster Monitoring Satellite Technology	社会基盤分野：１．減災対策により世界一安全な国・日本を実現。○減災を目指した国土の監視・管理技術。高機能高精度地震観測技術。災害監視衛星利用技術。効果早期発現減災技術。国土保全総合管理技術。社会科学融合減災技術 (p. 310)
47	次世代 スーパーコンピュータ	Next-generation Supercomputer	情報通信分野：①継続的イノベーションを具現化するための科学技術の研究開発基盤の実現...中略...【戦略重点科学技術１】科学技術を牽引する世界最高水準の次世代スーパーコンピュータ (p. 64)
48	次世代 ネットワーク 技術	Next-generation Network Technology	情報通信分野：③すべての国民が I T の恩恵を実感できる社会の実現...中略... 【戦略重点科学技術７】大量の情報を瞬時に伝え誰もが便利・快適に利用できる次世代ネットワーク技術 (pp. 67–68)
49	次世代 軽水炉 実用化 技術*	Next-generation Light Water Reactor Technology *	エネルギー分野：＜戦略３：基幹エネルギーとしての原子力の推進＞...中略... ○安全性・経済性に優れ世界に普及する次世代軽水炉の実用化技術 (p. 230)
50	自然共生社会 技術	Technology for a Nature-Symbiosis Society	環境分野：戦略３環境研究で国民の暮らしを守る...中略...○健全な水循環を保ち自然と共生する社会の実現シナリオを設計する科学技術＜地球・地域規模の流域圏観測と環境情報基盤＞＜自然共生型流域圏・都市実現社会シナリオの設計＞ (p. 141)
51	自動車 新液体燃料 技術*	New Liquid Fuel Technology for Automobiles *	エネルギー分野：＜戦略２：運輸部門を中心とした石油依存からの脱却＞...中略... ○石油に代わる自動車用新液体燃料 (G T L) の最先端製造技術 (p. 230)
52	社会資本 再生 革新 技術	Innovative Technology for Social Capital Regeneration	社会基盤分野：２．社会基盤の機能を適切に保持・再生し緊急課題に対応した社会を形成。○大更新時代・少子高齢化社会に対応した社会資本・都市の再生技術。社会資本再生革新技術。都市環境再生技術 (p. 310)
53	省エネ 建築物 技術	Energy-saving Building Technology	エネルギー分野：＜戦略１：世界一の省エネ国家としての更なる挑戦＞...中略... ○実効性のある省エネ生活を実現する先進的住宅・建築物関連技術 (p. 230)

Table A1. Cont.

No	Keywords (Japanese)	Keywords (English)	Original Text (Page)
54	省エネ 高性能汎用デバイス 技術 *	Energy-saving High-performance General-purpose Device Technology *	エネルギー分野：＜戦略１：世界一の省エネ国家としての更なる挑戦＞...中略... ○便利で豊かな省エネ社会を実現する先端高性能汎用デバイス技術 (p. 230)
55	省エネ 住宅 技術	Energy-saving Housing Technology	エネルギー分野：＜戦略１：世界一の省エネ国家としての更なる挑戦＞...中略... ○実効性のある省エネ生活を実現する先進的住宅・建築物関連技術 (p. 230)
56	省エネ 素材 製造プロセス 技術	Energy-saving Material Manufacturing Process Technology	エネルギー分野：＜戦略１：世界一の省エネ国家としての更なる挑戦＞...中略... ○究極の省エネ工場を実現する革新的素材製造プロセス技術 (p. 230)
57	省エネ 都市システム 技術	Energy-saving Urban System Technology	エネルギー分野：＜戦略１：世界一の省エネ国家としての更なる挑戦＞...中略... ○エネルギーの面的利用で飛躍的な省エネの街を実現する都市システム技術 (p. 230)
58	情報 活用 技術	Information Utilization Technology	情報通信分野：③すべての国民がＩＴの恩恵を実感できる社会の実現...中略... 【戦略重点科学技術９】世界と感動を共有するコンテンツ創造及び情報活用技術 (pp. 67–68)
59	食料供給 技術	Food Supply Technology	ライフサイエンス分野：「国際競争力を向上させる安全な食料の生産・供給科学技術」 (p. 16)
60	食料生産 技術	Food Production Technology	ライフサイエンス分野：⑤「国際競争力を向上させる安全な食料の生産・供給科学技術」 (p. 16)
61	新興 感染症 技術	Emerging Infectious Disease Technology	ライフサイエンス分野：④「新興・再興感染症克服科学技術」 (p. 15)
62	新世代 自動車 中核 技術	New Generation Vehicle Core Technology	エネルギー分野：＜戦略２：運輸部門を中心とした石油依存からの脱却＞...中略...○石油を必要としない新世代自動車の革新的中核技術 (p. 230)
63	水素 貯蔵 技術	Hydrogen Storage Technology	エネルギー分野：＜戦略２：運輸部門を中心とした石油依存からの脱却＞...中略...○先端燃料電池システムと安全な革新的水素貯蔵・輸送技術 (p. 230)
64	水素 輸送 技術	Hydrogen Transportation Technology	エネルギー分野：＜戦略２：運輸部門を中心とした石油依存からの脱却＞...中略...○先端燃料電池システムと安全な革新的水素貯蔵・輸送技術 (p. 230)
65	生活安心 ナノテクノロジー *	Nanotechnology for Safe Life *	ナノテクノロジー・材料分野：○『True Nano』や革新的材料で困難な社会的課題を解決する科学技術...中略...③生活の安全・安心を支える革新的ナノテクノロジー・材料技術 (pp. 188–89)
66	生活安心 材料 技術	Life Safety Materials Technology	ナノテクノロジー・材料分野：○『True Nano』や革新的材料で困難な社会的課題を解決する科学技術...中略...③生活の安全・安心を支える革新的ナノテクノロジー・材料技術 (p. 208)
67	生活安全 テクノロジー *	Nanotechnology for Secure Life *	ナノテクノロジー・材料分野：○『True Nano』や革新的材料で困難な社会的課題を解決する科学技術...中略...③生活の安全・安心を支える革新的ナノテクノロジー・材料技術 (p. 189)
68	生活安全 材料 技術	Life Safety Materials Technology	ナノテクノロジー・材料分野：○『True Nano』や革新的材料で困難な社会的課題を解決する科学技術...中略...③生活の安全・安心を支える革新的ナノテクノロジー・材料技術 (p. 208)
69	生態系 再生 技術	Ecosystem Restoration Technology	環境分野：戦略３環境研究で国民の暮らしを守る...中略...○多種多様な生物からなる生態系を正確にとらえその保全・再生を実現する科学技術＜マルチスケールでの生物多様性観測・解析・評価＞＜広域生態系複合における生態系サービス管理技術＞ (pp. 140–41)
70	生態系 保全 技術	Ecosystem Conservation Technology	環境分野：戦略３環境研究で国民の暮らしを守る...中略...○多種多様な生物からなる生態系を正確にとらえその保全・再生を実現する科学技術＜マルチスケールでの生物多様性観測・解析・評価＞＜広域生態系複合における生態系サービス管理技術＞ (pp. 140–41)
71	生命プログラム 再現 技術 *	Life Program Reproduction Technology *	ライフサイエンス分野：⑥「生命プログラム再現科学技術」 (p. 13)
72	石炭ガス化 技術	Coal Gasification Technology	エネルギー分野：＜戦略２：運輸部門を中心とした石油依存からの脱却＞...中略...○クリーン・高効率で世界をリードする石炭ガス化技術 (p. 230)
73	先端 エレクトロニクス	Advanced Electronics	ナノテクノロジー・材料分野：○『True Nano』で次世代のイノベーションを起こす科学技術。⑥デバイスの性能の限界を突破する先端的エレクトロニクス (p. 189)
74	先端 計測分析 技術	Advanced Measurement and Analysis Technology	ものづくり技術分野：戦略重点科学技術（１）ー日本型ものづくり技術をもとに進化させる、科学に立脚したものづくり「可視化」技術...中略...○革新的なものづくり技術の基盤となる先端計測分析技術や、その技術に基づく機器の開発 (pp. 262–63)
75	太陽光 発電 高効率化	High-Efficiency Photovoltaic Power Generation	エネルギー分野：＜戦略２：運輸部門を中心とした石油依存からの脱却＞...中略...○太陽光発電を世界に普及するための革新的高効率化・低コスト化技術 (p. 230)
76	太陽光 発電 低コスト化	Photovoltaic Power Generation Cost Reduction	エネルギー分野：＜戦略２：運輸部門を中心とした石油依存からの脱却＞...中略...○太陽光発電を世界に普及するための革新的高効率化・低コスト化技術 (p. 230)
77	大深度科学ライザー *	High-Depth Scientific Riser *	フロンティア分野：深海・深海底探査技術。大深度科学ライザー掘削技術、次世代型深海底探査技術の開発、有人深海底探査技術、無人深海底探査技術、船舶による深海底探査技術等 (p. 324)

Table A1. Cont.

No	Keywords (Japanese)	Keywords (English)	Original Text (Page)
78	脱温暖化社会 技術	Technology for a Climate Change-Free Society	環境分野：戦略1 地球温暖化に立ち向かう...中略...○地球温暖化がもたらすリスクを今のうちに予測し脱温暖化社会の設計を可能とする科学技術<気候変動リスクの予測・管理と脱温暖化社会設計> (p. 140)
79	超高速デバイス 中核 技術	Core Technology for Ultra High-Speed Devices	情報通信分野：②革新的 I T 技術による産業の持続的な発展の実現...中略...【戦略重点科学技術4】世界トップを走り続けるためのディスプレイ・ストレージ・超高速デバイスの中核技術 (pp. 65–66)
80	超微細化 製造 技術	Ultrafine Manufacturing Technology	情報通信分野：②革新的 I T 技術による産業の持続的な発展の実現、【戦略重点科学技術3】次世代半導体の国際競争を勝ち抜く超微細化・低消費電力化及び設計・製造技術 (p. 66)
81	超微細化 設計 技術	Ultrafine Design Technology	情報通信分野：②革新的 I T 技術による産業の持続的な発展の実現...中略...【戦略重点科学技術3】次世代半導体の国際競争を勝ち抜く超微細化・低消費電力化及び設計・製造技術 (pp. 65–66)
82	低消費電力化 製造 技術	Low Power Consumption Manufacturing Technology	情報通信分野：②革新的 I T 技術による産業の持続的な発展の実現...中略...【戦略重点科学技術3】次世代半導体の国際競争を勝ち抜く超微細化・低消費電力化及び設計・製造技術 (pp. 65–66)
83	低消費電力化 設計 技術	Low Power Consumption Design Technology	情報通信分野：②革新的 I T 技術による産業の持続的な発展の実現...中略...【戦略重点科学技術3】次世代半導体の国際競争を勝ち抜く超微細化・低消費電力化及び設計・製造技術 (pp. 65–66)
84	不足資源 代替材料 技術	Alternative Material Technology for Insufficient Resources	ナノテクノロジー・材料分野：○『True Nano』や革新的材料で困難な社会的課題を解決する科学技術...中略...②資源問題解決の決定打となる希少資源・不足資源代替材料革新技術 (p. 208)
85	物質環境 改善 技術	Material Environment Improvement Technology	ライフサイエンス分野：⑥「生物機能活用による物質生産・環境改善科学技術」 (p. 17)
86	物質生産 改善 技術	Material Production Improvement Technology	ライフサイエンス分野：⑥「生物機能活用による物質生産・環境改善科学技術」 (p. 17)
87	有害危険物 現場 検知 技術 *	Hazardous Materials On-site Detection Technology *	社会基盤分野：②現場活動を支援し人命救助や被害拡大を阻止する新技術...中略...○有害危険物現場検知技術 (p. 288)
88	有害物質 管理 技術	Hazardous Substance Management Technology	環境分野：戦略2 我が国が環境分野で国際貢献を果たし、国際協力でリーダーシップをとる...中略...○廃棄物資源の国際流通に対応する有用物質利用と有害物質管理技術<国際3 R 対応の有用物質利用・有害物質管理技術> (p. 140)
89	有用物質 利用 技術	Beneficial Substance Utilization Technology	環境分野：戦略2 我が国が環境分野で国際貢献を果たし、国際協力でリーダーシップをとる...中略...○廃棄物資源の国際流通に対応する有用物質利用と有害物質管理技術 (p. 140)
90	臨床研究	Clinical Research	ライフサイエンス分野：②「臨床研究・臨床への橋渡し研究」 (p. 13)
91	ライフサイエンス	Life Science	ライフサイエンス分野：I. 生命のプログラムの再現（統合的全体像の理解で生命の神秘に迫る）...中略...○本領域の研究を推進する際、イノベーションの源泉となり、高い波及効果や我が国のライフサイエンス研究の国際的優位性の確保が期待できる技術の研究を推進。 (p. 12)

Note: The asterisks represent keywords that were not identified in the KAKEN database. Additionally, the underlining of words in the original text indicates keywords extracted by this study for use in searching the KAKEN database.

Table A2. The 97 keywords and source text from the Fourth Basic Plan. (Source: The Fourth Science and Technology Basic Plan of Japan (Japanese)).

No	Keywords (Japanese)	Keywords (English)	Original Text (Page)
1	3次元 映像法	3D Imaging Method	また、より小型で侵襲が少ない高性能の内視鏡等の肉眼視技術・機器の開発、3次元映像法などの早期診断に資する新たなイメージング技術の開発を推進する。 (p. 14)
2	BMI 機器	BMI Equipment	高齢者や障害者のQOLの向上や介護者の負担軽減を図るため、生活支援ロボットやブレインマシンインターフェース (BMI) 機器、高齢者用のパーソナルモビリティなど、高齢者や障害者の身体機能を代償する技術、自立支援や生活支援を行う技術、高度なコミュニケーション支援に関する技術、さらには介護者を支援する技術に関して、安全性評価手法の確立も含めた研究開発を推進する。 (p. 15)
3	ES細胞 細胞増殖 技術	ES Cell: Cell Proliferation Technology	疾患の治療や失われた機能の補助、再生につながる再生医療に関しては、iPS細胞、ES細胞、体性幹細胞等の体内及び体外での細胞増殖・分化技術を開発するとともに、その標準化と利用技術の開発、安全性評価技術に関する研究開発を推進する。 (p. 14)
4	ES細胞 細胞分化 技術	ES Cell: Cell Differentiation Technology	疾患の治療や失われた機能の補助、再生につながる再生医療に関しては、iPS細胞、ES細胞、体性幹細胞等の体内及び体外での細胞増殖・分化技術を開発するとともに、その標準化と利用技術の開発、安全性評価技術に関する研究開発を推進する。 (p. 14)

Table A2. Cont.

No	Keywords (Japanese)	Keywords (English)	Original Text (Page)
5	Investigational Device Exemption	Investigational Device Exemption	国は、医薬品及び医療機器の臨床研究と治験を一体化した制度に関して、海外の類似した制度（例えば、米国における IND (Investigational New Drug)、IDE (Investigational Device Exemption)等）を調査研究し、その導入について検討するとともに、大学等に対して、国際標準に基づく臨床研究の実施を求める。(p. 15)
6	Investigational New Drug	Investigational New Drug	国は、医薬品及び医療機器の臨床研究と治験を一体化した制度に関して、海外の類似した制度（例えば、米国における IND (Investigational New Drug)、IDE (Investigational Device Exemption) 等）を調査研究し、その導入について検討するとともに、大学等に対して、国際標準に基づく臨床研究の実施を求める。(p. 15)
7	iPS細胞 細胞増殖 技術	iPS Cell Proliferation Technology	疾患の治療や失われた機能の補助、再生につながる再生医療に関しては、iPS細胞、ES細胞、体性幹細胞等の体内及び体外での細胞増殖・分化技術を開発するとともに、その標準化と利用技術の開発、安全性評価技術に関する研究開発を推進する。(p. 14)
8	iPS細胞 細胞分化 技術	iPS Cell Differentiation Technology	疾患の治療や失われた機能の補助、再生につながる再生医療に関しては、iPS細胞、ES細胞、体性幹細胞等の体内及び体外での細胞増殖・分化技術を開発するとともに、その標準化と利用技術の開発、安全性評価技術に関する研究開発を推進する。(p. 14)
9	イメージング 技術	Imaging Technology	また、より小型で侵襲が少ない高性能の内視鏡等の内視視技術・機器の開発、3次元映像法などの早期診断に資する新たなイメージング技術の開発を推進する。(p. 14)
10	グリーンイノベーション	Green Innovation	(1)で述べたグリーンイノベーションの目標実現に向けて、具体的には以下に掲げる重要課題を設定する (p. 16)
11	グリーンサステイナブルケミストリー	Green Sustainable Chemistry	製造部門における化石資源の一層の効率的利用を図るため、製鉄等における革新的な製造プロセスや、ここで用いられる材料の高機能化、グリーンサステイナブルケミストリー、バイオリファイナリー、革新的触媒技術に関する研究開発を推進する。(p. 12)
12	ゲノム配列 解析	Genome Sequence Analysis	国民の健康状態を長期間追跡し、食などの生活習慣や生活環境の影響を調査するとともに、臨床データ、メタボローム、ゲノム配列の解析等のコホート研究を推進し、生活習慣病等の発症と進行の仕組みを解明することで、客観的根拠(エビデンス)に基づいた予防法の開発を進める。さらに、疾患の予兆を発見し、先制介入治療(先制医療)による予防法の確立を目指す。(p. 14)
13	スマートグリッド	Smart Grid	さらに基幹エネルギーと分散エネルギーの両供給システム及びエネルギー需要システムを総合的に最適制御するスマートグリッド等のエネルギーマネジメントに関する研究開発及び自律分散エネルギーシステムの研究開発を促進し、これらの海外展開を図る。(p. 11)
14	スマートコミュニティ	Smart Community	国は、地方公共団体や大学、公的研究機関、産業界と協働し、それぞれの地域の特色を活かしつつ、スマートコミュニティ等の新しい社会システムの構築に向けて、研究開発から技術実証、普及、展開までを一体的に行う取組を支援する。(p. 13)
15	ゼロエミッション 火力発電	Zero-Emission Thermal Power Generation	さらに、基幹エネルギー供給源の効率化と低炭素化に向けて、火力発電の高効率化、高効率石油精製に加え、石炭ガス化複合発電等と二酸化炭素の回収及び貯留を組み合わせたゼロエミッション火力発電の実現に向けた研究開発等の取組を推進する。(p. 11)
16	ドラッグデリバリーシステム	Drug Delivery Systems	また、核酸医薬、ドラッグデリバリーシステム等の革新的な治療方法の確立を目指した研究開発を推進する。(p. 14)
17	ナノカーボン 材料	Nanocarbon Materials	我が国の最終エネルギー消費の約半分を占める民生（家庭、業務）及び運輸部門の一層の低炭素化、省エネルギー化に向けて、住宅及び建築物の高断熱化、家電及び照明の高効率化、高効率給湯器（コジェネレーション、次世代型ヒートポンプシステム）、定置用燃料電池、パワー半導体、ナノカーボン材料等の技術に関する研究開発、普及を推進する。(p. 12)
18	バイオリファイナリー	Biorefinery	製造部門における化石資源の一層の効率的利用を図るため、製鉄等における革新的な製造プロセスや、ここで用いられる材料の高機能化、グリーンサステイナブルケミストリー、バイオリファイナリー、革新的触媒技術に関する研究開発を推進する。
19	バイオベンチャー	Bioventure	国は、革新的な医薬品及び医療機器の開発につながる新たなシーズの創出に向けて、バイオベンチャーを長期的視点から支援するための取組を進める。(p. 15)
20	バイオマス 利用 技術	Biomass Utilization Technology	太陽光発電、バイオマス利用、風力発電、小水力発電、地熱発電、潮力・波力発電等の再生可能エネルギー技術の研究開発については、これまでの技術を飛躍的に向上させるとともに、例えば、宇宙太陽光発電、藻類バイオマスなど新たなブレイクスルーとなり得る革新的技術の獲得を目指し、戦略的に必要な取組や検討を進める。(p. 11)
21	パワー半導体	Power Semiconductors	我が国の最終エネルギー消費の約半分を占める民生（家庭、業務）及び運輸部門の一層の低炭素化、省エネルギー化に向けて、住宅及び建築物の高断熱化、家電及び照明の高効率化、高効率給湯器（コジェネレーション、次世代型ヒートポンプシステム）、定置用燃料電池、パワー半導体、ナノカーボン材料等の技術に関する研究開発、普及を推進する。(p. 12)
22	ブレインマシンインターフェース 機器	Brain-machine Interface Devices	高齢者や障害者のQOLの向上や介護者の負担軽減を図るため、生活支援ロボットやブレインマシンインターフェース (BMI) 機器、高齢者用のパーソナルモビリティなど、高齢者や障害者の身体機能を代償する技術、自立支援や生活支援を行う技術、高度なコミュニケーション支援に関する技術、さらには介護者を支援する技術に関して、安全性評価手法の確立も含めた研究開発を推進する。(p. 15)

Table A2. Cont.

No	Keywords (Japanese)	Keywords (English)	Original Text (Page)
23	メタボローム	Metabolomics	国民の健康状態を長期間追跡し、食などの生活習慣や生活環境の影響を調査するとともに、臨床データ、メタボローム、ゲノム配列の解析等のコホート研究を推進し、生活習慣病等の発症と進行の仕組みを解明することで、客観的根拠（エビデンス）に基づいた予防法の開発を進める。(p. 14)
24	ライフイノベーション	Life Innovation	このため、国として、国民が心身ともに健康で、豊かさや、生きていることの充実感を享受できる社会の実現に向けて、 <u>ライフイノベーション</u> を強力に推進する(p. 15)
25	ロボット手術 機器	Robotic Surgical Equipment	放射線治療機器、ロボット手術機器等の新しい治療機器の開発、内視鏡と治療薬の融合など診断と治療を融合させる薬剤や機器の開発、更に遠隔診断、遠隔治療技術の開発、それを支援する画像情報処理技術の開発を進める。(p. 14)
26	医療機関 ネットワーク	Medical Institution Networks	全国の大学や企業等にかかれた <u>医療機関ネットワーク</u> を構築する。(p. 15)
27	宇宙太陽光 発電	Space Solar Power	太陽光発電、バイオマス利用、風力発電、小水力発電、地熱発電、潮力・波力発電等の再生可能エネルギー技術の研究開発については、これまでの技術を飛躍的に向上させるとともに、例えば、宇宙太陽光発電、藻類バイオマスなど新たなブレークスルーとなり得る革新的技術の獲得を目指し、戦略的に必要な取組や検討を進める。(p. 11)
28	遠隔 治療 技術	Telemedicine Technology	放射線治療機器、ロボット手術機器等の新しい治療機器の開発、内視鏡と治療薬の融合など診断と治療を融合させる薬剤や機器の開発、更に遠隔診断、 <u>遠隔治療技術</u> の開発、それを支援する画像情報処理技術の開発を進める。(p. 14)
29	遠隔 診断 技術	Remote Diagnostic Technology	放射線治療機器、ロボット手術機器等の新しい治療機器の開発、内視鏡と治療薬の融合など診断と治療を融合させる薬剤や機器の開発、更に遠隔診断、遠隔治療技術の開発、それを支援する画像情報処理技術の開発を進める。(p. 14)
30	温室効果ガス 排出削減 基準	Greenhouse Gas Emission Reduction Standards	国は、例えば、バイオ燃料に関する温室効果ガス排出削減基準等の持続可能性基準の設定や自動車燃費基準の改定など、企業におけるイノベーションに向けた研究開発等の取組を促進するため、国際競争力も勘案しつつ、技術的、経済的合理性に立脚した新たな規制や制度の在り方を検討する(p. 13)
31	画像情報処理技術	Image Information Processing Technology	更に遠隔診断、遠隔治療技術の開発、それを支援する <u>画像情報処理技術</u> の開発を進める。(p. 14)
32	介護者 支援 技術	Caregiver Assistive Technology	さらには介護者を支援する技術に関して、安全性評価手法の確立も含めた研究開発を推進する(p.15)
33	核酸医薬	Nucleic Acid Medicine	また、核酸医薬、ドラッグデリバリーシステム等の革新的な治療方法の確立を目指した研究開発を推進する。(p. 14)
34	革新 触媒 技術	Innovative Catalyst Technology	製造部門における化石資源の一層の効率的利用を図るため、製鉄等における革新的な製造プロセスや、ここで用いられる材料の高機能化、グリーンサステイナブルケミストリー、バイオリファイナリー、 <u>革新的触媒技術</u> に関する研究開発を推進する。(p. 12)
35	緩和医療	Palliative Medicine	また、がん患者や高齢者の終末期における精神的、肉体的苦痛を取り除く緩和医療に関する研究を推進する。(p. 15)
36	気候変動対応	Climate Change Countermeasure	国は、我が国のもつ優れた技術を活かした途上国等への支援促進のため、気候変動対応に関する技術移転とシステム改革を、貧困対策や農業、水資源の開発、防災等の政策と連動させて総合的に推進し、これらの国々の自立的な対応力を強化する。(p. 15)
37	高機能 材料	High Functional Materials	製造部門における化石資源の一層の効率的利用を図るため、製鉄等における革新的な製造プロセスや、ここで用いられる <u>材料の高機能化</u> 、グリーンサステイナブルケミストリー、バイオリファイナリー、 <u>革新的触媒技術</u> に関する研究開発を推進する。(p. 12)
38	高効率 家電	Highly Efficient Home Appliances	我が国の最終エネルギー消費の約半分を占める民生(家庭、業務)及び運輸部門の一層の低炭素化、省エネルギー化に向けて、住宅及び建築物の高断熱化、家電及び照明の高効率化、高効率給湯器（コジェネレーション、次世代型ヒートポンプシステム）、定置用燃料電池、パワー半導体、ナノカーボン材料等の技術に関する研究開発、普及を推進する。(p. 12)
39	高効率 火力 発電	High-efficiency Thermal Power Generation	基幹エネルギー供給源の効率化と低炭素化に向けて、火力発電の高効率化、高効率石油精製に加え、石炭ガス化複合発電等と二酸化炭素の回収及び貯留を組み合わせたゼロエミッション火力発電の実現に向けた研究開発等の取組を推進する。(p. 11)
40	高効率 給湯器	High-efficiency Water Heaters	我が国の最終エネルギー消費の約半分を占める民生(家庭、業務)及び運輸部門の一層の低炭素化、省エネルギー化に向けて、住宅及び建築物の高断熱化、家電及び照明の高効率化、高効率給湯器（コジェネレーション、次世代型ヒートポンプシステム）、定置用燃料電池、パワー半導体、ナノカーボン材料等の技術に関する研究開発、普及を推進する。(p. 12)
41	高効率 交通 システム	High-efficiency Transportation Systems	環境先進都市の構築に向けて、 <u>高効率な交通及び輸送システム</u> の構築に向けた研究開発を推進する。(p. 12)
42	高効率 照明	High-efficiency Lighting	我が国の最終エネルギー消費の約半分を占める民生(家庭、業務)及び運輸部門の一層の低炭素化、省エネルギー化に向けて、住宅及び建築物の高断熱化、家電及び照明の高効率化、高効率給湯器（コジェネレーション、次世代型ヒートポンプシステム）、定置用燃料電池、パワー半導体、ナノカーボン材料等の技術に関する研究開発、普及を推進する。(p. 12)

Table A2. Cont.

No	Keywords (Japanese)	Keywords (English)	Original Text (Page)
43	高効率 石油 精製	High-efficiency Oil Refining	基幹エネルギー供給源の効率化と低炭素化に向けて、火力発電の高効率化、高効率石油精製に加え、石炭ガス化複合発電等と二酸化炭素の回収及び貯留を組み合わせたゼロエミッション火力発電の実現に向けた研究開発等の取組を推進する。(p. 11)
44	高効率 輸送 システム	High-efficiency Transportation Systems	環境先進都市の構築に向けて、 <u>高効率な交通及び輸送システム</u> の構築に向けた研究開発を推進する。(p. 12)
45	高効率 輸送機器	High-efficiency Transportation Equipment	さらに、 <u>高効率輸送機器</u> （次世代自動車、鉄道、船舶、航空機）やモーダルシフト等の物流を効率化するための手法 (p. 12)
46	高性能 内視鏡	High-performance Endoscopes	また、より小型で侵襲が少ない高性能の内視鏡等の肉眼視技術・機器の開発、3次元映像法などの早期診断に資する新たなイメージング技術の開発を推進する。(p. 14)
47	高断熱 建築物	Highly Insulated Buildings	我が国の最終エネルギー消費の約半分を占める民生（家庭、業務）及び運輸部門の一層の低炭素化、省エネルギー化に向けて、住宅及び建築物の高断熱化、家電及び照明の高効率化、高効率給湯器（コジェネレーション、次世代型ヒートポンプシステム）、定置用燃料電池、パワー半導体、ナノカーボン材料等の技術に関する研究開発、普及を推進する。(p. 12)
48	高断熱 住宅	Highly Insulated Housing	我が国の最終エネルギー消費の約半分を占める民生（家庭、業務）及び運輸部門の一層の低炭素化、省エネルギー化に向けて、 <u>住宅及び建築物の高断熱化</u> 、家電及び照明の高効率化、高効率給湯器（コジェネレーション、次世代型ヒートポンプシステム）、定置用燃料電池、パワー半導体、ナノカーボン材料等の技術に関する研究開発、普及を推進する。(p. 12)
49	高度 水処理 技術	Advanced Water Treatment Technology	<u>高度水処理技術</u> を含む総合水資源管理システムの構築に向けた研究開発等を、実証実験も含めて推進する (p. 12)
50	高齢者 パーソナルモビリティ	Personal Mobility for the Elderly	高齢者や障害者のQOLの向上や介護者の負担軽減を図るため、生活支援ロボットやブレインマシンインターフェース (BMI) 機器、高齢者用のパーソナルモビリティなど、高齢者や障害者の身体機能を代償する技術、自立支援や生活支援を行う技術、高度なコミュニケーション支援に関する技術、さらには介護者を支援する技術に関して、安全性評価手法の確立も含めた研究開発を推進する。(p.15)
51	再生可能 エネルギー	Renewable Energy	太陽光発電、バイオマス利用、風力発電、小水力発電、地熱発電、潮力・波力発電等の再生可能エネルギー技術の研究開発については、これまでの技術を飛躍的に向上させるとともに、例えば、宇宙太陽光発電、藻類バイオマスなど新たなブレークスルーとなり得る革新的技術の獲得を目指し、戦略的に必要な取組や検討を進める。(p. 11)
52	資源再生 技術	Resource Reclamation Technology	また、 <u>資源再生技術</u> の革新、レアメタル、レアアース等の代替材料の創出に向けた取組を推進する。(p. 12)
53	次世代 自動車	Next-generation Automobiles	また、 <u>次世代自動車</u> に用いられる蓄電池、燃料電池、パワーエレクトロニクスによる電力制御等のエネルギー利用の革新を目指した研究開発、普及に関する取組を推進する。(p. 12)
54	次世代 情報通信 ネットワーク	Next-generation Information and Communication Networks	さらに、新産業の創出とともに、経済社会システム全体の効率化を目指し、次世代の情報通信ネットワークの構築、信頼性の高いクラウドコンピューティングの実現に向けた情報通信技術に関する研究開発を推進し、これらの幅広い領域での利用、活用を促進する。(p. 12)
55	自然災害 軽減	Natural Disaster Mitigation	これらも含め、気候変動や大規模自然災害に対応した、都市や地域の形成、自然環境や生物多様性の保全、森林等における自然循環の維持、自然災害の軽減、持続可能な循環型食料生産の実現等に向けた取組を進める。(p. 12)
56	自然循環 維持	Natural Circulation Maintenance	これらも含め、気候変動や大規模自然災害に対応した、都市や地域の形成、自然環境や生物多様性の保全、森林等における自然循環の維持、自然災害の軽減、持続可能な循環型食料生産の実現等に向けた取組を進める。(p. 12)
57	循環 食料生産	Circular Food Production	これらも含め、気候変動や大規模自然災害に対応した、都市や地域の形成、自然環境や生物多様性の保全、森林等における自然循環の維持、自然災害の軽減、持続可能な循環型食料生産の実現等に向けた取組を進める。(p. 12)
58	小水力 発電	Small-scale Hydroelectric Power Generation	太陽光発電、バイオマス利用、風力発電、小水力発電、地熱発電、潮力・波力発電等の再生可能エネルギー技術の研究開発については、これまでの技術を飛躍的に向上させるとともに、例えば、宇宙太陽光発電、藻類バイオマスなど新たなブレークスルーとなり得る革新的技術の獲得を目指し、戦略的に必要な取組や検討を進める。(p. 12)
59	水素 供給 システム	Hydrogen Supply System	また、分散エネルギーシステムの革新を目指し、燃料電池や蓄電池等のエネルギーの創出、蓄積システム、製造・輸送・貯蔵にわたる水素供給システム、超電導送電の研究開発、さらに基幹エネルギーと分散エネルギーの両供給システム及びエネルギー需要システムを総合的に最適制御するスマートグリッド等のエネルギーマネジメントに関する研究開発及び自律分散エネルギーシステムの研究開発を促進し、これらの海外展開を図る (p. 11)
60	水素ステーション	Hydrogen Station	国は、次世代自動車、水素ステーション等の供給インフラ設備、再生可能エネルギー設備等の実用化、普及を促進するため、これを妨げるおそれのある関連法の点検、改革を推進する。(p. 13)
61	生活支援 ロボット	Lifestyle Support Robot	高齢者や障害者のQOLの向上や介護者の負担軽減を図るため、生活支援ロボットやブレインマシンインターフェース (BMI) 機器、高齢者用のパーソナルモビリティなど、高齢者や障害者の身体機能を代償する技術、自立支援や生活支援を行う技術、高度なコミュニケーション支援に関する技術、さらには介護者を支援する技術に関して、安全性評価手法の確立も含めた研究開発を推進する。(p. 15)

Table A2. Cont.

No	Keywords (Japanese)	Keywords (English)	Original Text (Page)
62	生活習慣病	Lifestyle-related Illnesses	国民の健康状態を長期間追跡し、食などの生活習慣や生活環境の影響を調査するとともに、臨床データ、メタボローム、ゲノム配列の解析等のコホート研究を推進し、 <u>生活習慣病等の発症と進行の仕組みを解明すること</u> で、客観的根拠（エビデンス）に基づいた予防法の開発を進める。（p. 14）
63	生物多様性	Bio-diversity	これらも含め、気候変動や大規模自然災害に対応した、都市や地域の形成、自然環境や生物多様性の保全、森林等における自然循環の維持、自然災害の軽減、持続可能な循環型食料生産の実現等に向けた取組を進める。（p. 12）
64	生命科学 基礎 研究	Basic Life Science Research	新薬の開発においては、動物疾患モデルやiPS細胞による疾患細胞等を駆使して疾患や治療のメカニズムを解明し、新規創薬ターゲットの探索を行う必要があり、そのために <u>生命科学の基礎的な研究を充実、強化する</u> 。（p. 14）
65	生命動態 システム科学	Biosystems Science	また、 <u>生命動態システム科学研究を推進する</u> 。（p. 15）
66	先制医療	Preemptive Medicine	さらに、疾患の予兆を発見し、先制介入治療（先制医療）による予防法の確立を目指す。（p. 14）
67	先制介入治療	Preemptive Interventional Therapy	さらに、疾患の予兆を発見し、 <u>先制介入治療（先制医療）</u> による予防法の確立を目指す。（p. 14）
68	総合 水資源 管理 システム	Integrated Water Resources Management System	さらに、高度水処理技術を含む <u>総合水資源管理システム</u> の構築に向けた研究開発等を、実証実験も含めて推進する。（p. 12）
69	藻類 バイオマス	Algae Biomass	太陽光発電、バイオマス利用、風力発電、小水力発電、地熱発電、潮力・波力発電等の再生可能エネルギー技術の研究開発については、これまでの技術を飛躍的に向上させるとともに、例えば、宇宙太陽光発電、藻類バイオマスなど新たなブレークスルーとなり得る革新的技術の獲得を目指し、戦略的に必要な取組や検討を進める。（p. 11）
70	太陽光 発電	Solar Power Generation	太陽光発電、バイオマス利用、風力発電、小水力発電、地熱発電、潮力・波力発電等の再生可能エネルギー技術の研究開発については、これまでの技術を飛躍的に向上させるとともに、例えば、宇宙太陽光発電、藻類バイオマスなど新たなブレークスルーとなり得る革新的技術の獲得を目指し、戦略的に必要な取組や検討を進める。（p. 11）
71	体性幹細胞 細胞増殖 技術	Somatic Stem Cell: Cell Proliferation Technology	疾患の治療や失われた機能の補助、再生につながる再生医療に関しては、iPS細胞、ES細胞、体性幹細胞等の体内及び体外での細胞増殖、分化技術を開発するとともに、その標準化と利用技術の開発、安全性評価技術に関する研究開発を推進する。（p. 11）
72	体性幹細胞 細胞分化 技術	Somatic Stem Cell: Differentiation Technology	疾患の治療や失われた機能の補助、再生につながる再生医療に関しては、iPS細胞、ES細胞、体性幹細胞等の体内及び体外での細胞増殖、 <u>分化技術</u> を開発するとともに、その標準化と利用技術の開発、安全性評価技術に関する研究開発を推進する。（p. 14）
73	代替材料 創出	Alternative Material Creation	また、資源再生技術の革新、レアメタル、レアアース等の <u>代替材料の創出</u> に向けた取組を推進する。（p. 12）
74	地場産業 再生	Local Industry Revival	東日本大震災により、東北及び関東地方の沿岸域を中心として、広範囲にわたり、地場産業である農林水産業等の第一次産業が甚大な被害を受けた。これを踏まえ、これら産業の復興、 <u>再生</u> 、さらには成長の実現に向けて、汚染された土壌や水質等の調査及び改善改良、海洋生態系の回復、生産性の向上、農林水産物の安全性の向上等に関する研究開発を推進するとともに、その成果の利用、活用を促進する（p. 9）
75	地熱 発電	Geothermal Power Generation	太陽光発電、バイオマス利用、風力発電、小水力発電、地熱発電、潮力・波力発電等の再生可能エネルギー技術の研究開発については、これまでの技術を飛躍的に向上させるとともに、例えば、宇宙太陽光発電、藻類バイオマスなど新たなブレークスルーとなり得る革新的技術の獲得を目指し、戦略的に必要な取組や検討を進める。（p. 11）
76	潮力 発電	Tidal Power Generation	太陽光発電、バイオマス利用、風力発電、小水力発電、地熱発電、潮力・波力発電等の再生可能エネルギー技術の研究開発については、これまでの技術を飛躍的に向上させるとともに、例えば、宇宙太陽光発電、藻類バイオマスなど新たなブレークスルーとなり得る革新的技術の獲得を目指し、戦略的に必要な取組や検討を進める。（p. 11）
77	超電導 送電	Superconducting Power Transmission	また、分散エネルギーシステムの革新を目指し、燃料電池や蓄電池等のエネルギーの創出、蓄積システム、製造・輸送・貯蔵にわたる水素供給システム、超電導送電の研究開発、さらに基幹エネルギーと分散エネルギーの両供給システム及びエネルギー需要システムを総合的に最適制御するスマートグリッド等のエネルギーマネジメントに関する研究開発及び自律分散エネルギーシステムの研究開発を促進し、これらの海外展開を図る。（p. 11）
78	定置 燃料電池	Stationary Fuel Cells	我が国の最終エネルギー消費の約半分を占める民生（家庭、業務）及び運輸部門の一層の低炭素化、省エネルギー化に向けて、住宅及び建築物の高断熱化、家電及び照明の高効率化、高効率給湯器（コジェネレーション、次世代型ヒートポンプシステム）、定置用燃料電池、パワー半導体、ナノカーボン材料等の技術に関する研究開発、普及を推進する。（p. 12）
79	電力 制御	Power Control	また、次世代自動車に用いられる蓄電池、燃料電池、パワーエレクトロニクスによる電力制御等のエネルギー利用の革新を目指した研究開発、普及に関する取組を推進する。（p. 12）
80	認知症 進行遅延 技術	Dementia Progression Delay Technology	さらに、認知症等による社会的、経済的な損失や負担の大きさを踏まえ、積極介入研究を推進することにより、 <u>認知症等の発症防止や、早期診断、<u>進行の遅延技術</u></u> 等の研究開発を推進する。（p. 14）

Table A2. Cont.

No	Keywords (Japanese)	Keywords (English)	Original Text (Page)
81	認知症 早期診断	Early Diagnosis of Dementia	さらに、認知症等による社会的、経済的な損失や負担の大きさを踏まえ、積極介入研究を推進することにより、 <u>認知症等の発症防止や、早期診断</u> 、進行の遅延技術等の研究開発を推進する。(p. 14)
82	認知症 発症 防止	Prevention of Onset of Dementia	さらに、認知症等による社会的、経済的な損失や負担の大きさを踏まえ、積極介入研究を推進することにより、 <u>認知症等の発症防止や、早期診断</u> 、進行の遅延技術等の研究開発を推進する。(p. 14)
83	燃料電池	Fuel Cells	また、次世代自動車に用いられる蓄電池、燃料電池、パワーエレクトロニクスによる電力制御等のエネルギー利用の革新を目指した研究開発、普及に関する取組を推進する。(p. 12)
84	波力 発電	Wave Power Generation	太陽光発電、バイオマス利用、風力発電、小水力発電、地熱発電、潮力・波力発電等の再生可能エネルギー技術の研究開発については、これまでの技術を飛躍的に向上させるとともに、例えば、宇宙太陽光発電、藻類バイオマスなど新たなブレークスルーとなり得る革新的技術の獲得を目指し、戦略的に必要な取組や検討を進める。(p. 11)
85	被災地 医療	Medical Care in Disaster Areas	さらに、新しい産業の創成と雇用の創出に向けて、被災地域を中心に、再生可能エネルギーや医療・介護、情報通信技術等の領域における研究開発等の取組を促進する。(p. 9)
86	被災地 介護	Nursing Care in Disaster Areas	<u>被災地域を中心に、再生可能エネルギーや医療・介護、情報通信技術等の領域における研究開発等の取組を促進する</u> (p. 10)
87	被災地 減災 対策	Disaster Mitigation Measures	二次災害防止のため、地方公共団体と連携しつつ、 <u>被災地</u> における防災、 <u>減災対策</u> に関する取組を強化する (p. 10)
88	被災地 交通 インフラ	Transportation Infrastructure in Disaster Areas	被災地域では、地震と津波、さらには液状化等によって、多くの建築構造物等が倒壊あるいは流失し、社会インフラが寸断され、甚大な被害が発生した。これを踏まえ、家屋やビル等の修繕や修復、堤防等の防災インフラ、港湾、空港、鉄道、橋梁、道路等の交通インフラ、さらに電気、ガス、上下水道、情報通信等の生活インフラの復旧、再生とその機能性、利便性、安全性の向上等に資する研究開発等の取組を進める。(pp. 9–10)
89	被災地 情報通信 技術	Information and Communication Technology in Disaster Areas	被災地域を中心に、再生可能エネルギーや医療・介護、 <u>情報通信技術</u> 等の領域における研究開発等の取組を促進する (p. 10)
90	被災地 生活 インフラ	Lifestyle Infrastructure in Disaster Areas	被災地域では、地震と津波、さらには液状化等によって、多くの建築構造物等が倒壊あるいは流失し、社会インフラが寸断され、甚大な被害が発生した。これを踏まえ、家屋やビル等の修繕や修復、堤防等の防災インフラ、港湾、空港、鉄道、橋梁、道路等の交通インフラ、さらに電気、ガス、上下水道、情報通信等の生活インフラの復旧、再生とその機能性、利便性、安全性の向上等に資する研究開発等の取組を進める。(pp. 9–10)
91	被災地 防災 インフラ	Disaster Prevention Infrastructure	被災地域では、地震と津波、さらには液状化等によって、多くの建築構造物等が倒壊あるいは流失し、社会インフラが寸断され、甚大な被害が発生した。これを踏まえ、家屋やビル等の修繕や修復、堤防等の防災インフラ、港湾、空港、鉄道、橋梁、道路等の交通インフラ、さらに電気、ガス、上下水道、情報通信等の生活インフラの復旧、再生とその機能性、利便性、安全性の向上等に資する研究開発等の取組を進める。(pp. 9–10)
92	被災地 防災 対策	Disaster Prevention Measures in Affected Areas	二次災害防止のため、地方公共団体と連携しつつ、 <u>被災地</u> における防災、 <u>減災対策</u> に関する取組を強化する (p. 10)
93	微量物質 同定 技術	Trace Substance Identification Technology	国民の健康を守るためには、疾患の早期発見につながる診断手法の開発が重要であることから、早期診断に資する微量物質の同定技術等の新たな検出法と検出機器の開発、新たなマーカーの探索や同定など、精度の高い早期診断技術の開発を推進する。(p. 14)
94	風力 発電	Wind Power Generation	太陽光発電、バイオマス利用、風力発電、小水力発電、地熱発電、潮力・波力発電等の再生可能エネルギー技術の研究開発については、これまでの技術を飛躍的に向上させるとともに、例えば、宇宙太陽光発電、藻類バイオマスなど新たなブレークスルーとなり得る革新的技術の獲得を目指し、戦略的に必要な取組や検討を進める。(p. 11)
95	放射線 治療 機器	Radiotherapy Equipment	<u>放射線治療機器</u> 、ロボット手術機器等の新しい治療機器の開発、内視鏡と治療薬の融合など診断と治療を融合させる薬剤や機器の開発、更に遠隔診断、遠隔治療技術の開発、それを支援する画像情報処理技術の開発を進める。(p. 14)
96	予防法	Prevention Methods	(i)革新的な <u>予防法</u> の開発 (p. 14)
97	臨床データ	Clinical Data	国民の健康状態を長期間追跡し、食などの生活習慣や生活環境の影響を調査するとともに、臨床データ、メタボローム、ゲノム配列の解析等のコホート研究を推進し、生活習慣病等の発症と進行の仕組みを解明することで、客観的根拠（エビデンス）に基づいた予防法の開発を進める。(p. 14)

Note: The underlining of words in the original text indicates keywords extracted by this study for use in searching the KAKEN database.

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