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The 11th S&T Foresight: S&T Foresight 2019

Delphi Survey

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Science and Technology Foresight Center
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Summary

1. Background

National Institute of Science and Technology Policy (NISTEP) has been conducting “Science and Technology Foresight” every five years since 1971. Since the Science and Technology Basic Law was established in 1995, the study has been conducted according to the formulation schedule of the Science, Technology, and Innovation Basic Plans. Since around the year 2000, back casting or seeking for solution to social challenges has become the mainstream attitude toward science and technology policymaking. To meet requirements from policymakers, there was a change in the study framework from technology or seeds driven approach, where they consider the future of society based on science and technology developments, to society or needs driven approach, where they discuss the better society before identifying relevant scientific and technological issues.

“The 11th Science and Technology Foresight: S&T Foresight 2019” (hereinafter referred to as the 11th Foresight) conducted an examination into science and technology development and the desired society in the future, aiming to provide fundamental information that contributes to the discussion of science, technology, and innovation policies including the 6th Science, Technology, and Innovation Basic Plan.

The structure of the 11th Foresight is outlined in Figure 1. In consideration of the increased complexity of the relationship between technology and society, the study is promoted from the dual viewpoints of science and technology, and society. It is configured to examine “future of society” and “future of science and technology” separately before integrated discussion of both futures for “future images of society brought about by the development of science and technology.”

The 11th Foresight was also required to meet an intense need for discussion on cross-cutting themes, transcending the boundaries of the fields of science and technology. In response to the requirement, the study of “future of science and technology” consists of two parts; “Delphi Survey” gives basic information about the medium- to long- term development of each scientific and technological issues, while the interdisciplinary discussion is made for “Close-up Science and Technology Areas for the Future” using results of Delphi Survey.

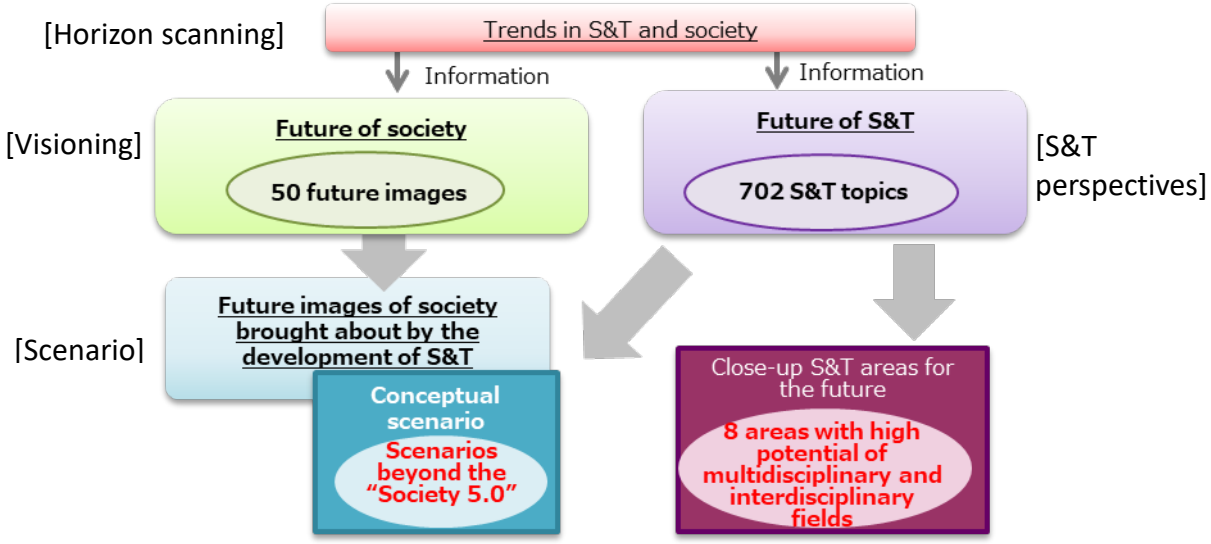

Figure 1. Structure of the 11th S&T Foresight

2. Method

The flow of the study on the future of science and technology is shown in Figure 2. The procedure of Delphi survey is as follows: First, based on the science and technology featured in the previous 10th Foresight in 2015, and the recent trends on science and technology development collected in "horizon scanning," research and development issues that are expected to be realized by 2050 are identified by the subcommittees, which are called "science and technology topics (S&T topics)." Next, repeated questionnaires with the same content are conducted to gather opinions of many experts regarding their importance, international competitiveness, realization prospects (forecasted times of realization), and policy measures for realization. Finally, the subcommittees analyze the results of the questionnaire.

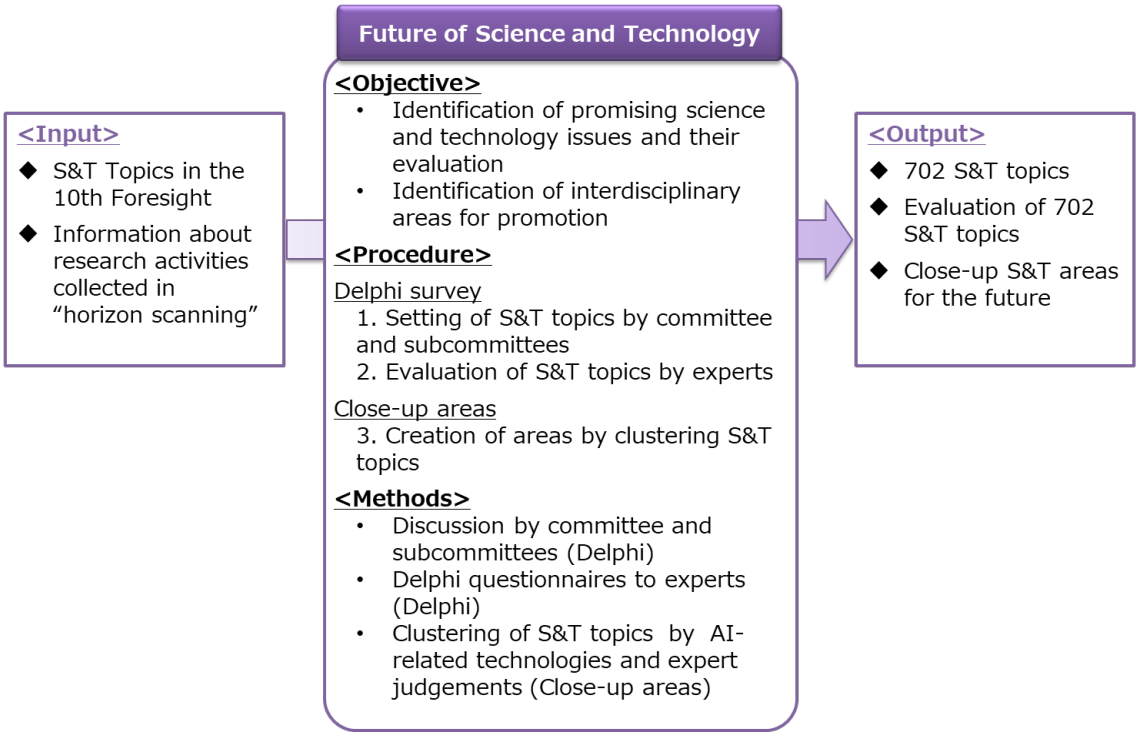

Figure 2. Flow of the study on the future of S&T

◆ Survey fields

Seven fields were set for the survey. A total of 702 S&T topics were established through the examination by the committee and the seven subcommittees by field. Each field had a hierarchical structure of "fields (7 fields) – subfields (59 subfields) – S&T topics (702 topics)." Each field has around 100 S&T topics. Table 1 shows the survey fields and subfields.

Table 1. Survey fields

Field*	Subfield
Health / Medicine / Life sciences [Health]	Pharmaceuticals (including regenerative and cellular medical products and gene therapy products)
	Medical equipment
	Senescence and non- infectious diseases
	Brain science (including mental/neurological diseases, and cognitive/behavioral science)
	Health crisis management (including infectious diseases, emergency medical care, and disaster medical care)
	Information for health and social medicine
	Basic technology for life sciences (including measurement technology, data standardization, etc.)
Agriculture / Forestry / Fisheries / Food / Biotechnology [Agriculture]	Production ecosystem
	Food ecosystem
	Resource ecosystem
	System platform
	Next-generation biotechnology
	Biomass
	Safety, security, and health
	Community
Environment/ Resources/ Energy [Environment]	Energy conversion
	Energy systems
	Resource development and 3Rs (reduce, reuse, recycle)
	Water
	Global warming
	Environment conservation (analysis, prediction, evaluation, restoration, regeneration, plan)
	Risk management
ICT (information and communication technology)/ Analytics/ Service science [ICT]	Future social design
	Data science and AI
	Computer systems
	IoT and robotics
	Network infrastructure
	Security and privacy
	Service science
	Industry, business, and management applications
	Policy and institutional design support
	Social implementation
	Interaction
Materials / Devices / Processes [Materials]	Substances and materials
	Processes and manufacturing
	Computational science and data science
	Advanced measurement and analysis methods
	Applied devices and systems relating to ICT and nanoelectronics
	Applied devices and systems relating to environment and energy
	Applied devices and systems relating to infrastructure and mobility

Field*	Subfield
	Applied devices and systems relating to life sciences and biotechnology
Cities / Architecture / Civil engineering Transportation [Infrastructure]	Land use and preservation
	Architecture
	Social infrastructure facilities
	Cities and environment
	Construction production system
	Transportation systems
	Cars, rail, marine, and aviation
	Technology for disaster prevention and mitigation
	Information for disaster prevention and mitigation
Space / Ocean / Earth / Science foundation [Frontier]	Space
	Ocean
	Earth
	Observation and prediction
	Computational, mathematical, and information sciences
	Elementary particle, nucleus, and accelerators
	Quantum beam: synchrotron radiation
	Quantum beam: neutrons, muons, charged particles, etc.
	Optical and quantum technologies

*Abbreviated names are shown in parentheses.

◆ Questions

Questions to each topic are shown in Table 2.

Table 2. Questions to the topics

Item	Content	Answers
Importance (Single answer)	Present level of the topic's importance for Japan, in order to realize a desirable society 30 years from now	very high; high; neither high nor low; low; very low; I'm not sure
International competitiveness (Single answer)	The level of Japan's current international competitiveness in terms of the topic	very high; high; neither high nor low; low; very low; I'm not sure
Prospect of scientific/techno-logical realization (Single answer)	The period in which the topic will be scientifically/technologically realized somewhere in the world	already realized; by 2025; 2026 to 2030; 2031 to 2035; 2036 to 2040; 2041 to 2045; 2046 to 2050; 2051 or later; It won't be realized; I'm not sure

Item	Content	Answers
Policy measures for scientific/ technological realization (Multiple answers allowed.)	Policy measures called for to scientifically/technologically realize the topic	human resources development (HRD); enlarged R&D funding; improvement of research platform; domestic collaboration/ cooperation; international collaboration/ standardization; improvement of legal regulations; addressing ethical/legal/ social issues (ELSI); other
Prospect of social realization (Single answer)	The period in which the topic will be socially realized in Japan, following its scientific/technological realization somewhere in the world	already realized; by 2025; 2026 to 2030; 2031 to 2035: 2036 to 2040; 2041 to 2045; 2046 to 2050; 2051 or later; It won't be realized; I'm not sure
Policy measures for social realization (Multiple answers allowed)	Policy measures called for to socially realize in Japan	human resources development (HRD); project subsidies; improvement of business environment; domestic collaboration/cooperation; international collaboration/ standardization; improvement of legal regulations, addressing ethical/legal/social issues (ELSI); other

*"Scientific/technological realization" refers to the establishment of a technological environment, such as by attaining the expected technological performance. This includes the prospect of technological development at the lab stage or scientific elucidation of principles/phenomena, for example.

*"Social realization" refers to a situation in which the realized technology can be used as products, services, etc. Depending on the topic, this implies that it will come into wide use. If the topic is not scientific or technological, it refers to the establishment of a system, establishment of an ethical norm, formation of a value, or formation of a social agreement. It includes cases in which the topic is not realized in Japan but is realized through international activities in which Japan plays a central role.

◆ Respondents

The survey respondents consist of three groups. The core group includes about 2000 members of the "Expert network" operated by NISTEP. The next group has members of approximately 90 academic societies recommended by the subcommittees. The widest group is of experts who are registered with "researchmap", a comprehensive list of researchers in Japan operated by Japan Science and Technology Agency (JST), the network of academic societies managed by the Science Council of Japan, and corporate networks owned by the Japan Business Federation (Keidanren) or Council on Competitiveness-Nippon (COCN).

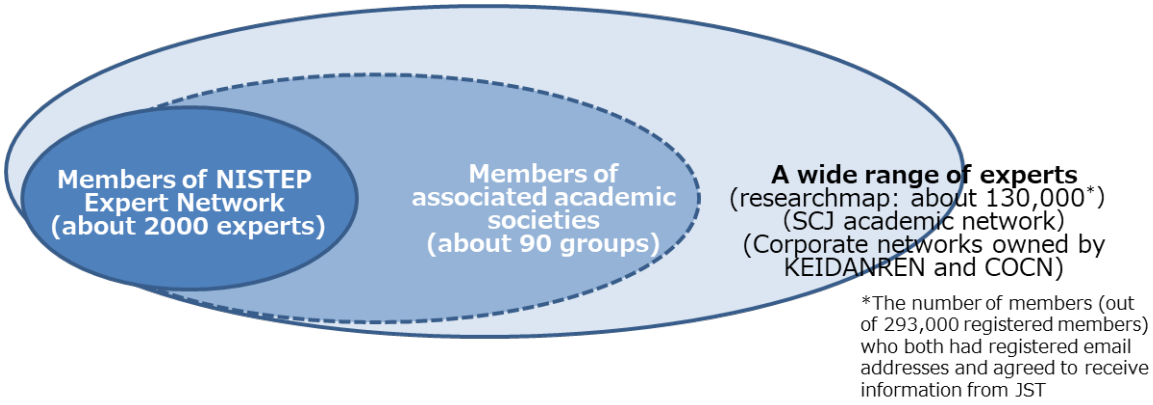

Figure 3. Respondents

◆ Questionnaire survey

In this survey, we asked for voluntary responses in the form of an online survey. Experts who were willing to respond accessed the survey site and selected the S&T topics at their discretion, according to their own specialty. By repeating the same questions twice for the same respondent, the accuracy of the opinions was expected to be improved.

Implementation status is as below. The responses to the second round (R2) questionnaire were analyzed as the final results.

1st Round (R1)	Period: February 20 to March 25, 2019 Respondents: 6697 experts
2nd Round (R2)	Period: May 16 to June 14, 2019 Respondents: 5352 experts

3. Results across the fields

3.1. Overview

◆ Importance

Most S&T topics were considered important for the future of Japan. The field of cities/architecture/civil engineering/transportation has more S&T topics with relatively high importance scores. S&T topics which respond to social issues such as aging and population decline, disaster prevention and mitigation, and security and safety of infrastructure (including information infrastructure) are all highly ranked.

◆ International competitiveness

Not so many S&T topics were considered competitive internationally in general. S&T topics with relatively high international competitiveness scores are often found in the fields of materials/devices/processes, cities/architecture/civil engineering/transportation, and space/ocean/earth/science foundation. Meanwhile, in the ICT/analytics/service science field, there are many S&T topics with relatively low international competitiveness scores. S&T topics related to disaster prevention and mitigation, optical and quantum technologies, and robotics are ranked high, and S&T topics regarding ICT application to society are ranked low.

◆ Prospect of realization (forecasted time of realization)

Most of the S&T topics were predicted to be realized by 2040. The environment/ resources/energy field accounts for half of its S&T topics said to be slow to realize (scientific/technological realization time will be after 2036). S&T topics regarding nuclear power/nuclear fusion, space science and development, resource extraction/ recovery, neuroscience, etc. are predicted to realize slow. Regarding the period from the scientific/technological realization to the social realization, S&T topics that are slow to realize from science and technology standpoint tend to take a long time for their realization in society. The environment/resources/energy field accounts for the majority of S&T topics that are said to take over six years to realize.

◆ Policy measures for realization

Human resources development, enlarged funding, and environmental improvement are the three major policy measures for both scientific/technological realization and social realization. The improvement of legal regulations and the addressing of ethical, legal, social issues (ELSI) are also key measures in some fields. Regarding the improvement of legal regulations, there are many S&T topics with high scores in the fields of ICT/analytics/service science and cities/architecture/ civil engineering/ transportation. As for addressing ELSI, there are many S&T topics with high scores in the fields of health/medicine/life sciences and ICT/analytics/ service science, followed by the agriculture/forestry/fisheries/food/biotechnology field and the cities/ architecture/civil engineering/transportation field.

Typical S&T topics are shown in Table 3 to Table 6.

Table 3. S&T topics with highest level of importance by field

Field	S&T topic (Number represents ID)	Score*	Realization**
Health, medicine, life sciences	39: Methods for prevention and treatment of motor function deterioration associated with aging	1.56	2028/2030
	58: Disease modification therapy effective for prevention and treatment of neurodegenerative diseases such as Alzheimer's disease based on pre-symptomatic biomarkers	1.55	2032/2035
Agriculture, forestry, fisheries, food, biotechnology	115: Agricultural robots to replace humans	1.35	2026/2029
	146: System for real-time high spatial and high temporal resolution meteorological prediction and disaster risk assessment, utilizing satellite and/or meteorological observation data	1.33	2028/2030
Environment, resources, energy	227: Long-life and low-cost secondary batteries that do not require replacement for electric cars	1.48	2029/2032
	261: Integrated water management technology in densely populated areas, including management of urban flooding, storm surge and land subsidence due to linear rain bands and torrential rain	1.36	2028/2029
ICT, analytics, service science	389: Technology such as AI, IoT, and robots that dramatically improves agricultural productivity, and eliminates labor shortages and lack of personnel	1.57	2029/2031
	350: Technology to prevent unauthorized access into control systems such as important infrastructure, vehicle control and personal IoT devices/ services	1.56	2028/2029
Materials, devices, processes	474: High-capacity, high-power battery with an energy density of 1 kWh/kg or more and a power density of 1 kW/kg or more	1.50	2030/2032
	497: Wearable devices that monitor *in vivo* information	1.32	2028/2031
Cities, architecture, civil engineering, transportation	541: Non-destructive inspection technology which may be used in the field to improve the reliability of inspection and diagnosis of infrastructure and to reduce the burden associated with this work	1.53	2025/2026
	546: Technology for creating highly accurate disaster hazard maps to enable detailed city planning	1.51	2027/2028
Space, ocean, earth, science foundation	629: Evaluation of the urgency of identifying the next volcano likely to erupt or unlikely to erupt, from all active volcanoes in Japan	1.51	2031/2033
	644: Technology for predicting localized heavy rain, tornadoes, hail, lightning, snowfall, etc., several hours ahead with spatial resolution of 100 m or less, using high-resolution simulation and data assimilation	1.50	2027/2029

*Importance scores were calculated based on the following point distribution: Very high (+2), High (+1), Neither high nor low (0), Low (-1), and Very low (-2).

** [Year of scientific/technological realization] / [Year of social realization] : Scientific/technological realization refers to the establishment of a technological environment. Social realization refers to a situation in which the realized technology can be used as products, services, etc.

Table 4. S&T topics with highest level of international competitiveness by field

Field	S&T topic (Number represents ID)	Score*	Realization**
Health, medicine, life sciences	63: Evaluation methods for the efficacy and side effects to develop the drugs of infectious diseases by using the cells established form the stem cells such as iPS cells, that can be substituted to animal models.	0.81	2028/2029
	5: Efficacy and safety evaluation technology using artificial organs and organoids derived from pluripotent stem cells that can reproduce the functions in the living body	0.75	2028/2030
Agriculture, forestry, fisheries, food, biotechnology	146: System for real-time high spatial and high temporal resolution meteorological prediction and disaster risk assessment, utilizing satellite and/or meteorological observation data	0.80	2028/2030
	121: Various functional foods based on the concept of foodmics that is conscious of the aging society	0.80	2027/2029
Environment, resources, energy	213: Car engines with 50% energy efficiency	1.09	2029/2031
	227: Long-life and low-cost secondary batteries that do not require replacement for electric cars	0.98	2029/2032
ICT, analytics, service science	344: Optical communication technology capable of accommodating innovatively large capacity and high-density communication, such as multi-core fiber and silicon photonics	0.82	2027/2028
	335: Robot equipment that supports the cognitive and motor function of elderly and mildly disabled people, enabling independent living, and driverless technology for robot equipment and robots that move at low speed over short distances	0.78	2028/2030
Materials, devices, processes	475: Aiming for a hydrogen society, a fuel cell where the amount of precious metal used is one tenth or less of that used in 2018, with consideration of catalyst deterioration	0.94	2032/2033
	412: High efficient power semiconductors for electrical power and motive power further exceeding silicon carbide (SiC) and gallium nitride (GaN)	0.92	2029/2033
Cities, architecture, civil engineering, transportation	587: Response control to long-term, long-duration ground motion of high-rise buildings and seismic base isolation buildings	1.16	2026/2028
	581: Technology that satisfies environmental standards for noise during continuous running at Shinkansen speed of 360 km, by using active noise control	1.10	2027/2029
Space, ocean, earth, science foundation	697: An optical lattice clock network using optical fibers, facilitating time measurement with an accuracy of 18 digits anywhere on Earth, enabling measurement of crustal and groundwater fluctuations and movement of magma chambers	1.11	2030/2033
	659: Elucidation of the origin of asymmetry of matter and antimatter in space	1.07	2033/-

※ Competitiveness scores were calculated based on the following point distribution: Very high (+2), High (+1), Neither high nor low (0), Low (-1), and Very low (-2).

* [Years of scientific/technological realization] / [social realization] : Scientific/technological realization refers to the establishment of a technological environment. Social realization refers to a situation in which the realized technology can be used as products, services, etc.

Table 5. S&T topics for which the establishment of legal regulations is most needed

Field	S&T topic (Number represents ID)	S&T	Society
ICT, analytics, service science	302: Internet-based individual authentication technology to a level that would enable all elections to be implemented on the Internet	81%	90%
ICT, analytics, service science	300: Technology to digitize all economic transactions	77%	81%
ICT, analytics, service science	374:30% or more of the total amount of payments made by ordinary people in daily life will be conducted in virtual currency managed by block chain technology without being controlled by central banks	71%	78%
ICT, analytics, service science	380: A social consensus will be reached on the relationship between machinery (AI, robot) and human beings	68%	71%
ICT, analytics, service science	382: Autonomous decentralization without central institutions in the distribution of intellectual property, through utilization of distributed ledger technology and smart contracts	66%	73%
ICT, analytics, service science	355: Economic infrastructure providing security, efficiency and a sense of security, with the ability to facilitate almost 100% cashless transactions for individuals' social activities and corporate economic activities	65%	77%
Cities, architecture, civil engineering, transportation	570: "Flying cars and drones" able to carry people in urban areas	64%	80%
Health, Medicine, Life Sciences	73: The management system for medical history, medication history, and personal genome information based on insurance cards, etc., incorporating IC chips, which will contribute to achieving precision medicine and improved medical quality.	64%	74%
ICT, analytics, service science	387: A system for automatic creation/modification of laws and ordinances using AI technology etc.	64%	77%
ICT, analytics, service science	396: Various means of transportation, such as automatic travel, drones, etc., to facilitate maintenance of local public transportation networks, and reform the field of logistics, as well as technology to support management and operation of these networks	63%	75%

*Analysis extracted ten topics with the highest rates of selection of "establishment of legal regulations" as policy measures for scientific/technological realization (selections in the "S&T" column). Analysis additionally showed the rate of selection of the same policy measures for social realization (selections in the "society" column).

Table 6. S&T topics most necessitating ELSI considerations

Field	S&T topic (Number represents ID)	S&T	Society
Health, medicine, life sciences	84: Solutions to Ethical, Legal and Social Implications (ELSI) regarding utilization of genome information from the neonatal period	70%	73%
ICT, analytics, service science	380: A social consensus will be reached on the relationship between machinery (AI, robot) and human beings	62%	69%
Health, medicine, life sciences	13: Human organ for transplantation produced from human-animal chimeric embryo consisting of animal embryo and human stem cell-derived cells	61%	69%
Health, medicine, life sciences	73: The management system for medical history, medication history, and personal genome information based on insurance cards, etc., incorporating IC chips, which will contribute to achieving precision medicine and improved medical quality.	60%	67%
Health, medicine, life sciences	16: Highly safe intrauterine gene therapy for congenital genetic diseases	58%	71%
ICT, analytics, service science	388: Health maintenance system based on data linkage of information such as health, medical care, nursing care, etc., from birth to the present, using block chain technology (achieving a pre-symptomatic society)	56%	67%
Health, medicine, life sciences	74: Health and medical database that continuously collects genome information, medical records and biological and behavior information obtained through wearable sensors and smart devices, toward promotion of large-scale cohort studies.	56%	64%
Health, medicine, life sciences	15: Gene therapy methods that widely realize gene repair therapy and single genetic disease treatment with next-generation genome editing technology	55%	72%
Agriculture, forestry, fisheries, food, biotechnology	160: Medical model pigs capable of xenotransplantation using gene modification techniques	54%	69%
ICT, analytics, service science	376: With the spread of AI and the ability to automate the majority of work, it will become a society where about 30% of the working generation will not work	50%	52%
ICT, analytics, service science	381: A system that makes it possible to estimate the social and economic impact of legal regulation, provides appropriate advice and risk presentation, including ascertaining situations where individuals and groups are located in real-time (including policy advice systems, advanced medical care advice systems, etc.)	50%	50%

*Analysis extracted eleven topics with the highest rates of selection of "solutions for ethical, legal, and social issues" as policy measures for scientific/technological realization (selection in the "S&T" column). Analysis additionally showed the rate of selection of the same policy measures for social realization (selection in the "society" column).

3.2 Summary of each field

< Health/medicine/life sciences field >

- Importance:
  High for S&T topics related to aging, neuroscience, and medical devices.
- Competitiveness:
  High for S&T topics related to regenerative/cell medicine, gene therapy, and treatment based on the immune system.
- Prospect of realization:
  Slow for S&T topics related to neuroscience, especially the elucidation of the neuronal basis of higher cognitive functions in humans.
- Policy measures:
  High requirement for addressing ELSI in the subfield of information for health and social medicine.

< Agriculture/forestry/fisheries/food/biotechnology field >

- Importance:
  High for S&T topics related to agricultural robots that replace humans, followed by the system construction such as resource prediction and management technology, and the fusion of food and information technology.
- Competitiveness:
  High for S&T topics related to weather forecasts, disaster risk assessments, and functional foods based on “foodmics.”
- Prospect of realization:
  Slow for the scientific/technological realization of the resource-ecosystem-related technologies. Social realization of next-generation biotechnology is also slow.
- Policy measures:
  High requirement for the improvement of legal regulations in the subfield of safety, security and health.

< Environment/resources/energy field >

- Importance:
  High for S&T related to secondary batteries, natural disasters, radiation removal, global warming, and risk management.
- Competitiveness:
  High for S&T topics related to automobiles, natural disasters, water treatment, and waste collection /effective utilization.
- Prospect of realization:
  Quick for the scientific/technological realization of S&T topics related to energy systems, water, and risk management.
  Realization of S&T topics related to energy conversion and resource development is slow. Water-related S&T topics are socially realized quickly, and energy-conversion- related S&T topics are slow.
- Policy measures:

High requirement for human resources development in S&T topics related to risk management. Resource development and risk management will need domestic collaboration. S&T topics related to global warming and water will be promoted by international collaboration and standardization.

< ICT/analytics/service science field >

- Importance:
  High for S&T topics in the subfields of “social implementation”, “security and privacy”, “IoT and robotics”, and “network infrastructure”.
- Competitiveness:
  High for S&T topics in the subfields of “network infrastructure”, “IoT and robotics”, “computer systems”, and “interaction”.
- Prospect of realization:
  Slow for the scientific/technological realization of S&T topics in the subfields of “policy and institutional design support”. Slow again for the social realization of S&T topics in the subfields of “computer systems”, “industry, business, and management applications”, “policy and institutional design support”, “social implementation”, and “interaction”.
- Policy measures:
  High requirement for human resource development for S&T topics in the subfield of “data science and AI”. High requirement for S&T topics in the subfield of “policy and institutional design support” to address ELSI.

< Materials/devices/processes field >

- Importance:
  High for S&T topics related to secondary batteries, solar cells, fuel cells, wearable devices, biomaterials, and structure diagnosis.
- Competitiveness:
  High for S&T topics related to fuel cells, power semiconductors, and secondary batteries.
- Prospect of realization:
  Slow for the scientific/technological realization of S&T topics in the subfields of “applied devices and systems relating to ICT and nanoelectronics” and “applied devices and systems relating to environment and energy”. Fast for social realization of S&T topics in the subfield of “process manufacturing”; slow for social realization of S&T topics in the subfield of “applied device systems relating to ICT and nanoelectronics”.
- Policy measures:
  High requirement to develop human resources for S&T topics in the subfield of “computational science and data science”. High requirement for R&D funding/project subsidies, research platform improvement/business environment improvement for S&T topics in the subfield of “applied devices and systems relating to environment and energy”. High requirement to improve legal regulations and to address ELSI for S&T topics in the field of “applied devices and systems relating to life science and biotechnology”.

< Cities/architecture/civil engineering/transportation field >

- Importance:
  High for S&T topics in the subfields of “social infrastructure facilities,” “cities and environment,” “information for disaster prevention and mitigation,” followed by “transportation systems”.
- Competitiveness:
  High for S&T topics in the subfields of “information for disaster prevention and mitigation” and “cars, rail, marine and aviation”.
- Prospect of realization:
  S&T topics related to disaster, information on danger, and mobility are the fastest to be realized in the subfields of “information for disaster prevention and mitigation”, “transportation systems”, and “land use and preservation”.
- Policy measures:
  High requirement for international cooperation and standardization for S&T topics in the subfields of “transportation systems” and “cars, rail, marine, and aviation.” High requirement for domestic cooperation and collaboration on S&T topics related to infrastructure maintenance.

< Space/ocean/earth/science foundation field >

- Importance:
  High for S&T topics related to measurement and analysis using quantum beams, disaster prediction, and positioning for automation.
- Competitiveness:
  High in importance and international competitiveness for S&T topics related to phenomenon elucidation, prediction of local heavy rainfall, and material structure analysis using multiple beams.
- Prospect of realization:
  The realization of S&T topics related to quantum beam is fast, and the realization for S&T topics related to the space, elementary particles, nuclei, and accelerators is slow.
- Policy measures:
  Space-related and the ocean-related S&T topics generally have a high requirement for policy support. Overall, in addition to human resources, R&D funding, and research platform, there is a high requirement for international collaboration and standardization.

3.3 Analysis of S&T topics with high importance scores

Table 7 shows the classification of the S&T topics into the top, middle, and bottom thirds according to their importance and international competitiveness scores. There are 135 S&T topics within the top third of both importance and international competitiveness, and 117 topics within the bottom third of both. S&T topics with relatively high importance scores tend to have relatively high international competitiveness scores.

Table 7. Classification of S&T topics according to their importance and international competitiveness scores

	Top third in competitiveness	Middle third in competitiveness	Bottom third in competitiveness
Top third in importance	135	61	38
Middle third in importance	62	93	79
Bottom third in importance	37	80	117

Subfields that include many S&T topics which rank high regarding both importance and international competitiveness are:

- Resource development and 3Rs (reduce, reuse, recycle)
- IoT and robotics
- Applied devices and systems relating to infrastructure and mobility
- Applied devices and systems relating to life sciences and biotechnology
- Social infrastructure facilities
- Technology for disaster prevention and mitigation
- Information for disaster prevention and mitigation
- Ocean
- Earth
- Quantum beam: synchrotron radiation
- Optical and quantum technologies

Conversely, looking at S&T topics that are of high importance but low in international competitiveness, topics in the subfields of “security and privacy”, “social implementation,” and “data science and AI” are listed in the ICT/analytics/service science field. In the health/medicine/life sciences field, topics in the subfields of “information for health and social medicine” are listed. Table 8 shows examples of topics with high importance and low competitiveness.

Table 8. Examples of S&T topics that are in the top third of importance and the bottom third in international competitiveness

Field	S&T topic (Number represents ID)	I score*	C score*
ICT	350: Technology to prevent illegal intrusion into critical infrastructure, automobiles, personal IoT devices and services	1.56	0.24
Infrastructure	561: Seamless transportation system extending from local transport to wide area transport, that enables elderly people to move door to door independently and with confidence, in a super aged society	1.42	0.19
ICT	349: Individual authentication system that can be used safely and securely, while protecting privacy, facilitating ease-of-use and at low-cost, even when accessing many sites on the internet over a long timeframe, from different environments, such as while driving, in addition to access from PCs and personal IoT equipment	1.35	0.23
ICT	348: Technology to prevent internal crimes by people allowed access to information systems and control systems (including behavioral science techniques, which can reduce the incidence of internal crime to a negligible amount)	1.29	0.05
ICT	305: Natural language processing to extract desired information from atypical sentences/conversations	1.28	0.03
ICT	392: Transition to a highly productive society with highly free employment configurations, premised on not requiring to go into the office, and having multiple jobs	1.27	-0.48
ICT	396: Various means of transportation, such as automatic travel, drones, etc., to facilitate maintenance of local public transportation networks, and reform the field of logistics, as well as technology to support management and operation of these networks	1.25	0.21

*I score (Importance score) and C score (international competitiveness score) are calculated as very high (+2), high (+1), neither (0), low (-1), very low (-2).

S&T topics with relatively low importance scores tend to be predicted to realize late in general. But there are some S&T topics in the fields of materials/devices/processes, health/ medicine/life sciences, that are regarded as relatively important but are late in their realization. Table 9 shows example topics, which are topics related to disasters, neuroscience, and applied devices and systems.

Table 9. Examples of S&T topics in top third in importance, with forecasted scientific/ technological realization after 2031, and social realization after 2036.

Field	S&T topic (Number represents ID)	Iscore[*1]	Realization time[*2]	Policy measures[*3]
Materials	473: Solar cell with conversion efficiency exceeding 50%	1.31	2033/ 2036	funding/ subsidies
Health	53: Clarification of the brain functions on memory, learning, cognition, emotion & etc. Understanding of the neural mechanisms of the higher mental functions such as consciousness, sociability, and creativity	1.27	2037/ 2041	HRD, funding / HRD
Health	55: New therapeutic method with an immediate effect and no recurrence based on cellular level classification of brain pathology of depression and bipolar disorder.	1.18	2036/ 2039	HRD, funding / -
Frontier	622: Environmentally friendly and economically viable technology for harvesting ocean floor mineral resources	1.18	2032/ 2036	-/-
Frontier	632: Technology to predict the location, scale, timing (within 30 years), and damage of inland earthquakes with magnitude 7 or higher	1.17	2037/ 2036	-/-
Environment	275: Improvement of the estimation accuracy of climate sensitivity (the mean increase in global surface temperature after sufficient time has elapsed after doubling of the concentration of CO_2 in the Earth's atmosphere) from 3°C to 1°C	1.13	2034/ 2036	HRD, research platform/-
Materials	498: Embedded healthcare device (examination, diagnosis, treatment) that continues operating semi-permanently with bioenergy	1.11	2032/ 2037	funding/-
Health	52: Clarification of the mechanisms of the neuron-glial network on its development, maintenance and aging. Understanding of the mechanisms of information processing in the neuron-glial network	1.09	2035/ 2039	HRD, funding, research platform / HRD
Materials	479: Photoreduction catalyst or artificial photosynthesis with an energy efficiency of 20% or more in CO_2 recycling (synthesis of fuel or chemical raw materials)	1.07	2036/ 2039	-/-
Health	57: Treatments and intervention for autism spectrum based on brain pathology, that enable disciplined social life	1.06	2034/ 2037	HRD/HRD
Materials	468: High-efficient quantum-communication device technology to realize quantum internet between quantum computers	1.00	2034/ 2038	HRD/-

*1 Importance scores are calculated as very high (+2), high (+1), neither (0), low (-1), very low (-2).
*2 Forecasted time of scientific/technological realization / forecasted time of social realization.
*3 Major policy measures for scientific/technological realization / social realization.

3.4 ICT-related technologies

Subfields related to ICT (information and communication technology) and data science have been seen in various fields besides ICT/analytics/service sciences field, such as :

- "Information for health and social medicine" (health/medical/life sciences field)
- "Computational science and data science" (materials/devices/processes field)
- "Information for disaster prevention and mitigation" (cities/architecture/civil engineering /transportation field)
- “Computational, mathematical, and information science" (space/ocean/earth/ science foundation field).

Comparing those subfields with other subfields in the same field, importance is generally recognized above a certain level, but international competitiveness is relatively low. As for policy measures for realization, it is necessary to improve legal regulations, comply with ELSI, and develop human resources.

3.5. Analysis according to attributes

We analyzed the differences in the forecasted time of realization by age and affiliation among the respondents' attributes of age and affiliation.

Comparing by affiliation, S&T topics related to quantum beams were expected to realize relatively late by experts from companies compared to those from universities and public research institutes. S&T topics in the subfield "network infrastructure," were expected to realize relatively late by experts from public institutions, and this trend is also true for the social realization.

Comparing by age group, the largest difference between the average of those in their 30s and 40s and the average of those in their 50s and 60s was seven years in the subfield of "elementary particles, nuclei, and accelerators," a difference of more than five years. In addition, there was a difference of more than five years in the subfield of "earth" in space/ocean/earth/science foundation field, and in the subfield of "system platform" in agriculture/forestry/fisheries/food/biotechnology field. There was no significant difference in the forecasted time of scientific/technological realization for these subfields, but only in the forecasted time of social realization. In general, the forecasted time of social realization was estimated to be later in the younger age groups for these items.

4 . Results of each field

4.1. Health, Medicine, and Life Sciences

(1) Subfields

Referring to the Health and Medical Care Strategy, the following research areas were newly focused from the perspective of social and research needs in Japan:

- Aging research: Considering the needs of a super-aging society.
- Disaster/emergency medical care: Response to natural disasters and mass gatherings such as the 2020 Tokyo Olympics and Paralympics will be taken into consideration.
- Environmental epidemiology: Considering responses to global issues, such as the World Health Organization (WHO) reporting on health problems caused by air pollution.
- Social medicine: Focusing on health inequalities as a cross-cutting and interdisciplinary area between medicine and social science.
- From the perspective of drug modalities, regenerative/cell therapy products and gene therapy products are classified as drug subcategories.

(2) Results

- ✧ The most important topics were those related to aging, neuroscience, and medical devices. Of these, topics related to "aging" occupied the top two positions (decline in motor function, Alzheimer's disease, etc.), indicating that science and technology are directly related to solving issues in a super-aging society.
- ✧ In addition, non-invasive diagnostic devices, early diagnosis of diseases using blood, and science and technology for medical treatment aimed at reducing the burden on patients and improving their quality of life were considered to be of high importance.
- ✧ The topics with high international competitiveness are those related to regenerative and cellular medicine using stem cells such as iPS cells, gene therapy and immune system-based therapy.
- ✧ The topics related to neuroscience were considered to have the relatively slowest prospects for scientific/technological and social realization, especially the elucidation of the neural basis of higher-order human mental functions (social realization is expected in 2041). Considering the fact that neuroscience has the highest response rate for human resources development as a policy tool for scientific/technological realization, it is thought that long-term efforts are needed for research and development in this area.
- ✧ The highest response rate for addressing ELSI as a policy tool for scientific/ technological and social realization was found in the subfield of "information for health and social medicine.” It is thought that efforts to link the progress of medical technology to its introduction into the field while appropriately handling various information related to individuals, such as genome, medical care, and daily life, will become more important in the future.

4.2. Agriculture, forestry, fisheries, food, and biotechnology

(1) Subfields

The subfields were set according to the basic policy below:

- Since science and technology alone cannot advance in this field, it is necessary to consider the entire system and the elemental technologies and sciences that support it as an ecosystem.
- To promote this field, it is necessary to consider the compatibility between production and environmental conservation, and to promote environment-friendly agriculture, forestry, fisheries, and food industry to improve production.

(2) Results

✧ The topic with the highest level of importance is "agricultural robots that can replace humans." The next most important topics are science and technology related to the development of system platform, such as "weather forecasting and disaster risk assessment systems using satellite and meteorological observation data" and "technology for forecasting and managing resource fluctuations based on the assessment of the impact of global warming on agriculture, forestry, and fisheries resources.

✧ In addition, the important topics are science and technology related to the integration of food and information technology, such as "monitoring and analysis technology for the food value chain to reduce food loss" and "AI application technology for health using big data for food and health care."

✧ The topics with relatively high international competitiveness are "weather forecasting and disaster risk assessment systems using satellite and meteorological observation data" and "various functional foods based on the concept of foodmics for an aging society."

✧ In the case of the subfield "resource ecosystem," the outlook for scientific/technological realization is relatively slow, and the response rate of R&D funding as a policy measure for realization is high.

✧ In the case of the subfield "next-generation biotechnology," the outlook for social realization is relatively slow, and the response rate for human resource development is high as a policy measure for realization.

✧ The highest response rate for improvement of legal regulations as policy measures for scientific/technological and social realization was seen for the subfield of "safety, security, and health."

4.3. Environment, resources, and energy

(1) Subfields

Seven subfields were set based on those in the previous survey (10th Delphi survey), considering recent trends and needs. Two subfields of "energy production" and "energy consumption" were integrated into the subfields "energy conversion." In addition, "environmental analysis, forecasting and assessment," "environmental

restoration and rehabilitation," and "environmental planning" were unified as "environment conservation." The subfield of "resource development and 3Rs (reduce, reuse, recycle)" includes circular economy as it has been taken up worldwide.

(2) Results

- ✧ Overall, the level of importance was proportional to international competitiveness.
- ✧ The top priority was given to risk management including secondary batteries, natural disasters, radiation removal, and global warming.
- ✧ Regarding international competitiveness, the top issues were related to automobiles, natural disasters, water treatment and monitoring, and waste recovery and effective utilization.
- ✧ S&T topics in the subfields of "Energy systems", "water", and "risk management" were cited as having the earliest prospects for scientific/technological realization. Conversely, "energy conversion" and "resource development and 3Rs" were cited as the slow ones.
- ✧ In addition, the subfield of "water" was cited as having the earliest prospects for social realization, while the subfield of "energy conversion" was cited as having the slowest.
- ✧ S&T topic with the longest period from scientific/technological realization to social realization is related to "energy conversion", which is expected to take about nine years.
- ✧ As a general trend, most of the S&T topics are predicted to be technologically realized by 2030, and their widespread use in society will be realized within five years. This is shorter than the result in the previous survey.
- ✧ Regarding the policy measures for scientific/technological and social realization, similar trends were seen, with the expansion of funds/subsidies and the improvement of environment being particularly sought after. A similar trend was Each subfield has similar trends, while differences among subfields were seen in international collaboration and legal regulations.
- ✧ The subfields that require human resource development are "risk management" and "resource development and 3Rs." The subfield of "risk management" needs domestic collaboration and the subfields of "global warming" and "water" require international collaboration and standardization for their realization.

4.4. ICT, analytics, and service science

(1) Subfields

This is a composite field of "ICT and analytics" and "service-oriented society" in the previous 10th Foresight and includes subfields such as social implementation.

(2) Results

- ✧ Regarding importance, the scores for the subfields of "social implementation," "security and privacy," "IoT and robotics," and "network infrastructure" were

relatively high.

- ✧ Regarding international competitiveness, the scores were relatively high in the subfields of "network infrastructure," "IoT and robotics," "computer systems," and "interaction.
- ✧ There is no strong correlation between the level of importance and international competitiveness.
- ✧ The top-ranked S&T topics regarding importance belong to the subfields of "security and privacy," "IoT and robotics," "network infrastructure," "data science and AI," and "social implementation," many of which are related to individual activities and behaviors.
- ✧ The top-ranked topics regarding international competitiveness were those close to the base technology, such as "network infrastructure," "IoT and robotics," "computer systems," and "interaction." Robot-related topics tend to be particularly competitive.
- ✧ The subfield with the highest percentage of responses to "human resources development" as policy measures for realization is "data science and AI" for both scientific/technological and social realization.
- ✧ The subfields with the highest response rate for "addressing ELSI" as policy measures for realization is "policy and institutional design support" for both scientific/technological and social realization.

4.5. Materials, devices, and processes

(1) Subfields

The subfields were set according to the basic policy below:

- The subfields are systematized according to the technical natures of core (materials and processes), tools (computation, data, measurement, analysis), and applications (devices, systems).
- A new subfield is set relating to life science and biotechnology in the application category.
- The field focused on scientific/technological issues that have recently attracted attention such as digital fabrication, informatics, and quantum technology, while considering comprehensive coverage of science and technology in each subfield.

(2) Results

- ✧ The following issues were selected as being of particularly high importance: secondary batteries, solar cells, and fuel cells in the subfield of “applied devices and systems relating to environment and energy”; wearable devices and biomaterials in the subfield of “applied devices and systems relating to life sciences and biotechnology; and structural diagnostics in the subfield of “applied devices and systems relating to infrastructure and mobility.
- ✧ S&T topics related to fuel cells, power semiconductors, and secondary batteries have particularly high international competitiveness and are of high importance. S&T topics related to structural materials, such as carbon-based materials and

anti-corrosion technology, and biomaterials, such as biomaterials and biocompatible materials, are particularly competitive.

- ✧ By subfield, “applied devices and systems relating to environment and energy” and “applied devices and systems relating to infrastructure and mobility” are high in both importance and international competitiveness, while “computational science and data science” and “applied devices and systems relating to ICT and nanoelectronics” are relatively high in importance but low in international competitiveness. “Computational science and data science” and “applied devices and systems relating to ICT and nanoelectronics” are relatively high in importance but low in international competitiveness.
- ✧ The most common period of scientific/technological realization is from 2026 to 2030, and by subfield, “applied devices and systems relating to ICT and nanoelectronics” and “applied devices and systems relating to environment and energy” will be realized later, from 2030 to 2035. All the S&T topics will be socially realized by 2039.
- ✧ Regarding policy measures for realization, the response rate (the percentage of respondents who selected each item) exceeded 50% in most of the subfields for both scientific/technological and social realization: human resources development, R&D funding and subsidies, and improvement of research platform and business environment.
- ✧ The response rate for the human resources development was highest for “computational science and data science”, while the response rates for the improvement of R&D funding and project subsidies, and the improvement of research platform and business environment were highest for “applied devices and systems relating to environment and energy.”
- ✧ The response rate for the improvement of legal regulations and addressing ELSI was highest for “applied devices and systems relating to life sciences and biotechnology.”

4.6. Cities, architecture, civil engineering, and transportation

(1) Subfields

A total of 9 subfields including 95 S&T topics were established, corresponding to administrative policy areas.

(2) Results

- ✧ The importance and international competitiveness of the S&T topics were moderately distributed. The dispersion of the subfield "architecture" was particularly pronounced.
- ✧ Times of scientific/technological realization and those of social realization have a similar distribution. The range for scientific/technological realization is slightly ahead of that for social realization for each subfield.
- ✧ The subfields with the most internationally competitive S&T topics are

"information for disaster prevention and mitigation" and "cars, rail, marine, and aviation." The topics with the fastest realization are related to disaster and danger information and mobility in the subfields of "information for disaster prevention and mitigation", "transportation systems", and "land use and conservation."

- ✧ The S&T topics with low importance are those that are bold and challenging, such as construction in/on ocean, outer space, moon, and Mars. The maximum period from scientific/technological realization to social realization is nine years, which is the longest among all the topics.
- ✧ Regarding policy measures, international collaboration and standardization, improvement of research platform, and the improvement of business environment are necessary, especially for transportation such as automated driving. In addition, there is a strong need to address ELSI and the improvement of legal regulations.
- ✧ Amid a declining birthrate and aging population, it is recognized that domestic collaboration and cooperation among stakeholders is essential for research and development related to infrastructure maintenance.
- ✧ The results show that the promotion of research and development in collaboration with the humanities and social sciences is expected, as new governance and rule formation are required in society for policy responses to scientific/technological and social realization.

4.7. Space, Ocean, Earth, and Science foundation

(1) Subfields

It is composed of vertical and horizontal axes; a vertical axis deals with huge targets such as space, ocean, and earth and a horizontal axis deals with functions (measurement, analysis, and simulation).

(2) Results

- ✧ The most important S&T topics were technologies for measurement and analysis using quantum beams, technologies leading to disaster prediction, and positioning technologies for automation. The top 10 S&T topics include half which are fundamental and half that address social issues.
- ✧ Many of the S&T topics with high international competitiveness are related to the elucidation regarding the beginning of the universe. Prediction of localized heavy rainfall and material structure analysis using multiple beams are of high importance and international competitiveness.
- ✧ The S&T topics with the earliest prospects for scientific/technological and social realization are found in the subfields of "quantum beams: synchrotron radiation" and "quantum beams: neutrons, muons, charged particles, etc.". Conversely, the S&T topics in the subfields of "space" and "elementary particles, atomic nuclei, and accelerators" are slow to be realized. In addition, a relatively large number of people think that S&T topics related to predicting the occurrence of disasters, such as earthquakes and eruption, will not be realized. S&T topics with a long period of

time between scientific/technological realization and social realization is related to quantum technology.

- ✧ In addition to human resources development, funds/subsidies, and environmental improvements, there is a high need for international collaboration, especially in the subfields of "space" and "elementary particle, nucleus, and accelerators" for scientific/technological realization, and "space", "ocean", and "observation and prediction" for social realization.

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Summary:

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Scenario:

Society in 2040 through the Development of S&T -Conceptual Scenario-, Research Material No. 291, June 2020, NISTEP
DOI: https://doi.org/10.15108/rm291

[APPENDIX] Questionnaire results

*I score: Importance score; C score: International competitiveness score
Scores are calculated as very high (+2), high (+1), neither (0), low (-1), very low (-2).
*Realization time: forecasted time of scientific or technological realization / forecasted time of social realization

<Health, medicine, and life sciences>

Pharmaceuticals (including regenerative and cellular medical products and gene therapy products)

ID	Topic	I score	C score	Realization time
1	Pharmacotherapy based on systematic understanding of pathological condition (gene network) of chronic diseases	1.10	0.04	2028/2032
2	Novel technology for peptide/antibody drugs that act on intracellular targets	1.03	0.42	2027/2029
3	Drugs of novel type of functional molecules following on small molecules, peptides, antibodies and nucleic acids	0.94	0.22	2029/2032
4	Technology for designing compounds that inhibit protein-protein interaction (PPI) based on protein conformational analysis	0.85	0.34	2029/2031
5	Efficacy and safety evaluation technology using artificial organs and organoids derived from pluripotent stem cells that can reproduce the functions in the living body	1.10	0.75	2028/2030
6	Nucleic acid drugs that realize delivery to target tissues/organs and intracellular delivery	0.95	0.32	2028/2030
7	Nanocarrier system that delivers drugs and genes (other than nucleic acids) to specific sites inside target cells	0.88	0.36	2030/2033
8	Large-scale culture technique of hematopoietic stem cells to solve donor shortage of hematopoietic stem cell transplantation	0.96	0.43	2027/2030
9	Treatment of neural circuit dysfunction of central nervous system (Parkinson's disease, amyotrophic lateral sclerosis (ALS), spinal cord injury, etc.) with cell transplantation or gene therapy	1.18	0.64	2029/2032
10	Regenerative medicine technology to control the functions of intrinsic stem cells or transplanted stem cells	1.12	0.71	2030/2033
11	Allogeneic regenerative medicine technology/products that can completely avoid immune rejection	0.92	0.48	2031/2034
12	Medical technology to regenerate auditory or visual function with cell therapy, gene therapy, etc.	1.01	0.53	2031/2034
13	Human organ for transplantation produced from human-animal chimeric embryo consisting of animal embryo and human stem cell-derived cells	0.49	0.28	2031/2035
14	Drugs that cure diabetes based on technology to regenerate and increase pancreatic β-cells	1.10	0.38	2030/2033
15	Gene therapy methods that widely realize gene repair therapy and single genetic disease treatment with next-generation genome editing technology	0.99	0.20	2029/2033
16	Highly safe intrauterine gene therapy for congenital genetic diseases	0.38	-0.06	2032/2037
17	Technology that enables drug delivery to eyes, brain, etc. (tissues that are difficult to reach)	0.91	0.17	2029/2033
18	Immunotherapy by controlling cellular immunity using genetically modified T cells that target solid cancers	1.04	0.48	2028/2030
19	Next-generation vaccine technology that enables oral administration such as edible vaccine	0.74	0.22	2029/2032
20	Artificial intelligence (AI)/simulation technology for compound generation/optimization (including prediction of efficacy, safety, and pharmacokinetics) that doubles the success rate of drug development compared to the present	0.96	0.02	2028/2031

Medical equipment

ID	Topic	I score	C score	Realization time
21	Compactification and Artificial intelligence (AI)-introduction of non-invasive diagnostic equipment (imaging, etc.) that enables rapid identification and early detection of lesions	1.46	0.44	2026/2028
22	Integrated medical software that enables simulation of diseases such as cerebral aneurysms in the body, prediction of therapeutic effects of implanted devices, and preoperative simulation at the notebook PC level	0.70	0.21	2027/2029
23	Simple wearable dialysis machine that enables reductions of the burden on patients and medical expenses	1.07	0.27	2028/2030
24	Treatment method that physically isolates and kills cancer cells by using material (polymer, etc.) that encloses or specifically absorbs cancer cells	0.70	0.29	2031/2034
25	Prosthetic limb with a function to feedback all skin sensations to the brain	0.61	0.28	2032/2036
26	Neurorehabitation equipment that directly reflects brain activity to support activities of daily living of people with severe motor dysfunction such as patients with amyotrophic lateral sclerosis(ALS)	0.69	0.20	2032/2036
27	Ultradispersed hospital system (regional network of home, clinic, and hub hospital) that enables treatment and care of dementia etc. remotely	1.36	0.37	2028/2030
28	Excretion assistive equipment that does not require help from others to be used for terminal cancer patients with intestinal fistula and at nursing care site	1.02	0.29	2028/2030
29	Simple and inexpensive functional assistive technology for musculoskeletal systems weakened by disease or aging	1.16	0.57	2026/2029
30	Standardized procedures using next generation surgical robots and Artificial intelligence (AI), independent of the skill of a surgeon	1.01	0.30	2029/2032
31	Miniaturization and wireless implementation of monitoring equipment using next-generation semiconductors, enabling elimination of all cables in the operating room and bedside	0.59	0.37	2027/2029
32	Advanced biocompatible materials that enable high function implant devices and drug delivery system (DDS) technology based on refinement of biological-artificial interface control using nanotechnology	0.83	0.53	2029/2032

Senescence and non-infectious diseases

ID	Topic	I score	C score	Realization time
33	Early diagnosis and pathology monitoring of cancer and dementia by using blood	1.46	0.61	2027/2029
34	Immune system-based therapies for cancer, autoimmune diseases, and allergic diseases, and prediction of their effects	1.24	0.71	2029/2030
35	Method to break vicious circle by discovering interactions of autonomic nervous system, psychological stress, depression and lifestyle-related diseases	1.16	0.10	2030/2034
36	Drugs for prevention and treatment of lifestyle diseases caused by environmental factors from the prenatal stage to infancy	0.74	0.13	2032/2036
37	Treatment based on etiology and pathophysiological classification by integrated omics analysis for non-infectious diseases	0.74	0.23	2030/2033
38	Quantitative diagnosis of angiopathy by noninvasive portable vascular imaging technology	0.48	0.25	2028/2031
39	Methods for prevention and treatment of motor function deterioration associated with aging	1.56	0.55	2028/2030
40	Methods for quantitative diagnosis and novel treatment of pain and fatigue	0.75	0.20	2029/2031
41	Maintenance of homeostasis by metagenome analysis and control	0.58	0.24	2030/2034
42	Elucidation of mechanisms of disease suppression and aging through analysis of genes of healthy elderly people and their environmental factors	0.98	0.37	2032/2035

ID	Topic	I score	C score	Realization time
43	Avoidance of infertility by preventing germ cell deterioration	0.89	0.26	2032/2035
44	Novel diagnostic method for non-infectious diseases targeting organelles in combination with live imaging and biochemical analysis	0.39	0.30	2031/2034
45	Elucidation of the etiology of diseases with gender differences in the frequency of onset	0.22	-0.02	2032/2035
46	Multidisciplinary prevention method by elucidation of the mechanism of fracture risk of degenerative osteoporosis	0.93	0.16	2030/2032
47	Methods for prevention and treatment of lifestyle diseases and neurodegenerative diseases targeting inter-organ metabolic communication	1.14	0.37	2031/2035
48	Treatment methods of lifestyle diseases based on technology that noninvasively quantifies the energy balance of living organisms	0.52	0.09	2030/2033
49	Dose optimization of drug administration with pharmacogenetic testing.	0.82	0.16	2029/2030
50	Novel treatment for non-communicable diseases (NCD) based on scientific evidence of the utility of exercise.	0.50	0.05	2029/2032
51	Evaluation methods of medical economics for planning healthcare policies on genomic medical treatment.	0.74	0.04	2027/2030

Brain science (including mental/neurological diseases, and cognitive/behavioral science)

ID	Topic	I score	C score	Realization time
52	Clarification of the mechanisms of the neuron-glial network on its development, maintenance and aging. Understanding of the mechanisms of information processing in the neuron-glial network.	1.09	0.41	2035/2039
53	Clarification of the brain functions on memory, learning, cognition, emotion & etc. Understanding of the neural mechanisms of the higher mental functions such as consciousness, sociability, and creativity.	1.27	0.30	2037/2041
54	New medicine for schizophrenia based on the clarified pathology of brain, which enable patients return to society.	0.93	0.15	2035/2039
55	New therapeutic method with an immediate effect and no recurrence based on cellular level classification of brain pathology of depression and bipolar disorder.	1.18	0.18	2036/2039
56	Prophylaxis and prevention of recurrence based on elucidation of brain pathology on the dependency of drug, alcohol, etc.	0.77	-0.05	2034/2037
57	Treatments and intervention for autism spectrum based on brain pathology, that enable disciplined social life.	1.06	0.08	2034/2037
58	Disease modification therapy effective for prevention and treatment of neurodegenerative diseases such as Alzheimer's disease based on pre-symptomatic biomarkers	1.55	0.54	2032/2035
59	Treatments for mental illness or neurological diseases targeting neural circuits by using deep brain stimulation, neuro-feedback, viral vectors, etc.	0.67	0.21	2033/2037
60	Novel therapy based on the elucidation of the pathogenic mechanism of psychological symptoms and sleep disorders in patients with neurological disorders	0.89	0.39	2034/2037
61	Method for dealing with bullying and truancy based on elucidation of brain functions of emotion, and etc.	0.95	-0.07	2034/2038

Health crisis management (including infectious diseases, emergency medical care, and disaster medical care)

ID	Topic	I score	C score	Realization time
62	Ultralight sensors that can be used in contaminated areas and aircraft, that can quickly detect infection with specific pathogens, infectivity to other persons, and the susceptibility of uninfected people.	1.00	0.32	2029/2031

ID	Topic	I score	C score	Realization time
63	Evaluation methods for the efficacy and side effects to develop the drugs of infectious diseases by using the cells established form the stem cells such as iPS cells, that can be substituted to animal models.	0.95	0.81	2028/2029
64	Epidemic prediction and alert system based on an electronic health record system and comprehensive infection surveillance system using test/prescription and other medical data and various web data.	0.85	0.21	2027/2029
65	Isolation and identification technologies for unknown pathogens using pathogen database.	0.77	0.25	2028/2030
66	A system that quantitatively predicts and evaluates the effects of emerging infectious diseases on humans, including the pathogenicity and the potentiality of causing global epidemics, with comprehensive consideration of factors such as the environment, pathogens, and hosts.	0.89	0.20	2030/2031
67	A system that controls the emergence and spread of drug-resistant infections [Science (pharmaceuticals, etc.) and social technology (new approaches to infection control, etc.)].	1.27	0.32	2029/2032
68	Mass-production technologies for neutralizing antibodies to pathogens in rapid and inexpensive way by using plants.	0.56	0.17	2029/2033
69	Blood substitutes that can be applied in emergencies (multiorgan failure) and massive bleeding	0.86	0.25	2031/2033
70	Novel infection control technology targeting inter-organelle migration in cell.	0.37	0.20	2032/2035
71	Transport organizing system for seriously injured people using artificial intelligence in the mass gathering disasters.	0.85	0.27	2029/2031

Information for health and social medicine

ID	Topic	I score	C score	Realization time
72	Healthcare policy utilizing the big data of lifestyle (anonymized information) accumulated from our everyday life (purchases, dining, and etc.)	1.03	0.05	2025/2028
73	The management system for medical history, medication history, and personal genome information based on insurance cards, etc., incorporating IC chips, which will contribute to achieving precision medicine and improved medical quality.	0.93	0.11	2026/2029
74	Health and medical database that continuously collects genome information, medical records and biological and behavior information obtained through wearable sensors and smart devices, toward promotion of large-scale cohort studies	0.99	0.20	2027/2029
75	Monitoring system that utilizes the behavior recognition sensors to ensure the safety in medical and nursing facilities and at home.	1.15	0.50	2025/2028
76	Emergency medical information system based on the detection of vascular events, such as cerebrovascular disorders, myocardial infarction and lethal arrhythmia, through sensing the living environment and the life log.	0.89	0.32	2027/2029
77	Medical information systems equipped with intelligent alert and artificial intelligence for decision making support, to eliminate medical errors related to medical equipment and systems, caused by misoperation and unsuitable settings for the patient condition, etc.	0.90	0.24	2026/2029
78	Information system equipped with intelligent inference algorithms on the risk of side effects of medicines for an individual based on molecular pharmacology, biomolecular interactions and genomic information.	0.83	0.23	2029/2031
79	Medical laboratory technologies for monitoring omics data (epigenome, proteome, metabolome), in addition to genome data, from body fluid samples within several hours for JPY10,000 or less.	0.72	0.23	2028/2031

ID	Topic	I score	C score	Realization time
80	Prevention and therapy adjusted to each stage of age from the viewpoint of life course healthcare based on the clarification of Developmental Origins of Health and Disease (DOHaD)	0.92	0.16	2029/2032
81	Large cohort study for the life course healthcare.	1.00	0.12	2027/2029
82	Methods for reducing health disparities based on the comprehensive factor analysis by integrating life science and sociology.	0.92	0.08	2028/2031
83	Information systems that contribute to solve health problems such as infectious diseases and heat stroke caused by climate change.	0.67	0.26	2028/2030
84	Solutions to Ethical, Legal and Social Implications (ELSI) regarding utilization of genome information from the neonatal period""	0.62	-0.05	2028/2032

Basic technology for life sciences (including measurement technology, data standardization, etc.)

ID	Topic	I score	C score	Realization time
85	Construction of a quantitative formula which describes biological functions as a multi-molecular system.	0.56	0.05	2031/2035
86	Artificial cells of which working principle, how many kinds of biomolecules cooperate, is well understood.	0.72	0.20	2034/2039
87	Detection technology for signs of disease onset or deterioration of condition using dynamic network biomarkers, that will contribute to preventive and pre-emptive medicine	1.08	0.21	2029/2033
88	Imaging technology that can measure brain function non-invasively at the cellular level	0.98	0.39	2030/2035
89	A minimally invasive real-time monitoring system for biopolymers and low-molecular weight molecules in circulating body fluids	0.87	0.16	2030/2033
90	One cell omics analysis technique that retains cell position information	0.70	0.34	2028/2030
91	Acquisition and establishing the database of the genome information of all the creatures (including plants, unicellular eukaryotes, prokaryotes) that can be contacted with human.	0.69	0.20	2029/2030
92	Technology for estimating the dynamic conformation of proteins in the active state from information on the primary sequence and the 3-D structure of the substrates of the protein.	0.91	0.39	2029/2033
93	Elucidation of the function of more than half of noncoding regions of the genome.	0.68	0.18	2029/2033
94	A system that records and saves all measurement data and all image data generated by research to prove the authenticity of the research results, and authenticates and guarantees that the data is original data.	0.74	-0.15	2027/2029
95	Laboratory automation and experiment robots available in many general laboratories	0.69	0.25	2028/2031
96	Quantum measurement technologies to obtain parameters required for understanding acting mechanisms of protein function at the quantum (mechanics) level.	0.47	0.18	2032/2035

<Agriculture, forestry, fisheries, food, and biotechnology>

Production ecosystem

ID	Topic	I score	C score	Realization time
97	Cultivation of crops by genome editing of wild species adapted to various global environments (neo-domestication)	0.85	0.07	2027/2032
98	Technology to efficiently produce medicines and functional polymers in the edible parts of crops, silkworms, cow and goat's milk	0.88	0.40	2027/2030
99	Lineage creation for livestock production utilizing the mechanism of hybrid vigor	0.59	0.11	2028/2031
100	Large-scale closed land-based aquaculture technology for fishes like eels, based on ecological circulation	1.08	0.67	2029/2030

ID	Topic	I score	C score	Realization time
101	Infection prevention technology based on elucidation of the immune system of fish and the regulatory factors	0.66	0.34	2029/2029
102	Aquaculture feeds with plants and insects for reducing environmental burden	0.82	0.32	2027/2028
103	Completely infertile farmed fish	0.26	0.33	2028/2030
104	Automation technology for logging, transporting, hauling and processing of timber	0.73	0.05	2029/2030
105	Efficient and systematic woodland creation technology in line with the current forest condition, to ensure reproduction after logging	0.85	0.13	2030/2031
106	Super tree with fast breeding using genome information of various trees such as cedar and cypress	0.53	0.24	2031/2035
107	A portable high-throughput (high-speed mass processing) phenotype measurement system for agricultural crops using a broadband, ultra-compact optical device ranging from X-ray to terahertz, omics, chemical analysis and ICT	0.63	0.23	2028/2030
108	Growth prediction and diagnosis system for agricultural crops through integration of short to mid-term weather forecast and a high-precision crop model combining biological knowledge and AI	1.02	0.36	2028/2031
109	Technology for improving the productivity of non-ruminant livestock by controlling intestinal bacteria	0.45	0.18	2030/2032
110	Technology to improve productivity by reducing stress on livestock and farmed fish based on animal welfare	0.55	-0.01	2029/2030
111	Automated/ unmanned circular plant factory for use in space and the polar regions	0.36	0.20	2032/2037
112	Ultra-high-speed breeding (tailor-made) using AI and big data obtained from field-omics, phenomics, etc.	0.76	0.18	2029/2031
113	Ecologically harmonious agriculture production system achieving high quality without losing productivity	0.98	0.21	2029/2032
114	Cultivation and measurement technology including high-precision, wide-area soil diagnosis by developing various microdevices making maximum use of microbial symbiosis	0.64	0.17	2030/2032
115	Agricultural robots to replace humans	1.35	0.59	2026/2029

Food ecosystem

ID	Topic	I score	C score	Realization time
116	Flexible cooking system applicable to various menus for restaurants	0.29	0.28	2027/2029
117	Identification technology for detecting contamination of organic matter (hair, etc.) in food production lines	0.57	0.76	2025/2026
118	Creation of an international research database, using an approach that integrates research fields including cognitive science, linguistics, chemistry and AI, considering taste, fragrance, and mouthfeel (texture), for convenient reproduction of "taste".	0.58	0.52	2028/2029
119	A system that quantitatively analyzes the quality (components, properties, maturity) of agricultural, forestry and fishery products on a production site in a non-destructive manner and in real time	1.13	0.71	2026/2028
120	Technology for producing food that does not cause allergies based on allergen measurement technology	1.10	0.66	2029/2030
121	Various functional foods based on the concept of foodmics that is conscious of the aging society	1.10	0.80	2027/2029
122	Technology for monitoring and analyzing the food value chain to reduce food loss	1.16	0.37	2027/2028
123	Short-term storage technology to maintain the freshness and quality of fresh foods without freezing	0.93	0.79	2026/2027
124	Production processing technology for new protein sources including insect resources	0.81	0.29	2026/2029

ID	Topic	I score	C score	Realization time
125	Manufacturing, processing and cooking technology to achieve mass customization to shorten the distance from the place of production to the place of consumption (improving footprint)	0.50	0.02	2028/2029
126	New resource generation technology by reuse of waste food (like a 3D food printer, for example)	0.57	0.29	2028/2030
127	Complete circular food value chain throughout the processes of production, distribution, processing and consumption	0.80	0.26	2028/2032

Resource ecosystem

ID	Topic	I score	C score	Realization time
128	Permanent preservation of gene resources by constructing a germ cell bank of varieties of aquaculture fish and the main species of fishery target	0.98	0.44	2027/2029
129	Technology for evaluating various types of resource at once by increasing the accuracy of the quantitative fish detection system (species recognition / size measurement)	0.76	0.48	2028/2029
130	Advanced lifetime logging system for fishery resources by embedding microelectronic chips	0.55	0.41	2027/2029
131	Three-dimensional image analysis system capable of identifying micro-marine organisms (microorganisms, plankton, etc.)	0.50	0.23	2028/2030
132	Effective capture technology for wildlife population control and innovative technology to prevent damage from wildlife	0.91	0.12	2029/2031
133	Forest pest and disease control system	0.84	0.23	2031/2033
134	Forest management technology to prevent landslide disasters	1.17	0.63	2031/2033
135	Scientific aquaculture management system with ICT through automatic collection and database creation of information related to aquaculture history	0.85	0.35	2027/2030
136	Technology for creating a scientific forest management plan with ICT	0.77	0.29	2031/2033
137	Technology for scientific design of specifications for a disaster-prevention forest road to deal with abnormal weather events	0.59	0.43	2031/2033
138	Technology to automatically open forest roads using technology that automatically ascertains forest geology	0.04	0.06	2033/2037
139	Technology to ascertain the current status of ocean plastic waste and assess impact, and emission mitigation system	1.08	0.33	2029/2032
140	Technology to conserve and manage rare species with the aid of understanding and analysis of the ecosystem using environmental DNA	0.94	0.57	2028/2029
141	Environmental and ecological impact assessment method that contributes to agriculture, forestry and fishery industries, using indicators of changes in familiar ecosystems	0.72	-0.04	2030/2033

System platform

ID	Topic	I score	C score	Realization time
142	Wide area monitoring system of agriculture, forestry and fishery resources, including forestry, seaweed, and sea grass, by utilizing remote sensing and networks	0.88	0.30	2028/2030
143	Circulation monitoring system of major elements and substances (nitrogen, carbon, etc.) in agriculture, forestry, and fishery ecosystems, using global IoT	0.74	0.40	2029/2032
144	Create a global grid (lattice spacing: 10 m square) database of crop data utilizing remote sensing technology, etc., to ascertain all information related to agriculture, forestry and fishery industries	0.60	0.40	2029/2031
145	Technology to predict and manage resource fluctuations based on an assessment of the impact of global warming on agricultural, forestry and fishery resources	1.20	0.46	2028/2031

ID	Topic	I score	C score	Realization time
146	System for real-time high spatial and high temporal resolution meteorological prediction and disaster risk assessment, utilizing satellite and/or meteorological observation data	1.33	0.80	2028/2030
147	Technology to restore the coastal environment, including seaweed beds and tidelands, based on clarification of the material circulation system connecting the land, river and coastal area	0.83	0.49	2029/2031
148	Observation and evaluation technology to prevent destruction of tropical forests and to enable regeneration activities	0.64	0.36	2031/2033
149	A system that monitors environmental information and biological information in real time, enabling early detection of abnormalities in agriculture, forestry and fishery sites	1.02	0.32	2028/2030
150	Automatic collection of fishery operations history and creation of a basic database for scientific management of fishing grounds using ICT	0.97	0.36	2027/2030
151	Automatic collection of forestry operations history and creation of a basic database for forest management using ICT	0.67	0.36	2029/2033
152	System for real-time monitoring of microorganisms during manufacturing, transportation and storage	0.64	0.50	2029/2032
153	Creation of a global grid database of semi-real time crop growth and diagnostic information	0.47	0.31	2031/2034

Next-generation biotechnology

ID	Topic	I score	C score	Realization time
154	Technology to control characteristics related to preferences such as taste, shape, aroma and aging of plants and marine products	0.83	0.53	2027/2030
155	Efficient germ cell production and preservation technology for maintenance and preservation of endangered species	0.78	0.49	2028/2031
156	Crops that can be harvested even in an environment not suitable for cultivation such as the desert (arid region)	0.67	0.36	2030/2034
157	Simulation of growth processes based on elucidation of gene-environment interactions, and optimization of gene structures using the simulation results	0.86	0.36	2030/2034
158	Production of plants with ability to fix nitrogen in the air, and the ability to use phosphate in soil, etc., through plant genome technology	0.91	0.44	2030/2033
159	Molecular genetic elucidation of hybrid vigor and inbreeding depression in crops	0.53	0.26	2029/2032
160	Medical model pigs capable of xenotransplantation using gene modification techniques	0.84	0.48	2029/2034
161	Technology to control the behavior of insects with ultrasonic waves and vibrations and behavior monitoring technology	0.25	0.15	2028/2031
162	Technology for visualization of plant function by converting various function sensors to LSI	0.45	0.23	2029/2031
163	Technology to promote sprouting of softwoods and aged hardwoods where sprout regeneration is difficult	-0.05	-0.11	2032/2034
164	System for large volume/large scale fixing (sequestering) of CO2 by plants (rice and algae) with dramatically increased photosynthesis capacity as well as a system for productivity improvement	0.93	0.55	2031/2035
165	Technology for reconstructing high definition 3-dimensional structures of the invisible parts of plant populations (including root areas)	0.12	0.16	2028/2032
166	Technology to enable free phenotype expression through epigenome control using biological memory	0.60	0.37	2031/2034
167	High-precision crop modeling combining biological knowledge and AI	0.84	0.16	2029/2032
168	Technology to draw out various past environmental memories from biological memory	0.07	0.00	2036/2040

Biomass

ID	Topic	I score	C score	Realization time

ID	Topic	I score	C score	Realization time
169	Cultivation of biomass producing crops exceeding 50 tons/ha/year with dry matter	0.77	0.05	2030/2033
170	Technology for decomposing and using vegetable fibers by using artificial proteins to relax the crystallinity of cellulose	0.56	0.30	2030/2032
171	Livestock cooperative production system using ingredient-stable fertilizer production technology through concentration of methane fermentation digestive juices	0.43	0.14	2027/2030
172	Technology to design fire-proof timber structures based on development of high-strength timber materials to achieve mid-to-high-rise timber buildings, which can be expected to reduce CO_2 by replacing steel and cement (reinforced concrete) structures, from which reduction of CO_2 emissions is difficult to achieve	0.79	0.48	2029/2031
173	Highly durable timber that can be used outdoors for a long period of time (around 50 years), with the aim of expanding demand in fields such as civil engineering	0.53	0.36	2031/2033
174	High-efficiency, low-cost power generation, thermal utilization technology using biomass such as wood	0.94	0.31	2028/2030
175	Biodegradability and photodegradable materials for the food ecosystem	0.95	0.50	2029/2031
176	Technologies for replacing fossil-fuel products with forest resources (road paving, construction materials, clothing materials, paint, consumer goods)	1.15	0.57	2029/2031
177	Technology for adding value to wood byproducts (technology for reusing, refining, separating and extracting lumbar remnants and nonstandard product at logging, and edible waste on processing lines)	0.95	0.37	2030/2030

Safety, security, and health

ID	Topic	I score	C score	Realization time
178	Technology to eliminate zoonotic pathogens and other such agents from animal bodies that are harmful to human health	0.97	0.36	2030/2033
179	Evaluation of toxicity caused by the interaction of multiple harmful factors in food	0.80	0.31	2029/2032
180	A food defense system that prevents bacterial and harmful substance contamination of the food chain, to achieve food safety and security	0.92	0.57	2028/2030
181	Technology that uses plants and microorganisms to effectively remove and extract dioxins, heavy metals and rare metals from the soil	0.75	0.39	2031/2033
182	Technology applying AI that contributes to health by using big data for food and healthcare	1.15	0.33	2027/2029
183	System for development of target species-specific pest control materials for plant pests and pathogens	0.77	0.29	2029/2032
184	Crops that do not absorb heavy metals and radioactive material	0.52	0.29	2031/2034
185	Technology to eradicate disease to overcome quarantine issues	0.77	0.14	2032/2033
186	Traceability system based on new technology that guarantees transparency using block chain, etc.	0.56	0.19	2027/2029

Community

ID	Topic	I score	C score	Realization time
187	Forest therapy based on physiological elucidation of the comfort enhancing effect of forests and woodlands	0.50	0.16	2032/2032
188	Food supply and demand prediction system based on an increase in world population; economic development and trends in crop production technology	1.09	0.04	2032/2033
189	Technology to evaluate the economic vitality, social impact and environmental burden of a society using renewable energy such as biomass	0.98	0.26	2029/2033
190	A social system utilizing humanities, social sciences and AI for fishery resource management	0.71	0.05	2030/2033

ID	Topic	I score	C score	Realization time
191	System for reevaluating traditional recipes	0.50	0.46	2024/2028
192	Social system to establish traceability of marine products	0.89	0.37	2026/2028
193	Community visualization monitoring technology using state-of-the-art digital technology	0.26	-0.02	2028/2030

<Environment, resources, energy>

Energy conversion

ID	Topic	I score	C score	Realization time
194	Hydrogen production technology using renewable energy such as solar heat and others	0.90	0.39	2028/2032
195	Co-production of energy and useful material using biomass	0.86	0.25	2029/2032
196	Technology that uses sodium and magnesium as sources of energy	0.27	0.22	2031/2034
197	CO2 recovery integrated gasification combined cycle power generation using low-grade fossil fuel such as lignite	0.64	0.51	2028/2031
198	High-efficiency integrated gasification combined cycle (IGCC) power generation system using the exhaust heat from gas turbines	0.84	0.83	2027/2029
199	1 GW-class large-scale power generation technology by 100% hydrogen fuel gas turbine	0.64	0.47	2029/2033
200	Technology using mid to low-temperature geothermal resources of 5 MW-class of binary power generation, heat pumps, etc.	0.72	0.41	2029/2031
201	50 MW-class offshore floating wind power generation	0.77	-0.05	2028/2032
202	An output of 10 MW-class or more power generation technology using marine energy resources such as waves, tides, tidal currents, and ocean temperature differences	0.67	0.15	2030/2034
203	Space solar power generation system (a system that generates electricity using sunlight in space and transmits the power to the earth)	-0.05	0.04	2040/2048
204	Nuclear fusion power generation	0.49	0.46	2047/2051
205	Fast breeder reactor (FBR) system technology, including nuclear fuel cycle and integrated fast reactors (IFR)	0.07	0.22	2038/2047
206	Next-generation light water reactor technology with features such as being able to use enriched fuel exceeding 5%, plant life of 80 years, and no requirements for the selection of site conditions	-0.14	-0.07	2036/2045
207	Industrial heat pump capable of generating steam exceeding 200°C	0.63	0.39	2029/2032
208	Ultra-high-efficiency heat pump for consumer use (COP ≥12 for air conditioning cooling, COP ≥8 for hot water supply)	1.03	0.63	2028/2030
209	General-purpose ZEB / ZEH (net zero energy buildings/houses) system that can be used in ≥30% of new construction	0.84	0.48	2029/2032
210	A smart grid control system that realized small cities (less than 100,000 populations) by 100% renewable energy supply	0.94	0.34	2029/2033
211	Achievement of closed-cycle energy self-sufficiency and complete resource recycling in small cities (less than 100,000 populations)	0.82	0.17	2033/2035
212	Method for designing autonomous metropolitan areas based on smart use of materials and energy	0.61	0.06	2036/2038
213	Car engines with 50% energy efficiency	0.94	1.09	2029/2031
214	Small-scale and highly efficient ammonia production technology to replace the Haber-Bosch methods	0.64	0.58	2029/2033
215	Commercially available compact module reactor with safety enhanced to the point where evacuation is unnecessary even in the event of an accident	0.08	0.13	2037/2046
216	Production of hydrocarbon fuels (such as aircraft fuel) by CO2 recovered from the atmosphere and hydrogen sourced from non-fossil energy	0.97	0.34	2035/2039
217	Long-term hydrogen storage technology enabling economical and large-scale stable supply	1.10	0.72	2032/2034

ID	Topic	I score	C score	Realization time
218	Establishment of technology to reduce the cost of biomass collection (technology integrating robotics and industrial machinery, etc.)	0.78	0.01	2029/2033

Energy systems

ID	Topic	I score	C score	Realization time
219	DC power transmission cable system for wind farms	0.76	0.21	2025/2028
220	Superconducting power cable (66-77 kV) with equivalent capacity to the current 275 kV CV cable (cross-linked polyethylene insulated vinyl sheath cable)	0.40	0.42	2032/2037
221	Non-contact charging technology while electric car operating	0.89	0.50	2028/2031
222	Power recovery system with a Stirling engine using CO2-free unused heat source	0.29	0.13	2029/2032
223	5 MW-class superconducting flywheel for power storage	0.41	0.38	2031/2035
224	Superconducting magnetic energy storage system for improving power stability on a scale of several tens of kWh	0.49	0.55	2032/2037
225	Construction of an artificial forest circulation production system to improve the economics of energy production from wood biomass	0.64	-0.08	2030/2035
226	Long-life and low-cost MW-scale secondary battery to stabilize grid connections (life: 20+ years, cost: ≤JPY 15,000/kWh)	1.32	0.70	2030/2033
227	Long-life and low-cost secondary batteries that do not require replacement for electric cars (life: 15 years, cost: ≤JPY5000/kWh)	1.48	0.98	2029/2032
228	Generalization of the electricity market focusing on power trading within communities and between individuals	0.43	-0.23	2026/2031
229	Hydrogen production using surplus power from solar and wind power generation	1.18	0.67	2027/2031
230	Energy system using ammonia as the energy medium	0.53	0.51	2030/2034

Resource development and 3Rs (reduce, reuse, recycle)

ID	Topic	I score	C score	Realization time
231	Efficient mine exploration technology using ICT and satellites	0.67	0.16	2029/2031
232	Mining and pumping technology required for mining ocean mineral resources	1.05	0.66	2032/2035
233	Shale gas mining technology without environmental pollution	0.15	-0.40	2031/2033
234	Technology to smelt titanium at ≤50% of the current cost	0.55	0.27	2033/2035
235	Treat and store arsenic technology in copper mines	0.38	0.36	2030/2032
236	Mining technology for methane hydrate	0.81	0.63	2036/2038
237	Economically recover technology for rare metals such as uranium from seawater	0.61	0.28	2039/2044
238	Technology to develop resources under temperature an pressure of 250°C and 500 atm, respectively	0.55	0.14	2035/2039
239	Economical extraction technology for deep-sea metal resources from hydrothermal deposits	0.89	0.56	2035/2040
240	Effective recovery technology of helium from the air	0.52	-0.02	2036/2043
241	Technology for economically separating and recovering useful metals from used products such as low-grade rare metal special steel	1.14	0.65	2030/2032
242	Technology to reasonably collect and use rare metals from small electronic devices, waste and sewage sludge from incineration fly ash	1.27	0.86	2028/2031
243	Biomass refinery format that enables production of various basic industrial products	0.67	0.29	2033/2035
244	Sorting sensor technology to further improve waste selection and sorting systems	1.00	0.62	2030/2031
245	Technology to drastically reduce the amount of waste with nuclear transmutation of radionuclides in high-level radioactive waste using an accelerator	0.94	0.31	2041/2044

ID	Topic	I score	C score	Realization time
246	Using digital technology for strata analysis, resource reserve estimation, development plan formulation, etc., in resource development	0.80	0.20	2031/2031
247	New EOR/ EGR (enhanced oil and natural gas recovery) technology using bio nanotechnology	0.54	0.17	2034/2039
248	Elucidation of the cause and actual conditions of induced earthquakes associated with resource development	0.67	0.22	2033/2035
249	Innovative dismantling and design technology that maintains function to promote reuse	0.89	0.45	2030/2032
250	Advanced physical separation and enrichment technology to promote advanced recycling of metals	1.00	0.54	2032/2034
251	Technology for dramatically improving the efficiency of the supply chain for resource circulation, such as collection and transport, using information technology	0.88	0.31	2029/2032
252	Technology to utilize steam generated from waste incineration for factories and power generation, implemented for more than half the incinerators	0.96	0.66	2031/2032
253	Management of resources and hazardous substances through creation of a common database for material flow	0.66	0.40	2030/2033
254	Automatic operation of waste disposal and recycling facility maintenance, including self-diagnosis using AI	0.69	0.25	2031/2033
255	High-temperature in-ground equipment for utilization of geothermal resources, with a view of utilizing supercritical geothermal resources	0.58	0.23	2034/2035
256	Geothermal power generation technology using supercritical water located at a depth of about 5000 m	0.37	0.20	2039/2042
257	Artificial recharge technology for depleted geothermal reservoirs	0.31	0.06	2030/2036
258	Nationwide expansion of potential geothermal maps based on a groundwater flow model	0.35	0.08	2033/2035

Water

ID	Topic	I score	C score	Realization time
259	Generalization of a nationwide groundwater map through effective integration of satellite observation and ground observation	0.64	0.35	2029/2032
260	Simultaneously and continuously monitor technology for water areas with non-contact continuous sensing of water environment quality	0.76	0.41	2029/2030
261	Integrated water management technology in densely populated areas, including management of urban flooding, storm surge and land subsidence due to linear rain bands and torrential rain	1.36	0.90	2028/2029
262	Water resource and energy optimization technology based on climate/snowfall models and observations to effectively use snow as a resource	0.59	0.31	2029/2032
263	Continuously monitor technology that harmful trace chemicals, pathogenic microorganisms, etc., in the water supply	0.92	0.76	2028/2030
264	Rapid analyze and remove technology for residual antibiotics in treated sewage	0.75	0.60	2028/2030
265	Water purification technology using a reverse osmosis membrane with pressurized energy reduced by 50% or more	0.52	0.64	2030/2032
266	Water purification technology with an economically recyclable reverse osmosis membrane	0.66	0.61	2029/2031
267	Recycling contaminated water treatment technology that could be widely used in developing countries	0.80	0.80	2026/2029
268	Establishment of an integrated water quality indicator able to evaluate the quality of water environment in place of BOD, COD, T-N, etc.	0.63	0.49	2028/2029
269	Establishment of a rapid analysis method to detect microplastic in the hydrosphere and assessment of the health risk	0.77	0.44	2027/2029

ID	Topic	I score	C score	Realization time
270	Geo-engineering (environmental chemistry technology) and biomimetic technology to acquire water resources from the atmosphere	0.32	0.23	2033/2036

Global warming

ID	Topic	I score	C score	Realization time
271	No fossil fuel required aircraft	0.94	0.22	2035/2039
272	Elucidation of the effect of seawater acidification on biodiversity, especially the impact on fishery resources	1.14	0.50	2030/2032
273	Technology to predict the impact of climate change on food production for each region and each item	1.11	0.47	2029/2032
274	A system that evaluates CO2 emissions of each country, based on observational data such as CO2 concentration and distribution	0.93	0.53	2028/2030
275	Improvement of the estimation accuracy of climate sensitivity (the mean increase in global surface temperature after sufficient time has elapsed after doubling of the concentration of CO2 in the Earth's atmosphere) from 3°C to 1°C.	1.13	0.73	2034/2036
276	Improvement of the estimation accuracy of the critical temperature (tipping point), at which instability of melting of the Greenland ice sheet occurs, to 1°C or less	0.45	0.33	2030/2034
277	Long-term global environmental change forecast over 100 years based on high-resolution atmospheric circulation models, ocean general circulation models and global environment prediction models considering material and energy circulation associated with social activities through data assimilation	1.07	0.72	2032/2035

Environment conservation (analysis, prediction, evaluation, restoration, regeneration, plan)

ID	Topic	I score	C score	Realization time
278	Simple and rapid restoration technology for salt-damaged agricultural soil	0.32	0.27	2030/2031
279	Mercury removal technology from coal combustion exhaust gas considering diffusion, migration and accumulation in the environment	0.26	0.35	2029/2031
280	Decontamination technology that a degree where health is not affected level of from contaminated water and soil by radioactive material	1.27	0.91	2030/2031
281	A rapid and accurate detection system for minute amounts of pathogenic microorganisms in public and customer facilities as well as transportation facilities such as airports, harbors and railways.	0.61	0.09	2028/2032
282	Technology to formulate measures based on factors governing diffusion of alien species and analytical evaluation of invasion risk	0.84	0.10	2030/2034
283	High-precision technology to assess the impact of transboundary air pollution on forests	0.61	0.35	2030/2032
284	Monitoring system for vegetation distribution and ecosystem function using big data based on mobile data terminals, remote sensing, etc.	0.61	0.38	2028/2030
285	Assess environmental and ecological impact evaluation system that based on changes in familiar ecosystems	0.77	0.25	2028/2030
286	Integrated technology for climate change and disaster mitigation and adaptation based on ecosystem function	0.95	0.38	2032/2036
287	Maintenance technology such as optimized buildings that can coexist with nature, are compatible the maintenance of the biological habitat and healthy water circulation	0.52	0.24	2030/2034
288	Technology to preserve and regenerate the genetic diversity of endangered species	0.71	0.18	2032/2036
289	Market economy approach (e.g., biodiversity mitigation-banking, offset-banking) that comprehensively manages the restoration and conservation of natural resources in rural mountain and fishing villages, as well as the urban environmental load	0.74	0.08	2030/2034

ID	Topic	I score	C score	Realization time
290	Regenerated technology for ecosystems and biodiversity in urban spaces	0.80	0.19	2031/2033
291	Technology to mitigate the disappearance of habitats due to heat islands and aridification	0.63	0.19	2031/2036
292	Technology for regenerate and maintain vegetation in arid and desert regions	0.34	0.33	2033/2038
293	Real-time monitoring and alarm system for heat risk using information technology (IoT, AI, big data, etc.)	0.88	0.42	2027/2030

Risk management

ID	Topic	I score	C score	Realization time
294	Formulation of safety standards for the use of nanoparticles in consumer goods such as cosmetics and food	0.84	0.44	2026/2028
295	Technology to manage and reduce the risk of hazardous chemicals that have long-term impact on human health, agricultural production and natural ecosystems	1.13	0.49	2030/2032
296	Elucidation of the mechanism of the health risk posed by low-dose radiation and establishment of rational safety regulation standards	1.18	0.43	2030/2033
297	Technology to quantitatively predict the impact of development activity on the natural world, and simulate and evaluate the impact considering the natural rate of regeneration	0.89	0.28	2030/2031
298	Methods to evaluate the risk of infrequent natural disasters	1.20	0.65	2031/2034
299	Technology that disperses power control (including renewable energy) to enhance the resilience of the power system against natural disasters	1.24	0.49	2028/2031

<ICT, analytics, and service science>

Future social design

ID	Topic	I score	C score	Realization time
300	Technology to digitize all economic transactions (all cash becomes electronic money and cash disappears, fundamentally changing the mechanism of the money economy)	1.02	-0.39	2027/2032
301	All books become electronic books (extinction of paper books)	0.30	-0.12	2028/2032
302	Internet-based individual authentication technology to a level that would enable all elections to be implemented on the Internet	0.96	-0.22	2027/2032
303	Real-time automated translation of movie speech, integrating image recognition and speech recognition	0.79	0.13	2027/2029
304	System for substitution of secretarial work, including budget execution by AI, scheduling the time and place of multi-person conferences, preparation of materials necessary for work, creation of proposals and reports	0.92	-0.15	2027/2030

Data science and AI

ID	Topic	I score	C score	Realization time
305	Natural language processing to extract desired information from atypical sentences/conversations	1.28	0.03	2026/2029
306	Interactive technology that allows communication without humans feeling uncomfortable	0.98	0.14	2028/2030
307	Elucidation of ultra-large-scale combinatorial optimization problems, elucidation of the mathematical structure of non-convex optimization problems and development of real time approximation solution	0.82	0.20	2029/2031
308	Technology that performs high-speed, accurate machine learning from large-scale nonstructural data, including information loss, noise, and non-stationarity	1.16	0.07	2027/2029
309	Real-world phenomena prediction and real-world system control integrating simulation and machine learning	1.20	0.17	2028/2030

ID	Topic	I score	C score	Realization time
310	Theoretical elucidation of the principle of optimization and generalization of deep machine learning	0.97	0.05	2028/2030
311	Acoustic speech recognition and speaker identification technology with performance at or above human performance in a natural environment	0.72	0.21	2028/2030
312	Image processing technology capable of extracting desired information from natural images	1.12	0.14	2025/2028
313	Spread of a machine learning utilization base capable of being used be beginners	0.77	-0.07	2024/2025
314	Technology that automatically generates desired sentences, images, sounds, etc., at a level that does not sound unnatural to people	0.74	0.04	2027/2029
315	Standardization of an AI software development environment	0.67	-0.18	2024/2027

Computer systems

ID	Topic	I score	C score	Realization time
316	A supercomputer (a large-scale computer system based on parallelization) with a greatly improved power: performance ratio (about 100 times) compared to computers in current use	1.33	0.75	2028/2029
317	A supercomputer (a large-scale computer system based on parallelization) with greatly improved scalability (about 100 times) compared to computers in current use	1.09	0.64	2028/2029
318	Gate type quantum computer (quantum circuit) which maintains several hundred bits of coherence by drastically improving the scalability of the currently considered methods (nuclear magnetic resonance and superconductivity) for achieving quantum gates	0.82	0.25	2033/2035
319	A quantum neural network including a quantum threshold gate and learning feedback achieved through realization of a quantum channel, quantum memory, etc.	0.74	0.14	2035/2040
320	Although general-purpose quantum computers (quantum circuits) cannot be achieved, diversification of specialized quantum computers using specific quantum mechanisms, as a follow-on from quantum annealing machines were developed	0.58	0.23	2031/2033
321	Optimal computer architecture when block chains are widely used as social infrastructure	0.71	0.00	2027/2029
322	Basic quantum algorithm to essentially improve classical algorithms other than Shor's algorithm and Grover's algorithm	0.58	0.21	2031/2035
323	Systematization and maintenance for software protection functions using hardware such as TEE (Trusted Execution Environment) and methods for utilizing safe software execution environments	0.58	0.08	2028/2031
324	Improvement of the clock frequency of processors using silicon, with the eventual demise of Moore's Law (approximately ten times the current level, and approximately 100 times the current level of LSI miniaturization)	0.56	-0.07	2031/2033
325	Dramatic improvement in software productivity, by enabling automatic generation of programs, automatic debugging, automatic verification, and automatic testing, by software using AI technology, etc., and global open-source software modules serve as a one-stop site for searching and downloading software	1.12	0.11	2029/2032
326	Software running in the real world with source code equating to 100 billion rows	0.25	-0.06	2030/2032
327	Dramatic, worldwide decrease in data distribution and sharing cost due to unification of all data ontologies	0.60	-0.22	2030/2033

IoT and robotics

ID	Topic	I score	C score	Realization time

ID	Topic	I score	C score	Realization time
328	Robot inspection technology to replace building/ infrastructure inspections by humans, which is associated with higher cost and danger	1.50	0.73	2025/2027
329	Development and dissemination of life-sized personal robots and telepresence robots able to facilitate shopping and meeting with other people on behalf of a person	0.50	0.52	2029/2031
330	Facilitation of internet connection of 1 trillion intelligent devices using electronic tags with compact short-range wireless communication	0.93	0.48	2027/2029
331	An efficient whole-city traffic control system that enables real-time location information of all people and vehicles (railway carriages, cars, etc.) in an urban space	1.18	0.57	2027/2030
332	Spread of unmanned agriculture using driverless tractors and other such equipment, spread of precision agriculture using IoT, and an environmental control system based on environmental data, etc., acquired through these technologies	1.35	0.61	2026/2027
333	Positioning technology with a ≤5 cm margin of error in every location in Japan, including underground facilities and indoors	0.92	0.62	2027/2029
334	All communication with digital devices that humans come into direct contact with, are converted to wireless communication, with phasing-out of communication cables	0.63	0.44	2028/2030
335	Robot equipment that supports the cognitive and motor function of elderly and mildly disabled people, enabling independent living, and driverless technology for robot equipment and robots that move at low speed over short distances	1.47	0.78	2028/2030
336	Achievement of unmanned factories, unmanned shops, unmanned logistics warehouses, unmanned home deliveries by extensive spread of work robots to the three-product (food, cosmetics and pharmaceuticals) industry, service industry and logistics industry	1.24	0.54	2026/2029

Network infrastructure

ID	Topic	I score	C score	Realization time
337	Wired and wireless mobile communication technology that simultaneously facilitates large capacity, ultra-reliable, ultra-low latency and super-multi-terminal communication	1.47	0.63	2027/2028
338	Communication network/ communication node technology that dramatically reduces power consumption per amount of data transferred	1.12	0.50	2028/2030
339	Data plane technology that achieves increased communication capacity in the cloud data center and allows for the potential for evolution of the architecture	0.96	0.10	2026/2028
340	Mobile communication technology that facilitates high-capacity communication with high-density multiplexing, can predict and follow the movement of the terminal, selectively perform large-capacity communication, and enables terminal-to-terminal communication	1.13	0.45	2027/2028
341	Optimally available communication infrastructure technology that links Cloud and Edge terminals, and organically combines dispersed computing resources, storage resources and communication resources	1.02	0.22	2028/2029
342	An information-oriented and content-oriented network that designates information and functions by name and carries out information processing within the network	0.43	0.04	2028/2030
343	Flexible information communication technology that contributes to mitigating network congestion and improving fault tolerance in normal times, enables preferential servicing of emergency communication in case of disaster, or that can be constructed rapidly from scratch	1.42	0.70	2027/2029

ID	Topic	I score	C score	Realization time
344	Optical communication technology capable of accommodating innovatively large capacity and high-density communication, such as multi-core fiber and silicon photonics	1.07	0.82	2027/2028
345	Innovatively secure quantum communication using quantum cryptography	1.00	0.43	2033/2034
346	Network device configuration technology converted to software, combining performance, flexibility and robustness	0.95	0.32	2027/2029
347	Slicing technology to accommodate non-interference applications and services, end-to-end	0.62	0.26	2028/2029

Security and privacy

ID	Topic	I score	C score	Realization time
348	Technology to prevent internal crimes by people allowed access to information systems and control systems (including behavioral science techniques, which can reduce the incidence of internal crime to a negligible amount)	1.29	0.05	2028/2031
349	Individual authentication system that can be used safely and securely, while protecting privacy, facilitating ease-of-use and at low-cost, even when accessing many sites on the internet over a long timeframe, from different environments, such as while driving, in addition to access from PCs and personal IoT equipment	1.35	0.23	2028/2030
350	Technology to prevent illegal intrusion into critical infrastructure, automobiles, personal IoT devices/services (technology to reduce the probability of fraudulent communication to an almost negligible level)	1.56	0.24	2028/2029
351	Technology (including automatic translation technology and digital image appraisal technology) that analyzes the authenticity and reliability of information obtained through mining of information from the internet, such as news summary sites and web-based social media, according to the characteristics of each field (politics, economics, academia, etc.)	1.04	0.06	2027/2029
352	IoT security technology and privacy management technology that can flexibly set the balance between privacy and convenience, by being able to ascertain all the types of sensors related to an individual and through that information, it is possible to ascertain who is being made aware of their behavior information (sensor information, purchase history, etc.) and how this is achieved, as well as enabling individual users to be responsible for use of the information (including deletion of information)	1.25	0.12	2028/2030
353	Technology that utilizes sensitive personal data without leaking privacy information to facilitate secure electronic voting and sharing of electronic medical charts while protecting personal data (including standardization of safety level)	1.39	0.35	2028/2029
354	New OS, software technology and remote maintenance technology capable of automatically implementing maintenance of PCs, smartphones and personal IoT devices (software updates, etc.) without burdening the user	0.83	0.14	2026/2028
355	Economic infrastructure providing security, efficiency and a sense of security (not only for financial institutions but also for shops and individuals), with the ability to facilitate almost 100% cashless transactions for individuals' social activities and corporate economic activities (including cryptocurrency)	0.89	0.03	2026/2030
356	With the development of quantum information communication technology, the basis of ICT system safety will be a new safety framework based on quantum technology, etc., replacing the existing cryptographic technology	0.94	0.34	2031/2035
357	Installation and maintenance of malware detection/ elimination function on networks, the performance of which can be autonomously improved and maintained with AI technology	1.14	0.00	2027/2029

Service science

ID	Topic	I score	C score	Realization time
358	Technologies that integrate and clarify the behavior of users that enter and exit cyberspace and real space, such as webrooming and showrooming (purchasing online after looking at products in a physical store or vice versa)	0.76	0.03	2025/2028
359	Quality measurement technology considering the subjectivity and diversity of service users	0.84	0.36	2027/2029
360	A system that enables receipt of individualized and appropriate services suited to the situation, even when stores and other service centers are visited for the first time, by managing profiles based on individuals, including individual sensor data, and by individuals carrying mobile terminals	0.63	0.18	2025/2029
361	A reviewable system that computes the possibility of share services combining various idle resources and skills on a computer (the result of effectively combining resources and skills of individuals and society, and theorical application of interaction dynamism in co-creation)	0.55	0.03	2027/2029
362	A new theory that further developed Service Dominant Logic, etc., whereby once the definition of a service based on dichotomy with things became completely a thing of the past, and after penetration of the perception that it is actions in general that brings value to individuals and society	0.39	-0.13	2028/2030
363	Theorization of the measurement scale of value generated by co-creation and evaluation based on data obtained from the real world (contribution to the formation of service ecosystems in various fields)	0.55	0.10	2028/2029
364	Design tools and personal fabrication technologies that can be easily used even by the end user by using information technology (the content of products and services jointly produced by high-level amateurs and multiple people increases, and this can be easily customized by the general users enjoying the products/services)	0.72	0.12	2025/2028
365	Methods for diagnosing the skills and maturity of service providers and organizations that are used across various industries as indicators in the process of education and training	0.57	-0.28	2028/2030
366	Research on feelings and physiological measurements such as comfort, discomfort, likes and dislikes arising from the use of goods and services has progressed, and it is now possible to directly analyze, measure and evaluate customer experience, and so methods can be established to use this information for research and development, sales, marketing, etc.	0.64	0.05	2029/2031
367	Theories and technologies to facilitate analysis of the contribution to well-being for individuals and contribution to Sustainable Development Goals (SDGs), as important measures for designing and evaluating new services, in addition to conventional customer satisfaction	0.59	0.02	2027/2028
368	Technology and systems that achieve improvements in productivity and quality of work (QoW) in situations where the majority of customer and interpersonal services in the service industry are areas where only people excel	0.93	-0.02	2028/2030
369	Based on academic knowledge on services, it is necessary to construct a model of the ability to utilize services (service literacy) from each standpoint, including service providers and users, as well as to provide liberal arts courses in a society where services have progressed in various familiar fields	0.71	-0.02	2026/2028

Industry, business, and management applications

ID	Topic	I score	C score	Realization time
370	The number of customers and the importance of intellectual property has increased, thus when evaluating corporate value, the evaluation ratio of intangible assets reaches on average, 70% of corporate value	1.01	-0.32	2028/2032

ID	Topic	I score	C score	Realization time
371	Handling of intellectual property and the proportion of new products and services based on open innovation accounts for more than 30% of all new business have been clarified	1.00	-0.30	2027/2030
372	With widespread crowdsourcing and job matching platforms, more than 30% of the working population will work as freelance workers, rather than employed workers of companies	0.45	-0.64	2028/2031
373	Sharing economy and service conversion will progress in a wide range of fields, including mobility, leisure, dining and clothing, and purchasing will account for 10% or less of the consumption expenditure of ordinary people	0.12	-0.42	2028/2032
374	30% or more of the total amount of payments made by ordinary people in daily life will be conducted in virtual currency managed by block chain technology without being controlled by central banks	0.28	-0.44	2027/2033
375	Energy systems utilizing block chain technology, etc., to conduct electric power transfers and transactions between communities and individuals	0.21	-0.44	2028/2033
376	With the spread of AI and the ability to automate the majority of work, it will become a society where about 30% of the working generation will not work	0.46	-0.25	2032/2036
377	Mass customization has become popular in a wide range of areas, including cars, clothing, leisure goods, etc. The mode of individually ordering and purchasing items to match the needs of the individual, rather than purchasing ready-made items, will become mainstream	0.70	0.18	2029/2031
378	As net-based sales and delivery services increase in popularity, purchases in real stores will account for 10% or less of the total consumption	0.63	-0.05	2030/2032
379	All businesses will be offered on a small number of global platforms and almost all business, including sales, settlement, purchase, marketing, and sales analysis, will be conducted on these platforms	0.78	-0.59	2028/2030

Policy and institutional design support

ID	Topic	I score	C score	Realization time
380	A social consensus will be reached on the relationship between machinery (AI, robot) and human beings (Three new principles of machinery are established, legal preparation progresses, and a stable socioeconomic system is achieved where machines coexist cooperatively with humans)	0.95	-0.08	2035/2035
381	A system that makes it possible to estimate the social and economic impact of legal regulation, provides appropriate advice and risk presentation, including ascertaining situations where individuals and groups are located in real-time (including policy advice systems, advanced medical care advice systems, etc.)	0.90	-0.27	2031/2033
382	Autonomous decentralization without central institutions in the distribution of intellectual property, through utilization of distributed ledger technology and smart contracts	0.78	-0.20	2031/2035
383	Technology to qualitatively/ quantitatively simulate the service system before social implementation from economic, technical and social perspectives	0.93	-0.11	2032/2032
384	Policy planning support technology making use of big data and AI, in addition to conventional statistical data	1.22	-0.05	2028/2032
385	Systems that process information related to situational awareness from social media in real time, enabling early decision-making	0.55	-0.08	2025/2029
386	Simulation technology that can realistically reproduce the real society on a network composed of a vast number of nodes (individuals)	0.18	-0.05	2031/2034
387	A system for automatic creation/modification of laws and ordinances using AI technology etc. (Law documents would change from a paper medium premise to a digital medium premise, utilizing linked data, etc.)	0.87	-0.14	2028/2033

Social implementation

ID	Topic	I score	C score	Realization time
388	Health maintenance system based on data linkage of information such as health, medical care, nursing care, etc., from birth to the present, using block chain technology (achieving a pre-symptomatic society)	0.85	-0.12	2028/2033
389	Technology such as AI, IoT, and robots that dramatically improves agricultural productivity, and eliminates labor shortages and lack of personnel	1.57	0.27	2029/2031
390	Achievement of push-type administration, which can minimize application procedures and other work undertaken at government offices, through 100% digitalization of administrative services, and 100% openness of data held by administrative organizations	1.16	-0.31	2027/2032
391	Build the foundation for new service creation by reducing work involved in payment and settlement through cashless procedures, and by promoting accumulation and utilization of consumer purchase history data	0.96	0.00	2026/2029
392	Transition to a highly productive society with highly free employment configurations, premised on not requiring to go into the office, and having multiple jobs	1.27	-0.48	2027/2030
393	AI/blockchain is introduced into education, establishing a learning style beyond the boundaries of schools, achieving a society with lifelong skill improvement	0.83	-0.32	2028/2032
394	Facilitate transmission of disaster information using digital technology through cooperation with My Number and streamlining procedures for rebuilding an individual's life	0.83	0.03	2026/2031
395	Enhance an environment that is accepting of foreigners by improving translation technology against a background of accepting foreigners	0.99	-0.10	2025/2028
396	Various means of transportation, such as automatic travel, drones, etc., to facilitate maintenance of local public transportation networks, and reform the field of logistics, as well as technology to support management and operation of these networks	1.25	0.21	2027/2031
397	Realization of an inclusive society where everyone can enjoy the benefits of digitization, by all citizens acquiring IT literacy and elimination of the shortage of IT talent	1.13	-0.23	2028/2032

Interaction

ID	Topic	I score	C score	Realization time
398	Media that record individual’s experiences as vivid skin sensation including not only sensory information but also psychological state, allowing edition, transmission, experience and sharing	0.74	0.34	2030/2033
399	Body sharing technology to manipulate part/whole body of remote person/robot and to work cooperatively	0.93	0.64	2030/2033
400	Small wearable devices that naturally extend human physical and intellectual abilities, such as vision, smell, tactile sense, memory ability, and physical strength (actually use these abilities in locations where superhuman abilities are needed, such as firefighting and rescue)	1.03	0.55	2030/2032
401	Technology that allows general users without expert knowledge to design and produce complex artifacts such as cars and houses themselves, by selecting functional elements from existing libraries, etc.	0.33	0.04	2029/2033
402	A portable conversation device that enables people and animals who cannot speak to understand linguistic expressions and express their intention in language	0.52	0.25	2031/2034
403	An interactive virtual agent that cannot easily be distinguished from a real person in terms of expressions, gestures, emotions, presence, etc. (natural interactions will be possible for several minutes, such as reception and guidance)	0.76	0.63	2028/2030

ID	Topic	I score	C score	Realization time
404	A system that recognizes buildings, people, cars, etc., from the first-person viewpoint video group acquired by crowd wearable devices, and provides accident and hazard prediction information to the wearer (also effective for rescue and evacuation support in large-scale disasters)	0.88	0.50	2029/2032
405	AR sports using information displays naturally in real space that enables the player to compete with their past self, great sporting figures, remote people, video game characters, etc.	0.17	0.31	2028/2030
406	Virtual embodiment that allows you to adjust the amount and quality of your own sensory feedback anytime, anywhere, and to change your body motion unconsciously using camera-less motion capture	0.25	0.23	2030/2032

<Materials, devices, and processes>

Substances and materials

ID	Topic	I score	C score	Realization time
407	High-resistant inorganic materials with high plasticity comparable to organic polymers	0.72	0.41	2029/2032
408	Self-assembled organic and inorganic macromolecular hybrid materials	0.83	0.70	2027/2030
409	Easily recyclable crosslinking resin	0.77	0.51	2028/2030
410	Polymer material with high electrical conductivity and environmental resistance at room temperature equivalent to copper	0.86	0.47	2032/2035
411	Carbon-based structural materials with lightweight, high-strength, highly corrosion resistant, and long-life, which can be used for large-scale structures such as super bridges and associated recycling technology	1.04	0.83	2030/2034
412	High efficient power semiconductors for electrical power and motive power further exceeding silicon carbide (SiC) and gallium nitride (GaN)	1.18	0.92	2029/2033
413	New material that maintains quantum coherence at room temperature for a long period	0.73	0.37	2034/2038
414	A thermoelectric generator element that can substitute a conventional water-cooled radiator system	0.62	0.45	2030/2033
415	A new material for vibration-generated power with a storable output scale capable of efficiently converting friction/ mechanical stress to electric energy	0.72	0.44	2030/2033
416	Absorbents of almost all electromagnetic waves in the whole wavelength/energy region with no scattering	0.66	0.44	2031/2035
417	General purpose molding compounds with an established recycling loop of molding, mounting, recovery, extraction, refining and remolding	0.84	0.53	2030/2034

Processes and manufacturing

ID	Topic	I score	C score	Realization time
418	Mass customization of consumer products and its business model utilizing product information with IoT and ICT	0.85	0.18	2025/2027
419	Technology for autonomous transformation and conjunction of parts enabling expression of a new functionality and system integration (4D printing, 4D material)	0.66	0.20	2030/2033
420	On-demand and short lead-time semiconductor manufacturing system for high-mix and low-volume production	0.90	0.55	2026/2028
421	New manufacturing technologies such as additive manufacturing for on-demand spare part supply	0.92	0.41	2025/2027
422	A system that automatically archives tacit knowledge through measurement and modeling of the skills of a craftsperson (skilled experts, etc.)	1.16	0.50	2026/2029

ID	Topic	I score	C score	Realization time
423	Technology for manufacturing functional structures composed of multiple materials (multi-material) and free forms	1.04	0.67	2028/2031
424	Processing technology able to simultaneously control the geometrical shape of a product, the microstructure of the material and its arrangement	0.99	0.65	2028/2030
425	Additional manufacturing technology（3D printing）with equivalent productivity to conventional mass production technology	0.96	0.33	2027/2030
426	Forming (near net shape) technology minimizing requirements of following finishing using subtractive machining	0.74	0.53	2027/2029
427	Micromachining technology that enables metamaterial fabrication applicable to consumer products	0.63	0.46	2029/2032
428	Low environmental impact smelting technology achieved by constructing a new manufacturing system such as direct reduction	0.73	0.55	2030/2033
429	Ultra-precision processing technology on the order of Angstroms (processing, analysis, testing, in situ monitoring), with enhanced beam technology (ion, electron, laser, etc.), equipment control technology and sensor technology	1.09	0.75	2027/2030

Computational science and data science

ID	Topic	I score	C score	Realization time
430	Multi-scale simulation technology to holistically analyze and predict time-dependent change from atomic-scale chemical reactions to macroscale characteristics and deterioration under external factors such as friction, stress, electromagnetic field, heat, photon, media, etc.	1.12	0.48	2029/2032
431	Technology for consistent simulations of synthesis process, machining process, and function prediction under actual use environments	1.18	0.44	2029/2032
432	Multi-physics materials simulation technology from electronic-scale to atomic-scale, mesoscopic structure, macroscopic structure and industrial components	1.13	0.48	2030/2033
433	Concert technology of numerical simulation and innovative measurement for elucidating microstructure on nano-scale and dynamics including chemical reactions	1.00	0.54	2029/2032
434	Facilitating direct comparison between all-atomic simulation and electron microscopy and realizing high accuracy of calculation models through the development of several-billion-atoms molecular dynamics simulation technology for micrometer-scale	0.64	0.57	2029/2032
435	Simulation technology enabling prediction of characteristics, functions, deterioration, etc. on the basis of the elucidation and understanding of higher-order structures in composite materials	0.99	0.58	2029/2032
436	Concert/joint technology of informatics and simulations such as first-principle calculation and molecular dynamics simulation	1.09	0.44	2027/2029
437	Material property calculation method using a quantum computing	0.93	0.30	2032/2034
438	Technology to shorten the lead time to actualize real-world application of new materials to a fraction of the current time, based on prediction using simulation for long-term reliability of materials, including simulation of creep and fatigue	0.86	0.37	2030/2033
439	Technology to estimate infer the structure, components, and process of material with the desired function and properties, by applying simulation using refined prediction models with data assimilation, information statistical mechanics, etc., to the inverse problem in material science	1.13	0.41	2029/2032
440	Technology Methodology for creating new molding shaping and processes utilizing three-dimensional fabrication, materials and design case data as collective intelligence gathered in open spaces	0.66	0.16	2028/2030
441	Artificial intelligence that estimates the properties and characteristics of material in current and future (degradation, etc.) material, from image information on substances and materials (electron microscopic photographs, X-ray diffraction patterns, charge distribution calculation results, etc.) on substances and materials.	0.94	0.39	2028/2031

ID	Topic	I score	C score	Realization time
442	Technology for evaluating and judging the "quality" of data based on data on the characteristics of substances and materials, and automatically acquired data of related events (synthesis method, evaluation method, etc.)	0.84	0.23	2026/2030

Advanced measurement and analysis methods

ID	Topic	I score	C score	Realization time
443	Time- and space-resolved analysis technology for carrier motion in materials used for light-energy conversion	0.76	0.67	2028/2031
444	Real-time three-dimensional visualization technology of mass transfer and substance change inside batteries during charge and discharge	1.06	0.78	2027/2028
445	Analytical technology for material fluctuation in supercritical state and phase transition	0.51	0.52	2030/2034
446	Simultaneous multichannel measurement of catalytic reaction process and operand analysis	0.78	0.62	2028/2029
447	Operand analysis of structure and properties at solid-solid interfaces including all solid-state secondary batteries, power devices, and solar cells	1.05	0.80	2027/2028
448	Small apparatus on neutron operand analysis available at laboratory and at practical environment	0.39	0.30	2032/2034
449	Technology to estimate the physiological safety of nanomaterials	1.05	0.46	2031/2032
450	Low-voltage and atomic resolution electron microscope operating at the accelerating voltages less than 100 V for observing insulators and biomaterials	0.88	0.74	2029/2031
451	Extreme-environment electron microscope at high temperatures more than 800°C and high pressures more than 3 kPa for observing catalysts, metals, molten salts, etc.	0.86	0.58	2029/2031
452	The microscope visualizing bonding and anti-bonding orbitals in real space	0.66	0.42	2033/2035
453	Ultra-high-resolution microscope capable of visualizing the interior of atoms and molecules on the picometer-scale measurement	0.86	0.69	2031/2034
454	Technology that produces, controls and detects polarized neutrons in a wide range of energies (wavelength), to elucidate functions such as high temperature superconducting, spintronics materials, etc.	0.64	0.44	2032/2035
455	The elliptical mesh with a diameter more than 1 m, used for the analysis of angle-resolved electron spectroscopy	0.08	0.19	2029/2030
456	High-throughput analysis of multidimensional big data of 10 to 100 terabytes using data-driven measurement informatics	0.87	0.19	2027/2030
457	High-resolution and high-throughput analysis of biological structure using a combination of robots, cryo-electron microscopy and high-speed data processing environment	0.81	0.48	2028/2031
458	Optical technology that enables the control of the position and measurement of the motion for micro/nano-machines and biomolecules	0.81	0.48	2030/2033

Applied devices and systems relating to ICT and nanoelectronics

ID	Topic	I score	C score	Realization time
459	Ultra-small human-machine interface (HMI) device with integrated sensing, information processing, and actuation functions to accelerate and support various abilities in the human mind and body, such as exercise, memory, information processing, and natural healing	1.20	0.48	2029/2032
460	Printable and stable flexible organic semiconductor transistors with mobility comparable to single crystal silicon, which can be mounted on curved surfaces and movable parts at low cost	0.89	0.71	2029/2030
461	High-level VR system (conference, manufacturing management) and a supporting high-speed information distribution system	0.82	0.34	2025/2027

ID	Topic	I score	C score	Realization time
462	Nonvolatile memory with lifetime of 50 years or more, with the reading and writing speed of DRAM and the large capacity of flash memory	1.21	0.81	2029/2030
463	Single-spin information devices with a high speed and low power consumption beyond the limitation of CMOS devices	1.10	0.70	2033/2035
464	A new device capable of generating single photons at a high rate on demand	0.78	0.41	2032/2036
465	Super parallel, low power consumption AI chip, achieved with monolithic three-dimensional integration of steep on/off transistors and analog memories	1.06	0.45	2030/2032
466	Micro communication device via a micro-antenna using a nonlinear response for a nano resonator	0.58	0.32	2031/2034
467	Palm-sized quantum computer accelerator able to be integrated into existing computers	0.93	0.19	2035/2038
468	High-efficient quantum-communication device technology to realize quantum internet between quantum computers	1.00	0.31	2034/2038
469	Quantum simulator that enables drug design and catalyst design based on quantum chemical calculations	1.09	0.27	2031/2033
470	Imaging technology using quantum entanglement: almost no light hits objects (e.g. living body) causing no damage to them	0.51	0.33	2035/2038
471	Ultra-compact quantum sensor that exceeds the shot noise limit	0.74	0.40	2034/2037
472	Quantum memory for high-security financial systems using quantum cryptography	0.97	0.19	2033/2036

Applied devices and systems relating to environment and energy

ID	Topic	I score	C score	Realization time
473	Solar cell with conversion efficiency exceeding 50%	1.31	0.71	2033/2036
474	High-capacity, high-power battery with an energy density of 1 kWh/kg or more and a power density of 1 kW/kg or more (for automotive, this would equate to a driving range of 500 km with the current size and weight battery)	1.50	0.91	2030/2032
475	Aiming for a hydrogen society, a fuel cell where the amount of precious metal used is one tenth or less of that used in 2018, with consideration of catalyst deterioration	1.23	0.94	2032/2033
476	Energy harvesting power generation system able to utilize unused mid to low-temperature wastewater at 60 - 100°C	0.88	0.42	2030/2033
477	Power generation system using high-rise westerlies and tidal currents with minimal environmental impact	0.52	0.12	2033/2034
478	Smart grid through low-cost and compact high-voltage DC power transmission equipment (power converter, insulator, cable)	0.81	0.31	2031/2034
479	Photoreduction catalyst or artificial photosynthesis with an energy efficiency of 20% or more in CO_2 recycling (synthesis of fuel or chemical raw materials)	1.07	0.65	2036/2039
480	Membrane separation technology for producing hydrogen using coal as the raw material, without releasing CO_2 into the environment	0.87	0.46	2032/2036
481	Method for removing harmful elements and substances (cesium, lead, arsenic, mercury, cadmium, benzene, hexavalent chromium, cyanide, etc.) from water and soil with low energy expenditure	0.98	0.57	2030/2034

Applied devices and systems relating to infrastructure and mobility

ID	Topic	I score	C score	Realization time
482	High-performance hybrid structural materials (structural performance, design, corrosion resistance, etc.) made of iron and nonmetallic materials (wood, concrete, CFRP, etc.)	1.03	0.76	2029/2032
483	Structural materials with self-repairing functions preventing deterioration and damage over time which can maintain the function of structures such as buildings	1.02	0.59	2033/2035

ID	Topic	I score	C score	Realization time
484	High-strength steel material for construction, capable of high-heat input welding (780 MPa structural material capable of welding 100 mm thickness at once) for large buildings such as skyscrapers, etc.	0.64	0.64	2029/2034
485	A high-density hydrogen carrier with a hydrogen storage density of 100 kg/m^3 or more and a mass storage density of 10 wt.%, for fuel cell vehicles	1.05	0.69	2031/2035
486	3D printing materials able to manufacture arbitrarily-shaped infrastructure repair parts at low cost	0.89	0.48	2028/2029
487	Simple technology in joining and bonding for structural material, independent of the skills of a person, considering the lack of skilled workers	0.94	0.53	2028/2031
488	Corrosion-resistant technology (including coating film) capable of achieving an ultra-long life of more than 50 years for structures in marine atmospheric environment	1.16	0.78	2030/2032
489	Technology to diagnose the state of deterioration inside an infrastructure in real time	1.29	0.71	2028/2029
490	Mobility system that automatically operates the necessary infrastructure such as energy (fuel and gas) supply and waste collection in the event of a labor shortage due to the declining birthrate and aging population	1.13	0.34	2028/2030
491	A system that automatically decentralizes the existing centralized water supply and sewerage infrastructure needed in underpopulated areas where infrastructure cannot be economically maintained	1.17	0.43	2029/2031
492	A system capable of providing a non-contact power supply of 20 kW or more to a passenger car traveling at 100 km/h, which has a structure that can withstand the travel of a truck equipped with heavy loads	0.55	0.43	2030/2036

Applied devices and systems relating to life sciences and biotechnology

ID	Topic	I score	C score	Realization time
493	3D food printing technology for manufacturing (forming) made-to-order food based on artificial foods such as artificial meat	0.12	0.17	2028/2030
494	Ultra-small chemical analysis system able to confirm food safety on the spot	0.98	0.71	2027/2029
495	Soft material with functions for robots to enable the same soft movements and feel as a person	0.95	0.75	2028/2030
496	Biomimetic material compensating for loss of human sense and even reinforcing to achieve superhuman levels	0.97	0.42	2032/2036
497	Wearable devices that monitor *in vivo* information (pharmacokinetics, cancer markers, infection, other blood components)	1.32	0.58	2028/2031
498	Embedded healthcare device (examination, diagnosis, treatment) that continues operating semi-permanently with bioenergy	1.11	0.38	2032/2037
499	Biocompatible material with biomimetic based surface and / or structure that dramatically improves durability and safety	1.07	0.80	2028/2031
500	Biomaterial and processing technology for long-term preservation of organs for transplantation	1.21	0.54	2030/2034
501	System and biomaterial for *in vitro* culture of biological tissue	1.26	0.82	2029/2033
502	Production of regenerated tissues and organs using 3D printing technology (biofabrication)	1.06	0.47	2031/2034
503	Monitoring technology capable of tracking the dynamics of cells and intracellular proteins, amino acids, ions, etc., with a time resolution of microseconds or less	0.75	0.38	2031/2033
504	Technology for predicting the three-dimensional conformation of proteins from their primary sequence structure	0.75	0.42	2029/2031
505	Elucidation of novel biological and biochemical phenomena using ultra-high precision measurements with quantum entangled light	0.48	0.33	2033/2036

ID	Topic	I score	C score	Realization time
506	Technology for practical application of devices and daily commodities composed solely of biodegradable materials (for example, items that can be left in the body and in the environment)	1.16	0.61	2030/2032
507	Biodegradable materials or materials with biochemical functions that achieve CO_2 fixation and waste recycling processes	1.06	0.50	2031/2034

<Cities, architecture, civil engineering, and transportation>

Land use and preservation

ID	Topic	I score	C score	Realization time
508	Floating structures compatible with preserving the marine environment (traffic, communication, production, activity base, etc.)	0.73	0.41	2031/2031
509	Sewage technology for recovery of resources such as precious metals from sewage and to achieve energy self-reliance	0.87	0.41	2028/2029
510	Technology for estimating and observing underground water quality and flow	0.66	0.45	2027/2028
511	Estimation of global groundwater reserves (fossil water) that can only be used non-continuously for appropriate international management	0.16	0.05	2029/2032
512	Technology to sense levee breaches in advance using a combination of prediction and observation	1.22	0.72	2028/2030
513	Technology for emergency restoration which includes the rapid closure of riverbank breach when river levee deformation occurs	1.31	0.88	2025/2027
514	River channel design technology integrating long-term environmental conservation and maintenance	0.98	0.78	2029/2030
515	A sediment transport system for predicting geographical changes of land, including mountain and coastline regions, estimations and technology to appropriately conserve land	0.90	0.66	2032/2033
516	Tourists from all countries who are traveling in Japan are able to receive information and support related to sightseeing spots and may travel anytime and anywhere, to ensure that inbound tourism can be enjoyed smoothly and comfortably	0.86	0.05	2024/2027
517	Technology for quantitatively determining real-time changes in land, large structures and deformation during disasters using the positioning data from quasi-zenith satellites	1.26	0.78	2028/2029
518	Technology for elucidating the mechanism at which microplastics are generated and the actual load in public waters, in order to implement appropriate pollution source control	0.75	0.39	2030/2033

Architecture

ID	Topic	I score	C score	Realization time
519	Adhesive bonding technology for steel framework to greatly streamline steel framework construction	0.48	0.64	2029/2031
520	Advanced indoor environmental health monitoring and control technology that suppresses indoor "health disorders" and "outbreaks of infectious disease"	0.76	0.58	2028/2030
521	Advanced and integrated worker productivity monitoring technology to improve the health and comfort of office workers, and promote work efficiency improvement and reformation of working style	0.71	0.24	2028/2030
522	Improvement and normalization of living functions of housing for elderly and disabled people and households with children, etc. through utilization of AI, IoT, robots, etc. that are integrated into the building & facilities	1.38	0.56	2029/2030
523	New technology integrated residential buildings, mobility and ICT or AI to improve variable updates over time, everyday environmental energy impact, and ease of evacuation in an emergency	1.22	0.69	2029/2030

ID	Topic	I score	C score	Realization time
524	Recycling process technology for building materials, which greatly transforms the production efficiency of recycled materials and the mechanism of recovery and recycling, using 3D printers and other such technology	0.75	0.25	2031/2034
525	Technology for construction of a "marine city", which utilizes the potential of the ocean, and facilitates a new eco-city and eco-lifestyle on the ocean	-0.39	0.03	2043/2048
526	Construction technology for 'space architecture' in space and on the surface of the moon and Mars for enlarging the human habitat based on a long-term perspective	0.08	0.38	2043/2052
527	Technology for new wooden materials and construction methods that enable construction of buildings such as high rise buildings of a certain size or larger	0.58	0.60	2028/2031
528	Best mixed technology for surplus small-scale renewable energy in a wide area, to improve the renewable energy consumption ratio of existing cities and buildings	0.95	0.40	2029/2033
529	Infrastructure-free autonomous architecture exceeding ZEB (Zero Energy Building)	0.80	0.33	2036/2037
530	Further rational refurbishment and dismantling technology for existing buildings (technology that enables rapid repair and dismantling of buildings, including skyscrapers)	1.33	0.88	2029/2033

Social infrastructure facilities

ID	Topic	I score	C score	Realization time
531	Technology that utilizes remote sensing technology to monitor horizontally and vertically displaced infrastructure in a wide area on the order of millimeters	1.10	0.86	2027/2029
532	Rapid evaluation of the applicability and durability of new technologies and materials using numerical simulation	1.22	0.64	2027/2028
533	General use of high-functional, highly durable, environmentally friendly and low-cost infrastructure materials in construction of infrastructure, based on material informatics	0.93	0.37	2028/2029
534	Technology to monitor, predict and control infrastructure with seamless coupling of physical and cyber space	0.96	0.25	2028/2030
535	Technology for detecting abnormalities in civil engineering structures and foundations, using radar mounted on a fast-moving vehicle	1.15	0.65	2028/2028
536	Technology to design, construct, maintain and manage infrastructure for space use	0.36	0.18	2036/2038
537	Technology to extend the life and rapidly renew infrastructure facilities using robots, new materials, and 3-D printers	1.16	0.41	2029/2030
538	Infrastructure highly resistant to environmental degradation and external forces	1.27	0.73	2029/2030
539	Real-time prediction of damage related to slope failure and earth structure based on highly accurate predictions of localized torrential rainfall over a short time	1.38	0.91	2027/2029
540	Technology for water purification, rainwater management and runoff control by implementing technology for the design and operation of infrastructure facilities actively using the ecosystem such as trees, vegetation and soil	0.72	0.36	2031/2031
541	Non-destructive inspection technology which may be used in the field to improve the reliability of inspection and diagnosis of infrastructure and to reduce the burden associated with this work	1.53	0.80	2025/2026

Cities and environment

ID	Topic	I score	C score	Realization time
542	Platform capable of sharing linking and using data held by various organizations to strive to make city-related data open data	1.17	0.03	2026/2029

ID	Topic	I score	C score	Realization time
543	Technology for comprehensive and efficient provision, maintenance and quantitative evaluation of green infrastructure, developed using nature's diverse functions	0.90	0.21	2026/2029
544	Nudge-type housing information provision system promoting rational residential selection behavior (Housing information provision system with a mechanism to urge voluntary desired choice by using knowledge of behavioral science)	0.36	-0.03	2029/2032
545	Residential district independent of wide area infrastructure	0.19	-0.13	2029/2030
546	Technology for creating highly accurate disaster hazard maps to enable detailed city planning	1.51	0.99	2027/2028
547	Consensus building support system that enables discussion and decision-making on urban planning without being limited by time and place	0.64	-0.18	2026/2030
548	A system for monitoring changes in land use and for proposing appropriate urban planning methods to enable detailed city planning (zoning and development of urban facilities)	0.71	0.09	2027/2029
549	Environmental assessment technology to accurately evaluate micro changes brought about by development	0.49	0.29	2028/2031
550	Technology for extensive maintenance and management of low-use or unused areas caused by population decrease	1.23	0.00	2029/2031

Construction production system

ID	Topic	I score	C score	Realization time
551	Technology to search for and notify the existence of abnormalities, where robots and sensors automatically and autonomously check and diagnose abnormalities based on design, construction and past inspection data	1.29	0.48	2028/2029
552	Electronic map that becomes the basic national map, including dynamic information, and collection of automatically updated information	1.12	0.41	2027/2030
553	Unmanned construction machine capable of autonomous construction based on design data, while recognizing changes in working conditions and surrounding construction conditions, etc.	1.22	0.59	2028/2031
554	Technology that constantly ascertains the work environment of workers (high place work, crane turning range, heat stroke, etc.) based on camera and biometric sensor information and automatically issues alerts	1.03	0.61	2026/2027
555	Technology to constantly ascertain and analyze the status of work progress at the construction site using AI, which properly manages and automatically optimizes and modifies processes	1.03	0.55	2029/2030
556	Automation of on-site assembly by unitization of concrete structures such as bridges	0.84	0.56	2026/2027
557	Construction of an infrastructure data platform that enables automatic accumulation and integrated utilization of 4D data (including time series) for the entire construction process from surveying and investigation through to design and construction, supervision and inspection, maintenance and management.	1.27	0.36	2027/2029
558	Technology based on BIM data which manages construction projects from design to construction through to confirmation of form, and to maintain and manage projects with sensors and robots	1.14	0.46	2027/2029
559	Futuristic streamlined construction methods for structural framework and finishing and fitting-out, including on-site production of parts with a 3D printer, autonomous transportation of building materials by robots and drones.	1.07	0.31	2030/2033

Traffic systems

ID	Topic	I score	C score	Realization time
560	Navigation system providing information that elderly people and visually impaired people can act safely and freely	1.43	0.35	2025/2028

ID	Topic	I score	C score	Realization time
561	Seamless transportation system extending from local transport to wide area transport, that enables elderly people to move door to door independently and with confidence, in a super aged society	1.42	0.19	2028/2031
562	A transport system that halves the time, cost, and environmental burden at each transport hub constituting the railroad and road, road and port/airport, and railway and port/airport, to improve the efficiency of cargo transport between cities	1.23	0.23	2027/2029
563	A mobility management system developed to a scale of hundreds of thousands of people, to ensure smooth movement of people between cities in an emergency (some service interruption due to disaster and failure, etc.)	1.34	0.54	2028/2029
564	Electric personal mobility that occupies a similar area as pedestrian space and has a cruise distance of about 20 km	0.70	0.25	2026/2027
565	A system that automatically measures changes in factors such as temperature, impact and components in intermodal transport and can trace products from production, transportation and storage, through to use and disposal	0.50	0.34	2025/2028
566	Mobile service with level 4 automatic operation in urban areas (the system performs all driving operations but the driver appropriately responds to system intervention request, etc.)	1.42	0.48	2025/2029
567	Ticketless toll collection system using face authentication etc. on public transport	0.60	0.53	2024/2026
568	Level 5 automatic operation (system operates every aspect without being limited by location)	1.24	0.44	2030/2034
569	A system that automatically measures environmental conditions such as car probe data, vehicle weight, and weather and accurately predicts deterioration of road infrastructure	1.00	0.75	2027/2029
570	Flying cars and drones" able to carry people in urban areas	0.47	-0.17	2029/2033
571	A system that smoothly adjusts traffic conflicts that occur in locations like confluence points, provides optimal route guidance, and collects road tolls according to time and place, using dynamic maps that store real-time position information on moving objects such as cars, bicycles and pedestrians	1.04	0.64	2028/2032

Cars, rail, marine, and aviation

ID	Topic	I score	C score	Realization time
572	Cheaper technology for contactless charging infrastructure technology that sequentially charges cars when parked in public parking lots or when stopped at intersections, and technology for storing and supplying hydrogen with improved safety	0.87	0.62	2028/2030
573	Autonomously navigable unmanned merchant vessels	0.74	0.45	2027/2031
574	Technology that assesses ship performance and safety (able to give feedback on life expectancy and design, etc.) using big data related to the ship's operation, structure and safety by continuously monitoring the vessel	0.57	0.51	2027/2029
575	Clean ships that do not emit CO_2 within the bounds of the marine transportation system	0.86	0.61	2029/2030
576	An unmanned piloted aircraft with a lower probability of failure than the probability of human error, using a highly accurate operating system capable of safely controlling both aircraft and air traffic control based on the current traffic volume	0.83	0.15	2028/2032
577	Low noise and energy-saving aircraft (noise level reduced by 90%, fuel consumption halved) achieving low noise at takeoff and landing and low emission gas during flight, further reducing friction resistance of the aircraft and improves combustion efficiency of the engine	0.88	0.30	2031/2034
578	A maintenance system that reduces maintenance costs through maintenance efficiency and optimization by predictive combinations of huge information groups (big data) and AI, including fault detection for each fuselage	0.79	0.25	2027/2029

ID	Topic	I score	C score	Realization time
579	System technology to facilitate a supersonic passenger aircraft that can compete with existing subsonic aircraft in terms of environmental friendliness, safety and economy, as well as improving convenience by greatly shortening travel time	0.26	-0.17	2032/2037
580	A system that preemptively prevents accidents by determining human error and issuing advanced warning when erroneous operation is performed in a given situation, through contactless monitoring of the brain waves of the operator and pilot	0.77	0.47	2029/2034
581	Technology that satisfies environmental standards for noise (70 dB (A) or less in residential areas) during continuous running at Shinkansen speed of 360 km, by using active noise control	0.83	1.10	2027/2029
582	Unmanned operation of railways at railroad crossings and other locations where people can enter from outside	0.86	0.59	2026/2029
583	A system that notifies surrounding vehicles of a train approaching a railroad crossing and automatically prevents cars entering the railroad crossing area (prevention of railroad crossing accidents by communication with cars)	0.84	0.73	2025/2027
584	A system that automatically controls acceleration / deceleration of each train in a given area, minimizing energy consumption (railway smart grid) to enable effective use of energy obtained through regenerative braking	0.97	0.89	2025/2025

Technology for disaster prevention and mitigation

ID	Topic	I score	C score	Realization time
585	Technology to determine earthquake damage in real-time using the digital twins of nuclear power station building, piping and nuclear reactors	1.11	0.58	2028/2029
586	High-performance radar capable of ascertaining detailed information on rainfall in linear rain bands and torrential rain	1.33	1.09	2025/2026
587	Response control to long-term, long-duration ground motion of high-rise buildings and seismic base isolation buildings	1.33	1.16	2026/2028
588	Zero-damage structures that incur zero damage during earthquakes by performing optimum control including feed forward, and facilitating active vibration control on a large scale and large output, together with early earthquake warning at the waveform level	0.95	1.00	2034/2037
589	Design methods and structural technology (establishment of "crisis tolerance") that avoid severe damage in the event of disturbance or deterioration of the structure	1.38	0.93	2029/2031
590	Technology or a system that predicts peak flood flow rate in river basins and dam catchment areas of several hundred square kilometers, within a time error of ±1 hour, 12 hours before the peak, and a flow estimation accuracy of ±10%	0.86	0.64	2030/2032
591	Technology or a system that predicts the total inflow between June and August in the catchment area of dams of tens to hundreds of square kilometers, with an estimation accuracy of ±10% as of April	0.36	0.27	2030/2032
592	Clarification of the mechanism of various types of liquefaction and the nationwide liquefaction risks, and establishment of countermeasure technology that can be executed at low cost and in a short period of time	0.96	0.86	2030/2033
593	An intelligent disaster response robot capable of autonomous movement in an unlimited environment (unknown environment)	1.12	0.49	2031/2034

Information for disaster prevention and mitigation

ID	Topic	I score	C score	Realization time
594	Real-time damage observation and expanded prediction system in a major earthquake using IoT device	1.48	0.85	2026/2028
595	Danger forecast, warning and avoidance system to halve the incidence of maritime accidents such as capsize, collision, and running aground	0.63	0.33	2024/2027

ID	Topic	I score	C score	Realization time
596	Rapid and accurate detection system for trace amounts of hazardous substances in public places, places where customers congregate, and transportation infrastructure such as airports, ports, railroads, etc.	0.93	0.22	2025/2029
597	Disaster evacuation navigation system using multilingual/ nonverbal communication with the use of personal mobile terminals	1.20	0.37	2025/2028
598	Construction of a highly accurate weather observation system that allows for early warning, evacuation and regulation and more sophisticated disaster prediction methods	1.38	0.81	2027/2030
599	Technology using ICT to guide the disaster prevention behavior of each individual citizens	1.32	0.64	2026/2029
600	System for disaster information sharing and disaster response support using earthquake-proof elementary and junior high schools as the regional disaster prevention base	1.12	0.67	2024/2026
601	Numerical analysis and visualization technology capable of simulating large-scale disasters associated with strongly nonlinear behavior	1.06	0.71	2027/2031
602	SNS information analysis system that provides the necessary evacuation information required by local residents for real-time tsunami prediction	0.92	0.64	2025/2027

<Space, ocean, earth, and science foundation>

Space

ID	Topic	I score	C score	Realization time
603	A reusable transportation system (partial use launch vehicle, complete reuse launch vehicle, inter-orbit reuse launch vehicle, etc.) able to achieve space utilization at low cost	1.07	0.08	2029/2032
604	Service technologies including refueling, repair inspection, equipment replacement, etc. for satellites that conduct a variety of space activities (including removal and recovery of space debris)	0.84	0.25	2030/2033
605	Construction of a permanent manned base on an extraterrestrial object (the Moon or Mars), for scientific observation and resource utilization	0.52	0.00	2035/2040
606	Technology to construct a water generation plant utilizing robotics, with the aim of securing a water production and supply base on the lunar surface	0.18	-0.01	2034/2038
607	Technologies for exploration that contribute to life exploration in target solar systems and elucidation of the formation of planets (direct exploration by artificial satellites, etc.)	0.72	0.80	2032/2033
608	Twenty-four-hour high-precision surveillance system of the national territory using satellites, etc., to secure public safety and security and for industrial use	1.14	0.54	2027/2029
609	Highly accurate positioning technology that provides accurate position information with an error margin of a few centimeters, using artificial satellites, to enable automated driving of automobiles and unmanned and automated agriculture (including improving the performance of atomic clocks)	1.32	0.80	2026/2027
610	Establishing a theory on the formation and evolution of the solar system, the sun and planets in the system	0.30	0.67	2033/--
611	Establishing a theory on the formation and evolution of galaxies and the Milky Way	0.31	0.63	2034/--
612	Elucidation of the mechanism of generation of super high energy cosmic rays	0.22	0.64	2033/--
613	Gravitational wave interferometer to be deployed in space	0.19	0.25	2037/2039

Ocean

ID	Topic	I score	C score	Realization time
614	Inexpensive system capable of automatically monitoring ocean acidification on a global scale	1.06	0.59	2028/2030
615	Completely autonomous system capable of exploring the ocean interior to a depth of 6000 m for extended missions (1- 3 months)	0.98	0.86	2029/2030
616	Autonomous observation system with equivalent capability of investigation to current manned ships	1.11	0.57	2030/2033
617	High-speed acoustic communication technology exceeding 1 Mbps at a distance of 10,000 m in the ocean	0.65	0.36	2029/2031
618	Sensor for in situ detection and quantification of microplastic in the ocean	1.01	0.44	2027/2030
619	Autonomous technology for in situ analysis of environmental DNA in the ocean	0.83	0.56	2028/2030
620	Technology for high-precision evaluation of fishery resources using molecular biological approaches	1.20	0.51	2030/2032
621	Fully-automated ocean farming facilities	1.05	0.62	2030/2033
622	Environmentally friendly and economically viable technology for harvesting ocean floor mineral resources	1.18	0.49	2032/2036
623	Technology for marine environment monitoring and exploration (oil, natural gas, mineral resources, etc.) in ice-bound seas (including under the ice)	0.96	0.44	2030/2033

Earth

ID	Topic	I score	C score	Realization time
624	Scientific deep drilling technology for sampling from deep Earth	0.80	0.96	2029/2030
625	Examination of the Earth's mantle and core using ultra-high-pressure, ultra-high-temperature experiments and data analysis technology	0.49	0.99	2030/--
626	Optical measurement technology enabling real-time observation in extreme environments (optical fiber sensing, optical interference seismometers, etc. No power supply required for sensors)	0.98	0.49	2028/2030
627	Oceanic geodetic surveying technology with spatial resolution of 20 km on the seafloor that achieves observations equivalent to GEONET on the land (GNSS (Global Positioning Satellite System) continuous observation system)	0.99	0.68	2031/2032
628	Observation and data processing system for discovering underground resources, marine resources, etc., using satellites, marine and ocean sensors and autonomous unmanned vehicles (AUV), etc.	1.15	0.50	2028/2030
629	Evaluation of the urgency of identifying the next volcano likely to erupt or unlikely to erupt, from all active volcanoes in Japan	1.51	0.91	2031/2033
630	Forecast technology based on the mechanism of sector collapse	1.08	0.51	2033/2035
631	Technology to improve the dating accuracy of 50 to 100 thousand years ago to elucidate the history of active faults and volcanic eruptions	0.88	0.73	2030/2030
632	Technology to predict the location, scale, timing (within 30 years), and damage of inland earthquakes with magnitude 7 or higher	1.17	0.83	2037/2036
633	Technology to predict the occurrence of large-scale earthquakes with magnitude 8 or higher by analyzing the distribution of crustal strain and past earthquake history	1.29	0.87	2034/2035
634	Technology for measuring regional crustal stress fields in seismogenic area	0.94	0.72	2030/2032
635	A technology to observe signs and occurrence of disasters that may be overlooked by humans using artificial intelligence which uses big data such as images, earthquake and tsunami data, etc.	1.08	0.44	2029/2032
636	Forecast of earthquakes induced by underground discharge as a result of CO_2 storage, shale gas extraction, enhanced geothermal reservoir power generation, etc.	0.60	0.18	2030/2034

Observation and prediction

ID	Topic	I score	C score	Realization time
637	Technology to observe atmospheric conditions such as water vapor, precipitation and aerosol on a global scale, with higher precision and sensitivity than currently available methods, using satellites, etc.	1.31	0.88	2028/2030
638	System for observation of trace atmospheric components using imaging spectrometer technology with satellites etc.	0.81	0.53	2029/2030
639	System to observe the status of vegetation environment using Lidar technology with satellites, etc.	0.60	0.30	2027/2028
640	Technology for constant observation of terrestrial and coastal areas at a spatial resolution of 30 m with geosynchronous satellites, for use in food, water and disaster risk management in East Asia, Southeast Asia and Australia	0.91	0.75	2029/2031
641	Oceanographic surveillance system that ascertains sea ice, sea surface temperature, waves, ocean currents, chlorophyll, primary production, etc., by satellite on a global scale in real time	1.06	0.69	2028/2029
642	High-precision sea surface height observation system for real-time determination of global oceanographic conditions and ocean floor topography, including coastal seas and marginal seas, using interference SAR technology	0.79	0.51	2029/2031
643	Technology to monitor the characteristics of temporal changes in snowfall and accumulated snow and to predict the scale and extent of danger of snow and ice accidents in a wide area, using a snow and ice disaster model	0.93	0.53	2028/2031
644	Technology for predicting localized heavy rain, tornadoes, hail, lightning, snowfall, etc., several hours ahead with spatial resolution of 100 m or less, using high-resolution simulation and data assimilation	1.50	1.05	2027/2029
645	A system that rapidly identifies the contribution of long-term climate change to abnormal weather that actually occurs, such as heat waves and heavy rain	1.01	0.78	2028/2030
646	Technologies that allow for the use of the internet in ocean spaces	0.76	0.26	2027/2029

Computational, mathematical, and information sciences

ID	Topic	I score	C score	Realization time
647	Construction of an environment in which supercomputers exceeding 10 exaFLOPS through a 1 Tbps network class can be used by many researchers from industry, academia and government, used to record and store experimental data on natural science generated at a rate of 1 exabyte per year at each organization	0.92	0.30	2028/2030
648	Algorithms that fully utilize the characteristics of gate type quantum computers that can reduce the number of operations by 10 digits or more compared with classical gate type computers	0.81	0.08	2031/2036
649	A method for developing tailor-made medicines, cosmetics, etc., using pharmacokinetic simulation technology by supercomputer and a bioassay system using iPS cells, etc.	0.81	0.46	2031/2035
650	Simulation technology enabling prototype-less development of cars, large industrial products, buildings, etc., based on the inverse problem material development method that adapts material characteristics including aging (deterioration, etc.) to the required performance	0.57	0.18	2030/2032
651	A mathematical-scientific congestion prediction model that prevents congestion even during abnormal times such as during natural disasters and accidents, and a real-time navigation system integrated with an IoT sensing system	1.00	0.42	2028/2029
652	Social integrated disaster prevention system that can promptly provide information on optimization of the logistics related to relief supplies, human resources and evacuation routes, as well as information pertaining to urban infrastructure restoration such as electricity, water, communication, etc., to local governments, corporations, and other individuals, based on a system that processes various observational data, social media data, etc., in an integrated and real time manner and ascertains the situation of the disaster with immediacy	1.18	0.54	2029/2030

ID	Topic	I score	C score	Realization time
653	Data assimilation technology incorporated into an observation information model and an Earth system model that considers high-resolution atmospheric and ocean general circulation models, as well as matter and energy circulation through biological and chemical processes, which enables predictions ranging from natural fluctuations on a scale of 10 years to precisely predict long-term global environmental changes of anthropogenic origin over a 100-year period	0.74	0.47	2033/2036
654	A system that can use the various dataset and databases owned by industry, academia and government, at least in a specific field (for example, material field), convert the format and style differences between datasets and databases without human intervention and link the information and data, thus enabling these datasets/databases to be used as a single large dataset database with various analytical tools	0.76	-0.06	2028/2030
655	A system that supports policy decision-making with large scale simulation using social mathematical models and social activity data based on mathematical analysis of social activities	0.52	-0.22	2030/2034
656	Knowledge-intensive data mining technology that extracts meaning from information such as writing, speech, and images, summarizes the data in a form without loss of key information, and performs conversion and association between information media (reading physical values from figures and graphs of experiment results, etc.)	0.79	0.15	2027/2030
657	Generic machine learning algorithm (including mathematical scientific elucidation of the application limit of the machine learning model) that assembles a machine learning model matched with the purpose from collected data without human intervention	0.90	0.08	2029/2032

Elementary particle, nucleus, accelerator

ID	Topic	I score	C score	Realization time
658	Establishment and verification of the theory of quantum gravity	0.18	0.49	2043/--
659	Elucidation of the origin of asymmetry of matter and antimatter in space	0.53	1.07	2033/--
660	Elucidation of the Majorana nature of neutrinos	0.39	1.00	2032/--
661	Elucidation of the true character of dark matter	0.55	0.66	2034/--
662	Elucidation of the true character of dark energy	0.28	0.44	2043/--
663	Establish an inflation hypothesis	0.30	0.75	2035/--
664	Elucidation of the nuclear process from light element synthesis in the early universe to heavy element synthesis associated with evolution of a star	0.57	0.98	2032/--
665	Academic and industrial use of accelerators using new accelerating technology such as plasma wakefield acceleration and dielectric acceleration	0.85	0.47	2034/2039
666	Novel Lepton Collider technology (muon collider, unprecedented electron and positron colliders including use of plasma acceleration, etc.)	0.67	0.86	2035/2039

Quantum beam: synchrotron radiation

ID	Topic	I score	C score	Realization time
667	Development and utilization of high-brilliance synchrotron radiation for soft X-ray in Japan	1.43	0.63	2024/2024
668	High-speed synchrotron-radiation operand measurements (ps to fs time resolution) to directly visualize the kinetics of chemical reactions and dynamics in materials and electronic devices	1.13	0.62	2026/2029
669	Cost-effective, ultra-high brilliance X-ray source with ultra-low emittance storage ring	1.21	0.63	2027/2029

ID	Topic	I score	C score	Realization time
670	Technology for observing the local structure and electronic state with nm space- and fs time-resolutions, which is required for elucidation of functional mechanism and the control of functional materials (electronic materials, magnetic materials, catalyst materials, battery materials)	1.38	0.74	2027/2029
671	An X-ray microscope with a μm-order field of view and a sub-nm spatial resolution, capable of imaging element-specific structure and electronic state of materials in three dimensions	1.22	0.67	2028/2030
672	Coherent diffraction imaging using high coherence synchrotron radiation of aperiodic functional materials such as cells, glass, polymers, surfaces and interfaces	1.17	0.67	2027/2028
673	Diffraction imaging of a single protein molecule	0.99	0.60	2029/2030
674	Analysis of protein structure and dynamics under active conditions	1.00	0.51	2028/2030
675	Development of high-speed two-dimensional X-ray detectors with high spatial resolution (<10 μm) and high-sensitivity (detection quantum >0.8) to make the best use of X-ray-free-electron lasers	1.01	0.44	2028/2029
676	Advanced synchrotron-radiation measurement combined with information science (machine learning, Bayesian inference, data assimilation, optimization problem, etc.)	0.98	0.18	2025/2026
677	Elucidation of temporal- and spatial- hierarchical structure of materials by combining scattering and spectroscopy experiments	0.93	0.40	2027/2028
678	Elucidation of non-equilibrium/ non-linear phenomena in materials using X-ray free electron lasers	0.71	0.77	2027/2028

Quantum Beam: neutrons, muons, charged particles, etc.

ID	Topic	I score	C score	Realization time
679	Technology for generating and controlling polarized neutrons and precisely measuring the local magnetic structure and magnetic excitation of a magnetic substance	0.86	0.70	2027/2029
680	In-situ observation technology that visualizes three-dimensional stress and strain, magnetic field distribution, etc., of functional materials and structural materials in the actual working process of using neutrons and X-rays	1.21	0.86	2026/2028
681	Technology to generate and control ultra-slow muon to elucidate the magnetic state by analyzing depth decomposition on a nanometer scale	0.89	1.04	2027/2028
682	Technology to generate and control polarized positrons and conduct model-free observations of the structure and magnetic structure of the first surface layer	0.42	0.62	2028/2030
683	Technology to process and control while analyzing material structure and function on a wide scale (nm to mm), using multiple quantum beams (neutrons, synchrotron radiation, positrons, lasers, ions, etc.) in a complex and complementary manner	1.23	0.99	2028/2029
684	Technology to enable high-quantity and stable manufacturing of radioactive isotopes such as At211, using neutron and ion beams, which are required for development of new radioactive drugs for precise diagnosis and highly efficient treatments	0.90	0.49	2026/2029
685	Technology for three-dimensional visualization measurements of microstructures and magnetic fields in metal material using enhanced high-intensity neutron imaging technology	1.04	0.93	2027/2028
686	Technology for visualization of magnetic field distribution using high-intensity polarized neutrons and the associated operand measurement technology	0.53	0.62	2029/2030
687	Stroboscopic measurement technology using characteristics of pulse neutron beams	0.70	0.70	2027/2028
688	New measurement technologies, including imaging with high-intensity muons and operand measurements	0.66	0.84	2028/2029
689	Muon microscopy technology	0.75	0.82	2029/2030

ID	Topic	I score	C score	Realization time
690	Technology to clarify the characteristics of mutation with quantum beams such as ion beams and gamma rays, using comprehensive molecular information and technology to securely acquire a desired mutation using the aforementioned	0.60	0.53	2030/2033
691	Technology that enables acquisition of the nuclear data of unexplored regions by generating short-lived super heavy elements, etc., through fusion of an ion accelerator and high-intensity laser and simultaneously extracting the data in an ionic state	0.45	0.78	2029/2033

Optical and quantum technologies

ID	Topic	I score	C score	Realization time
692	Technology to link broadband coherent frequencies, ranging from radio waves, terahertz, infrared light, visible light, ultraviolet light to the X-ray region	1.05	0.77	2029/2032
693	Technology applied to measurement and materials science, etc., that enables free operation and control of all light wave parameters and generates arbitrary waveforms, according to requirements such as super broadband spectrum generation, timing control of phase level, precise mode operation, utilization and synthesis, etc.	1.02	0.73	2029/2031
694	Quantum sensors such as superconducting qubits, NV (nitrogen-vacancy) centers with coherent time exceeding 10 ms	1.16	0.64	2028/2032
695	Quantum relay technology to facilitate a quantum cryptographic communication network that maintains the quantum state over 1000 km	1.17	0.63	2029/2034
696	Hybrid system comprised of conventional computers, quantum annealing machines, and gate type quantum computers, which improves the efficiency of drug discovery and investment, and financial decision-making, etc., by 3 digits	1.08	0.22	2030/2035
697	An optical lattice clock network using optical fibers, facilitating time measurement with an accuracy of 18 digits anywhere on Earth, enabling measurement of crustal and groundwater fluctuations and movement of magma chambers (geoid measurement)	0.74	1.11	2030/2033
698	Attosecond laser technology that enables direct observation and control of electron behavior in molecules.	0.71	0.63	2028/2032
699	Label-free molecular-vibration-sensitive high-resolution microscopy with a detection sensitivity for low concentration biomolecules at a μM level and spatial resolution of about 100 nm.	0.91	0.41	2028/2031
700	A 1-Pbit/s photonics network based on the WDM system, equipped with an ultra-high-speed transmission system of 1 Tbit/s per wavelength	1.02	0.72	2028/2031
701	Extreme ultraviolet (EUV) lithography technology to achieve a wafer-scale integrated semiconductor circuit with a gate length of ≤4 nanometers	0.93	0.37	2027/2029
702	High-quality laser processing through the development of a sub-kW class high-power laser with a pulse duration of the pico-femtosecond range and an automobile engine manufacturing system using 3D laser printer	0.70	0.49	2028/2030

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