1st Preliminary Report on The 10th Science and Technology Foresight Survey

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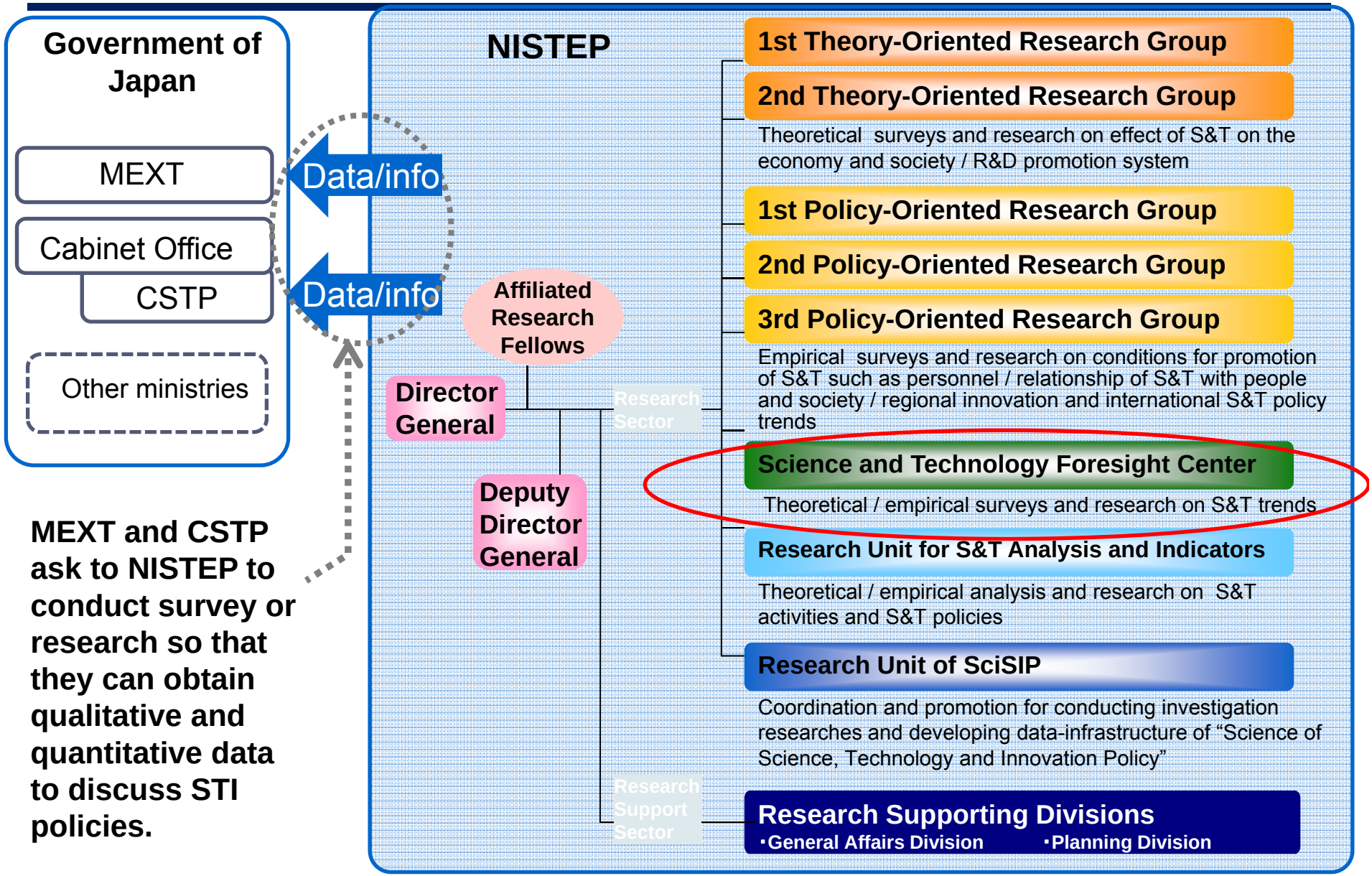
Structure



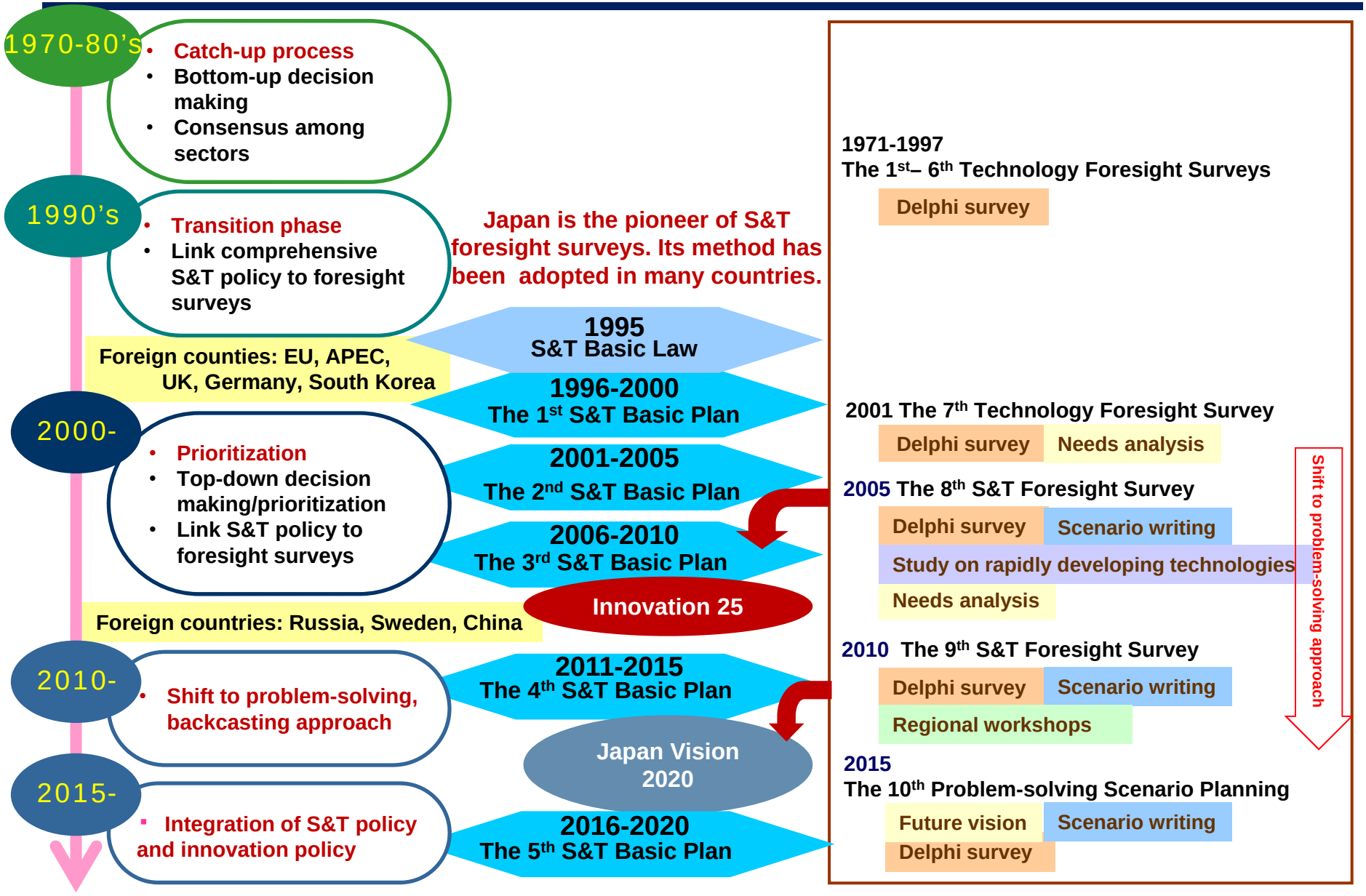
MEXT and CSTP ask to NISTEP to conduct survey or research so that they can obtain qualitative and quantitative data to discuss STI policies.

S&T Foresight in Japan

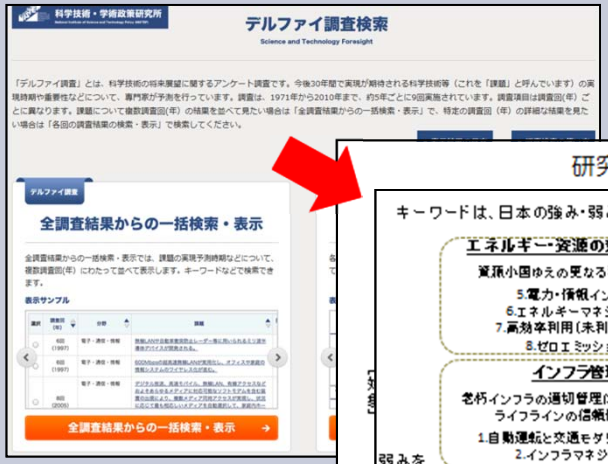
The Technology Foresight survey, which has been conducted every five years since 1971, canvasses a wide range of science and technology experts in Japan to get a grasp of the future path of technological development over the next 30 years.

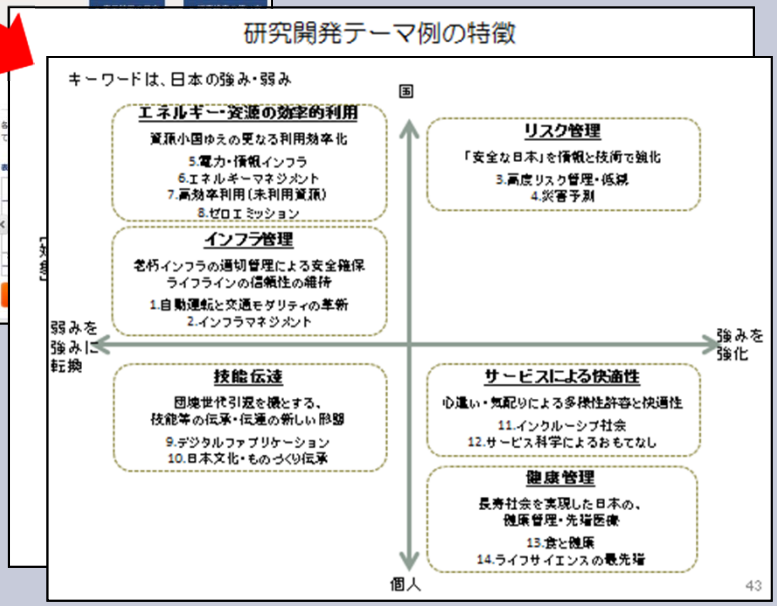
The main purpose of the survey is to contribute to government policy decision-making and decisions on resource allocation in the area of science and technology.

History of the Foresight Surveys

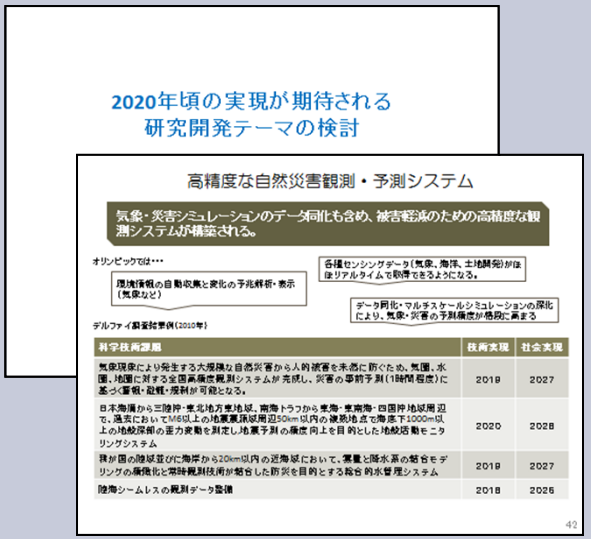


Contribution to Developing the Future Vision (Utilizing the results from the 9th Foresight Survey)



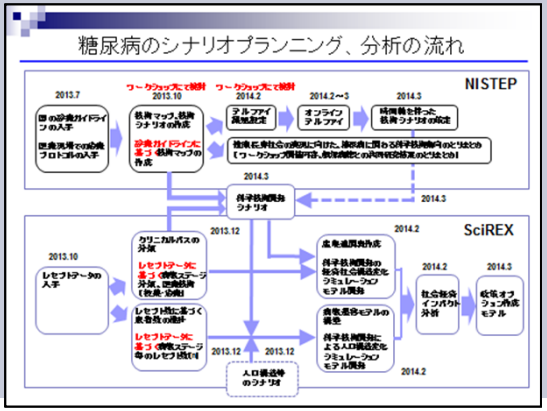


MEXT “Japan Vision 2020”



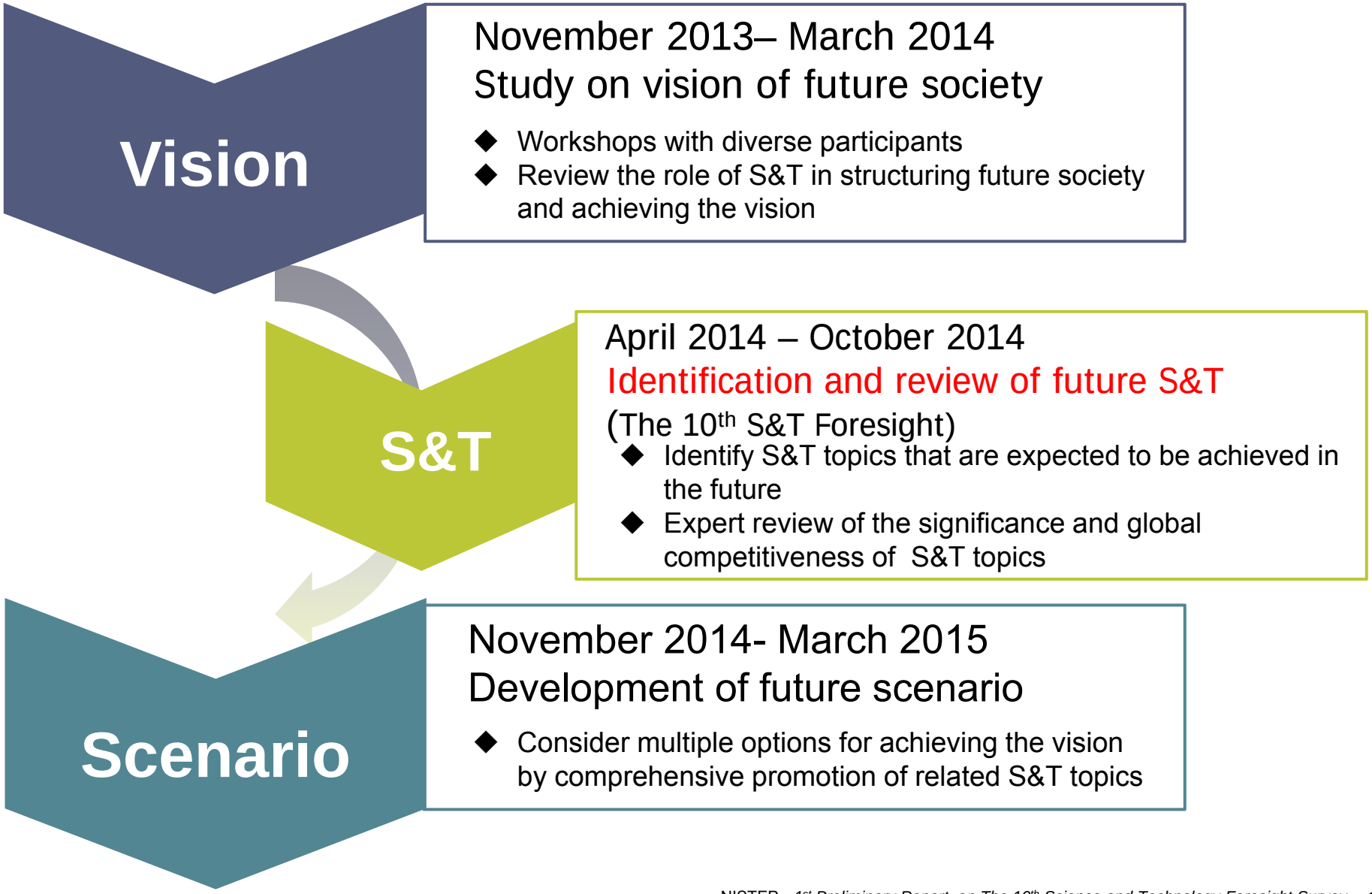
Identify the challenges in 2030

Demonstrate SciREX Policy Option Review



Contribution to development of 2020 Vision (integrated policy field) and 2030 Vision (interdisciplinary policy field) which will serve as starting points for backcasting

Problem-solving Scenario Planning (1)



Problem-Solving Scenario Planning (2)

- Review instances that, for example, have multiple options available to solve one challenge
- Identify effective policy options while considering potential trade-offs in economic impact, financial strain, technological feasibility, obstacles in adoption, and societal acceptance.

(Example)

In a society experiencing the population decline due to the effect of aging population along with declining birth rate, diabetes has become one of the major diseases impacting the productivity of labor force population (between 15 and 65 years of age that are classified as economically active in the population statistics)

Potential S&T policy options to solve this problem include:

o Early treatment intervention option through development of diagnostics technologies such as imaging technology and marker to capture microscopic changes in pancreatic β-cells.

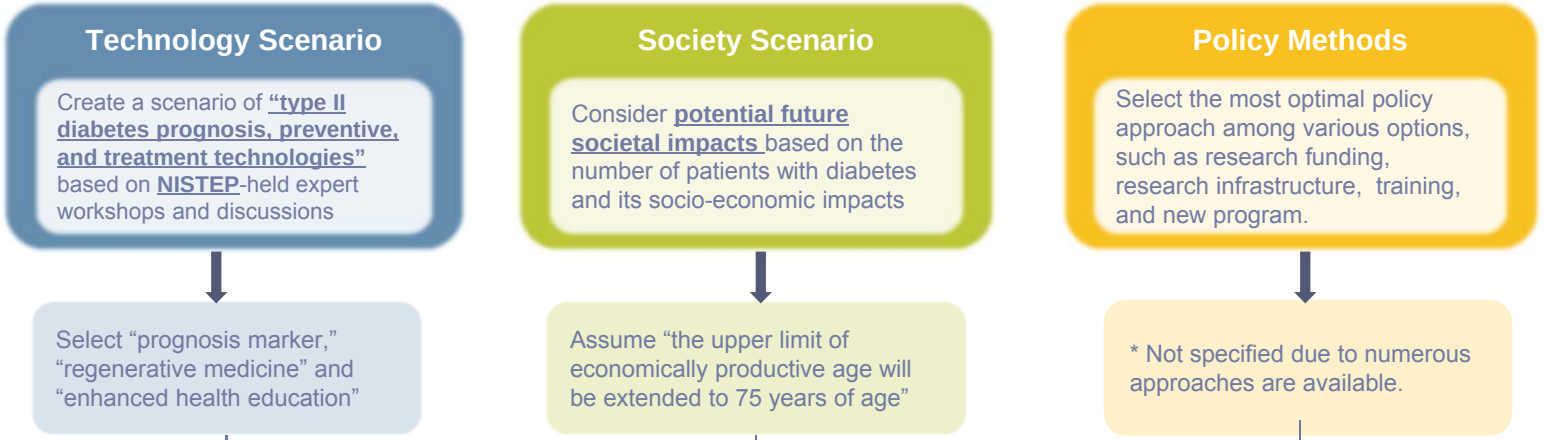
o Late-stage treatment intervention option through regenerative medicine, such as pancreatic β-cells injection for regeneration

o Drug cost reduction option by replacing insulin with low-molecular drugs that can be mass-manufactured.

o Preventive intervention option by developing preventive treatment technology such as lifestyle coaching including kinesitherapy and dietary therapy.

Problem-Solving Scenario Planning (3)

- Combining technology scenario and social scenario to create five policy options that are likely to be considered during the actual policymaking process



Policy Option 1	Investment in all technological development	30 Billion yen*1	Realizing options 2 through 4	Realizing option 2 through 4	Policy Goal
Policy Option 2	Targeted investment in prognosis marker technology development	10 Billion yen*1	Realized by 2020	Adoption ratio: 50%*2	Policy Goal
Policy Option 3	Targeted investment in regenerative treatment technology development	10 Billion yen*1	Realized by 2025	Adoption ratio: 15%	Policy Goal
Policy Option 4	Targeted investment to assist education technology enhancement	10 Billion yen*1	Realized by 2020	Adoption ratio: 50%	Policy Goal
Policy Option 5	No policy	-	-	-	

*1 Amount based on estimate (annual investment amount sill stay the same until realization)

*2 Assuming life-style improvement was found among 50% of marker users

Survey Objectives

- There are two survey objectives: 1) to consider science and technology development toward realization of the future society to aim for, which is considered to be one of the future directions of S&T development, in order to contribute to discussions for development of science, technology and innovation related policies and strategies, and 2) to enhance possibility of utilizing for developing academic and industry roadmaps.
- In order to achieve these objectives, we will collect and analyze opinions from experts about the direction of mid- and long-term development (the next 30 years) of science and technology and social system required to realize the future society to aim for.
- Based on the analysis, we will identify science and technology topics with high potentials and significance for the future of our country.

Survey Implementation Structure

NISTEP

Request for cooperation

Professional organizations including academic societies and associations

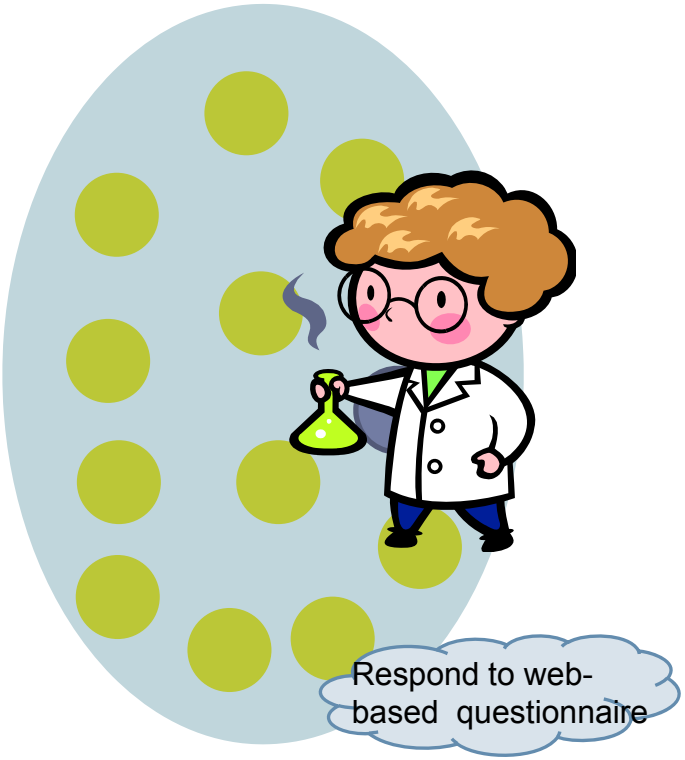
Experts in each field

Committees by field

- ① ICT and analytics
- ② Health, medical care and life Sciences
- ③ Agriculture, forestry and fisheries, food and biotechnology
- ④ Space, ocean, earth and science infrastructure
- ⑤ Environment, resources and energy
- ⑥ Material, device and process
- ⑦ Social infrastructure
- ⑧ Service-oriented society

Provide science and technology topics

Evaluate the importance



Committee on scenario analysis

Future Society Vision Review Workshop (FY2013)

Trial analysis of lifestyle related diseases (Type II diabetes mellitus) for realization of a healthy and longevity society (FY2013)

Interindustry analysis of renewable energy (- FY2013)

Implementation Outline (1) Overview

- Take an expert survey about R&D characteristics of science and technology to be achieved in the future ("science and technology topics")
  - **Period of foresight**
    - Up to 2025, but the target years are 2020, 2030, and 2050.
  - **Covered fields**
    - 1) ICT and analytics, 2) Health, medical care and life sciences, 3) Agriculture, forestry and fisheries, food and biotechnology, 4) Space, ocean, earth and science infrastructure, 5) Environment, resources and energy, 6) Material, device and process, 7) Social infrastructure, 8) Service-oriented society
  - **Science and technology topics**
    - The committee discussed topics in each item and 932 topics were selected.
  - **Survey period**
    - Date: From September 1, 2014 to September 30, 2014
    - Methodology: Online survey
      - NISTEP asked experts in the NISTEP expert network (approx.2000) as well as members of related professional organizations to participate in the survey
    - Response Rate: Our of 5,237 registered, 4,309 responded
      - Affiliation: University 49.1%, Business 36.4%, Public sector 14.5%
      - Age: -39 30%, 40-49 26%, 50-59 22%, 60+ 12%, Unknown 11%

Implementation Outline (2) Questions

[R&D Characteristics]

Variables	Definitions	Options
Importance	Comprehensive importance from both S&T and societal perspectives	Select one from: Very High / High / Low / Very Low * Responses are coded as Very High=4, High=3, Low=2, Very Low=1
Uncertainty	Involving many stochastic elements and needing methods to tolerating failures and multiple approaches to be considered during R&D	
Discontinuity	The result of R&D is not merely an extension of current state but is market-destructive and innovative	
Morality	Needing to consider morality and societal acceptance during R&D	
Global competitiveness	Enabling Japan to have global competitiveness over other countries	

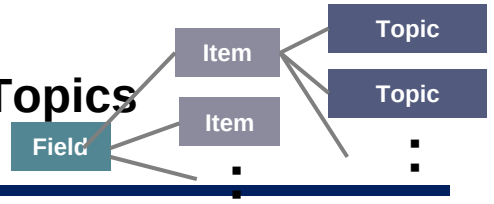
[Predicted Timing of Realization]

Variables	Definitions	Options
Technology achievement	When technology is expected to be achieved (somewhere in the world including Japan) When technological environment is ready such as achievement of anticipated performance. (e.g., when prospect of technology development becomes clear in stage of R&D in a lab) When a theory or phenomenon becomes scientifically established in case of fundamental science	Select one from: Achieved / Achievable / Not Achieved/ Not Sure If “Achievable” selected, additional question will be asked to identify the year that will be achieved between 2015 and 2050
Real-world implementation	When it’s applied in the Japanese society or internationally led by Japan When achieved technology is available to be used as a product or service (or when it’s diffused widely) When a framework, ethical standard, values, or societal consensus is established in case of non-S&T topics	

[Policy Priority]

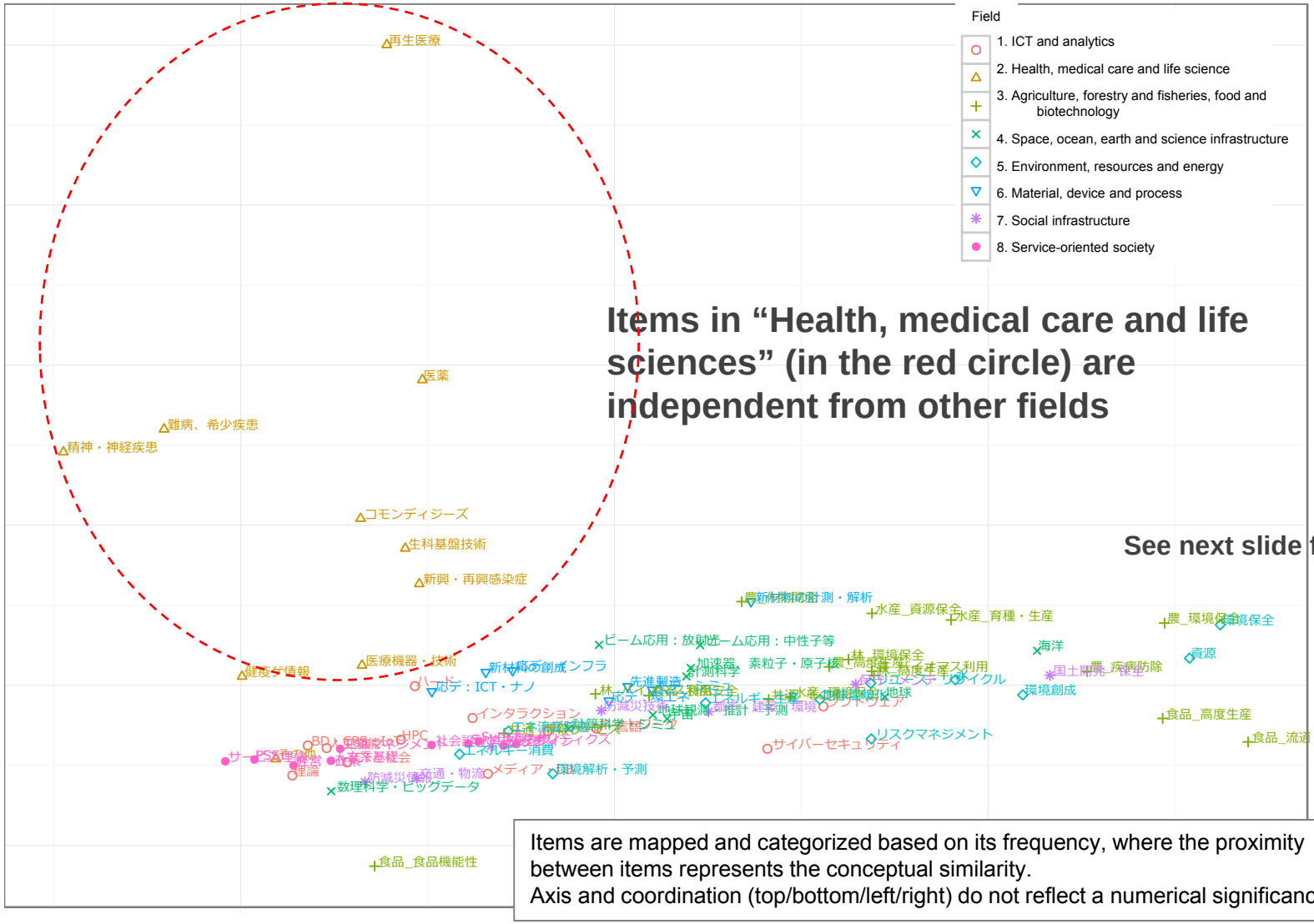
Variables	Options
Policy that need to be focused for technology achievement	Select one from: Human resource strategy / Resource allocation / Internal and external collaboration and cooperation/ Environment enhancement/ Other
Policy that need to be focused for commercialization	

Implementation Outline (3)　Items and No. of Topics



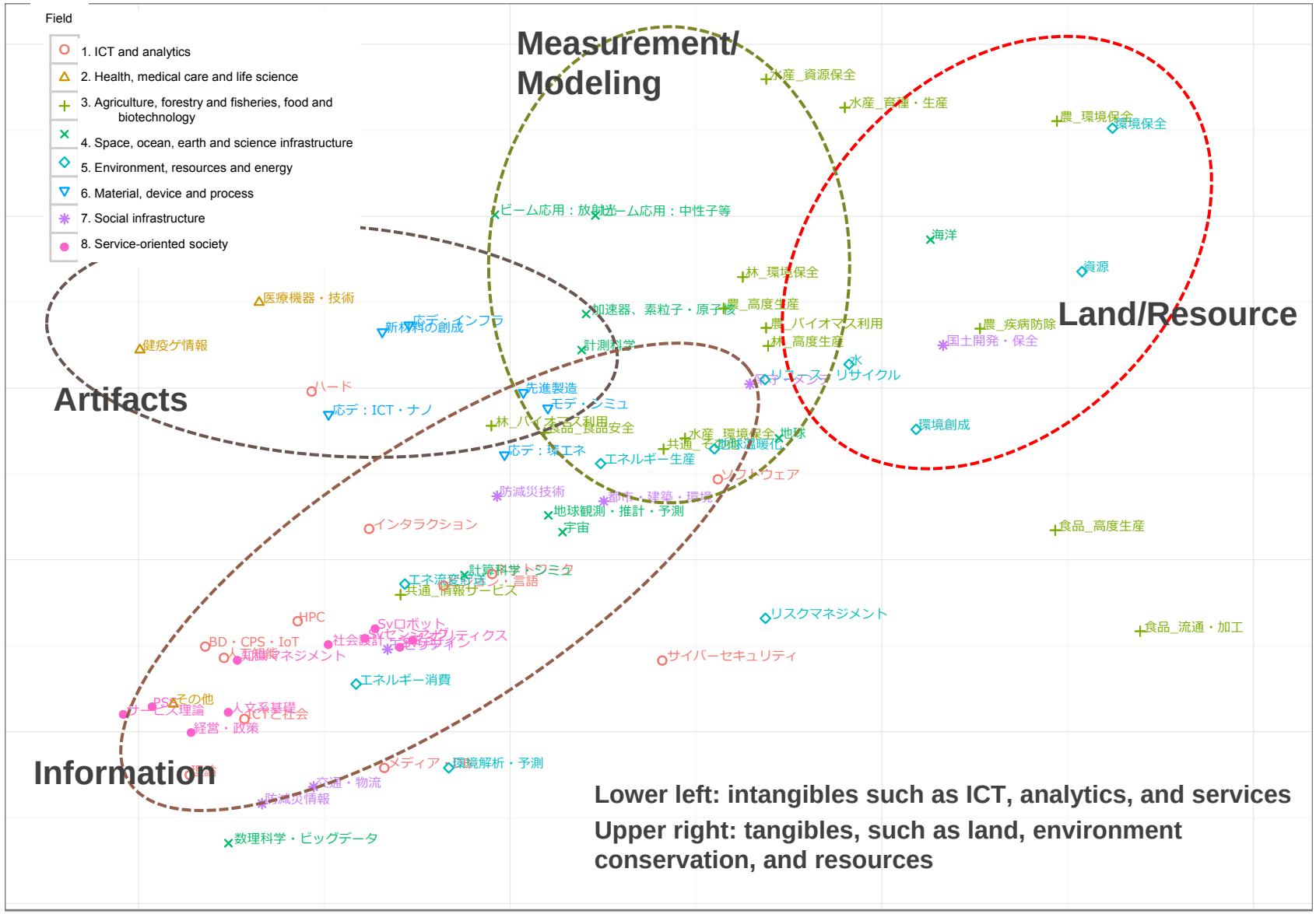
Field (abbreviations are shown in parentheses)	Items	Number of topics
ICT and analytics (ICT)	Artificial intelligence; Vision and language processing; Digital media and database; Hardware and architecture; Interaction; Network; Software; HPC; Theory; Cyber security; Big data, CPS and IoT; ICT and Society	114
Health, medical care and life sciences (Health)	Pharmaceuticals; Medical device and technology; Regenerative medicine; Common disease; Intractable and rare disease; Psychiatry and neuropathology; Emerging and re-emerging infectious disease; Health and medical information and epidemiology; Enabling technology	171
Agriculture, forestry and fisheries, food, and biotechnology (Agriculture, forestry and fisheries)	Agriculture: Advanced production; Crop development; Disease control; Biomass utilization; Environmental conservation Food: Advanced production; Distribution and processing; Food safety; Food functionality Fishery: Resource conservation; Breeding and production; Environmental conservation Forestry: Advanced production; Biomass utilization; Environmental conservation Common: Information service; Others	132
Space, ocean, earth and science infrastructure (Frontier)	Space; Ocean; Earth; Earth observation and prediction; Accelerator, elementary particle and atomic nucleus; Beam application: synchrotron radiation; Beam application: neutron, muon, charged particle etc.; Computational sciences and simulation; Mathematical sciences and big data; Measurement infrastructure	136
Environment, resources and energy (Environment and resource)	Energy production; Energy consumption; Energy distribution, transformation, storage and transportation; Resources; Reuse and recycle; Water; Global warming; Environmental conservation; Environment analysis and forecasting; Environment creation; Risk management	93
Material, device and process (Material)	Creation of new substance, material and function; Advanced manufacturing; Measurement and analysis method of advanced material and device; Application device and system (in the fields of ICT and nanotechnology, environment and energy, and infrastructure)	92
Social infrastructure (Social infrastructure)	Land development and conservation; City, architecture and environment; Infrastructure management and maintenance; Transportation and distribution infrastructures; Automobile, rail, vessel and aviation; Technology for disaster prevention and reduction; Information of disaster prevention and reduction	93
Service-oriented society (Service)	Management and policy; Knowledge management; Product Service Systems (PSS); Society design and simulation; Service sensing; Service Design; Service Robots; Service theory; Analytics; Basic research in humanities	101

Implementation Outline (4a)
Future Technology Conceptual Map (Full view)



Items are mapped and categorized based on its frequency, where the proximity between items represents the conceptual similarity.
Axis and coordination (top/bottom/left/right) do not reflect a numerical significance.

Implementation Outline (4b)
Future Technology Conceptual Map (Detail)

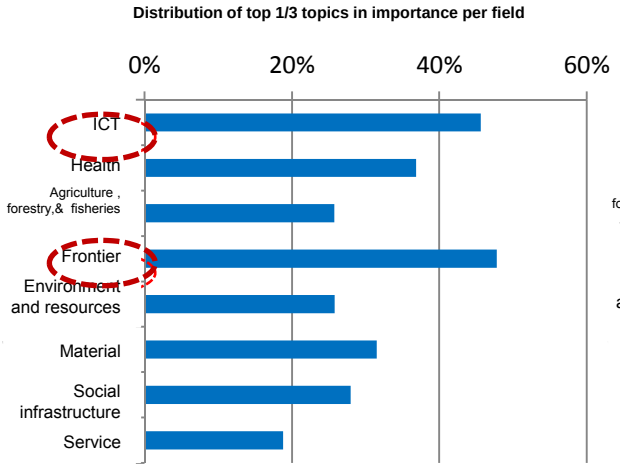


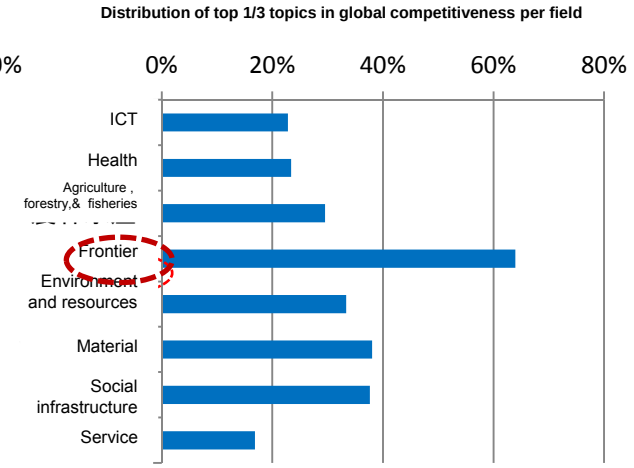
R&D Characteristics (1) Trend Overview

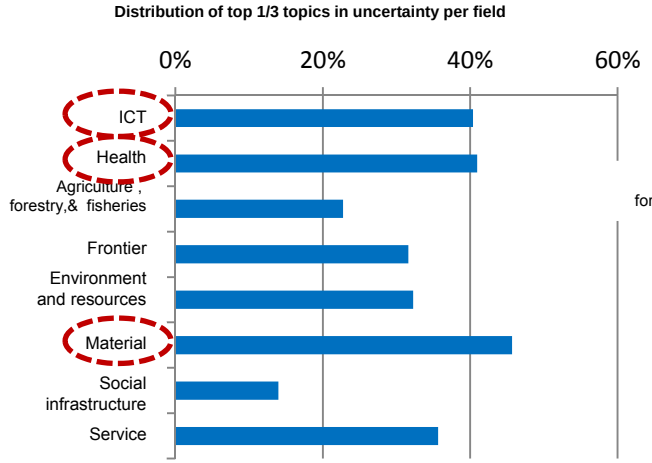
ICT:	High importance Low global competitiveness High uncertainty High discontinuity High morality
Health:	Low int'l competitiveness High uncertainty High morality
Frontier:	High importance High global competitiveness
Material:	High uncertainty High discontinuity
Service:	Low global competitiveness High morality

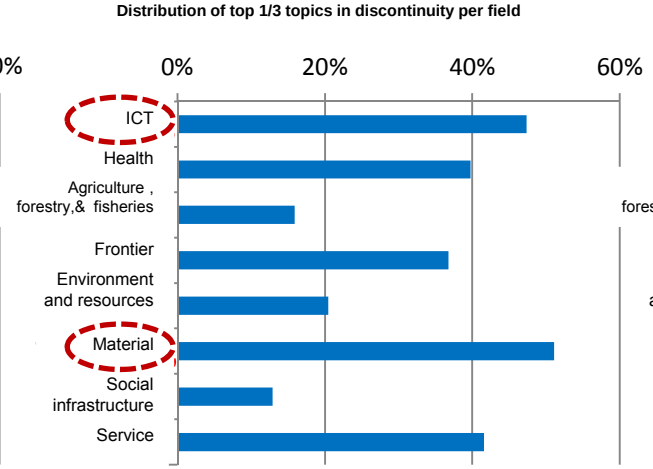
Scores are computed based on coded responses in characteristics
(Very high=4, High=3, Low=2, Very low=1)

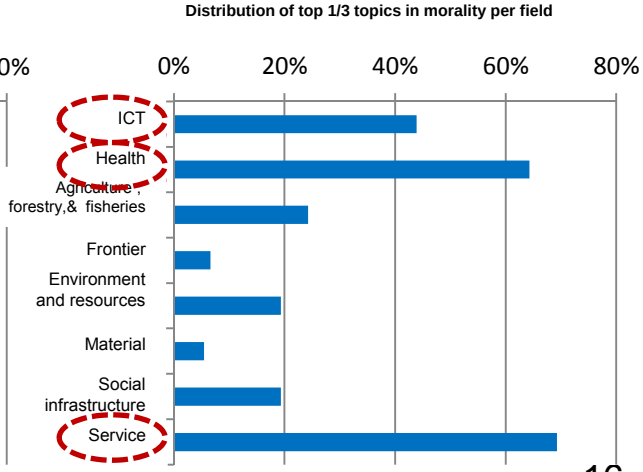
The following charts represent distribution of 310 topics (top 1/3 per field)







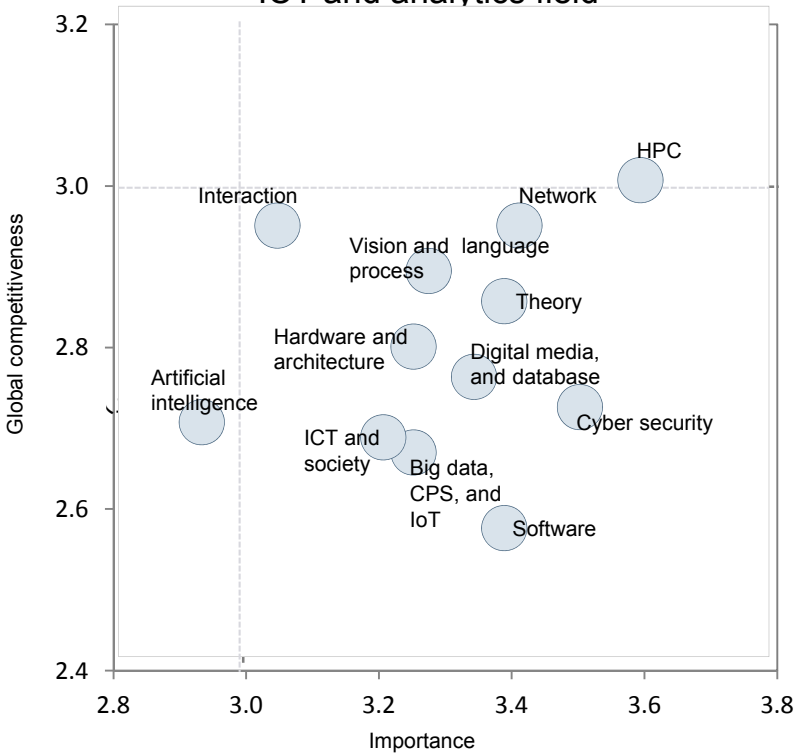




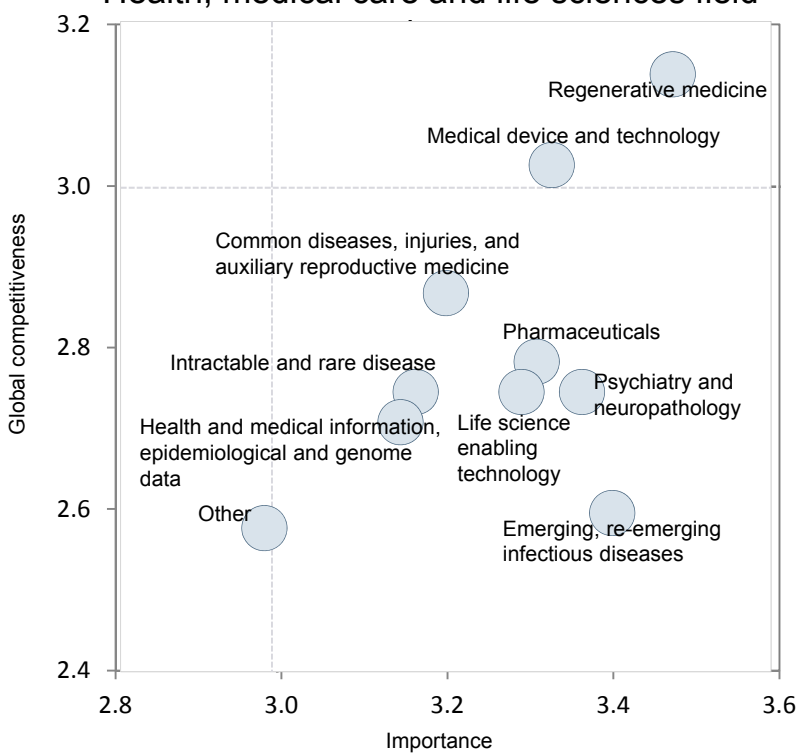
R&D Characteristics (2)
Importance and Global Competitiveness

- Characteristics of “ICT and analytics” and “Health, medical care and life sciences” that show high importance and low global competitiveness
  - ICT and analytics
    - Items in “HPC”: High importance, high global competitiveness
    - Items in “Cyber security” and “Software”: High importance, low global competitiveness
  - Health, medical care, and life sciences
    - Items in “Regenerative medicine”: High importance, high global competitiveness
    - Items in “Emerging and re-emerging infectious diseases”: High importance, low global competitiveness

ICT and analytics field



Health, medical care and life sciences field



NISTEP, *1st Preliminary Report on The 10th Science and Technology Foresight Survey*

R&D Characteristics (3)
Example of Top 100 Topics in "Importance"

Field	Topic
ICT	Development of data utilization techniques with theoretically guaranteed preservation of privacy
ICT	Technology to develop software without security holes which allow remote exploitation
ICT	Technology to improve performance to power ratio of super-large-scale supercomputers and big data IDC systems with more than one million nodes by a factor of 100 compared to current systems
ICT	A low cost, easy-to-use, secure personal authentication system which can be used with confidence even when accessing many different websites over a long period of time
ICT	A health care system that monitors the condition of patients in real time to provide optimal nursing or medical care at a low cost
Health	A cheap, easy-to-introduce dementia care assistance system
Health	Medical technology to regenerate auditory and visual functions
Health	Preventative medicines which inhibit the development of carcinogenesis from a precancerous state
Agriculture, forestry and fisheries	Crops that can be expected to produce a good harvest even in environments generally unsuitable for farming such as deserts (arid regions), etc.
Agriculture, forestry and fisheries	Technology to predict the variation in sardines, tuna, and other major fishery resources under different harvesting and long-term environmental conditions, as well as technology for the proper management of fishery resources based on this prediction technology
Agriculture, forestry and fisheries	Technology to remove radioactive substances in order to revitalize fishing in coastal areas
Frontier	Urgency assessments for all active volcanoes to identify the volcano or volcanoes most likely to erupt in the near future

Field	Topic
Frontier	Technology to observe local structure and electron state information essential to understanding the mechanisms for the functional expression of physical characteristics in functional materials and the control of such properties at the nanometer-scale and femtosecond order
Frontier	Technology to predict the local occurrence of heavy rain, tornadoes, hail storms, lightning strikes, and snow which will occur several hours in the future at a spatial resolution of less than 100m using a high-resolution simulation and data assimilation
Environment and resources	Mineral extraction and mining technology needed for extracting ocean mineral resources
Environment and resources	Predictive technology to assess the impact of global climate change on food production
Environment and resources	Technology for the purification and recycling of contaminated water that is economical and generally available in developing countries
Material	A rechargeable automotive battery capable of a range of 500km while maintaining the size and weight of current batteries
Material	Integrated circuit technology to realize the performance level similar to the existing super computer with one chip by improving the information processing ability without increasing the electricity consumption per unit area
Material	Simulation technology that does not predict functions and physical properties based on structural information but rather predicts the structure itself using the desired functions and physical properties as inputs
Social infrastructure	Low-emission and energy efficient aircraft to realize reducing noise at the takeoff and landing as well as the emission gas during the flight, and to achieve lowering the frictional resistance on the body and improving the combustion efficiency of the engine
Social infrastructure	Establishment of decommissioning and radioactive waste disposal technology for 1 million KW-class nuclear reactors.
Service	The generalization of robot inspection technology to inspect buildings or infrastructures that would be more dangerous or costly for humans to inspect.

Example: Top-rated Topics in "Importance"

- Health, medical care, and resources. Top-rated topics in ICT and analytics equally consist of enabling topics and application topics such as care taking.

Field	Topic	Importance	Competitive-ness	When to be achieved
Social infrastructure	Establishment of decommissioning and radioactive waste disposal technology for 1 million KW-class nuclear reactors	3.8	3.1	2029 2035
ICT	Technology to improve performance to power ratio of super-large-scale supercomputers and big data IDC systems with more than one million nodes by a factor of 100 compared to current systems	3.8	3.2	2021 2025
Health	A cheap, easy-to-introduce dementia care assistance system	3.8	3.0	2022 2025
ICT	Innovation through the application of exabyte- to zettabyte-scale high performance computing and big data analytics technologies to social phenomena, science, and advanced production	3.8	3.2	2022 2025
ICT	A health care system that monitors the condition of patients in real time to provide optimal nursing or medical care at a low cost	3.7	3.0	2021 2025
Health	Preventative medicines which inhibit the development of carcinogenesis from a precancerous state.	3.7	3.1	2025 2030
Health	Medical technology to regenerate auditory and visual functions	3.7	3.3	2025 2025
Environment and resource	Mineral extraction and mining technology needed for extracting ocean mineral resources	3.7	3.1	2025 2030
ICT	Technology to develop software without security holes which allow remote exploitation	3.7	2.6	2025 2026
ICT	Support system for the elderly and people with disabilities to enable a daily life without human assistance	3.7	3.1	2025 2028

∗ Importance/competitiveness: Responses are coded (Very high=4, High=3, Low=2, Very low=1)
∗ When to be achieved: Top=Technology achievement, Bottom=Real-world implementation

Example：Top-rated Topics in “Global Competitiveness”

- Beam-related applications in space, ocean, earth and science infrastructure (Frontier) have come up many times.

Field	Topic	Competitive-ness	Importance	When to be achieved
Frontier	A high-precision optical lattice clock with an accuracy of 10^-18 seconds using techniques such as suppression of blackbody radiation shift that is precise enough to be applied to geoid measurement	3.5	3.4	2022 2026
Agriculture, forestry and fisheries	Production system technology to artificially fertilize in large quantities, farm and ship unagi (Japanese fresh water eels)	3.5	3.4	2023 2025
Frontier	Next-generation cost reducing, super high-brightness radiation light sources based on ultra-low emmitance storage rings	3.4	3.6	2020 2022
Frontier	Buoy-type technology to observe crustal deformation and tsunami formation at sea without laying submarine cables	3.4	3.5	2020 2025
Frontier	A medium-size high-intensity synchrotron radiation facility surpassing SPring-8 in the soft X-ray area	3.4	3.6	2020 2020
Health	An infertility treatment that uses reproductive cells that have been induced to differentiate from human iPS cells	3.4	2.9	2025 2035
Material	Tough, high-strength ferrous building materials with a yield strength of over 1,800MPa (three times that of existing steel) and a ductile-brittle transition temperature of below -40℃	3.4	3.4	2025 2030
Frontier	Technology to enable the acquisition of nuclear data in unexplored areas of research by producing short-lived super-heavy elements and eliciting specific ionic states at the same time through the fusion of ion accelerators and the high-intensity lasers	3.4	3.3	2025 2030
Frontier	Technology to analyze the magnetic state at the nanometer-scale depth by generating and controlling ultraslow muons	3.4	3.4	2020 2021
Frontier	Multilateral and precise analysis and observation technologies for a composite approach to atomic structure, electronic structure, and transient phenomena in highly complex systems and highly domain-dependent substances by exposing a sample to multiple quantum beams at the same location either at the same time or sequentially with a good ability to reproduce the same target location.	3.4	3.5	2025 2025

Example: Top-rated Topics in "Uncertainty"

- Includes new architecture in ICT and analytics field.

Field	Topic	Uncertainty	Importance	When to be achieved	% of "Not achievable"
ICT	Post-John von Neumann HPC: Development of superconductive single-flux quantum circuits (SFQ), carbon nanotube and spintronics devices, and post-sillicon devices such as memristors, and the use of these items to enable new processor architechture technologies, the application of quantum computers to HPC computing, and the establishment of computing utilizing models that mimic the neuron model of human brain function	3.6	3.3	2026 2033	8%
Frontier	Prediction technologies for the timing (within a one year horizon), scale, affected regions, and damage of earthquakes greater than magnitude 7 on the Richter scale	3.6	3.5	2030 2032	40%
ICT	A gate-type quantum computer that can achieve coherence across 10,000 qubits to solve problems difficult for conventional computation methods at high speed	3.6	2.9	2030 2038	33%
Frontier	Technology to predict the occurrence of large-scale earthquakes greater than magnitude 8 on the Richter scale through the analysis of strain distribution on the Earth's crust and the history of past earthquakes	3.5	3.5	2030 2030	28%
Material	A portable device which can reduce radioactivity through artificial transmutation	3.5	3.3	2030 2035	36%
Material	Room-temperature superconducting materials that make use of strongly-correlated electron systems	3.4	3.4	2030 2040	27%
ICT	Clarification of the human brain's capability through the theoretical understanding and modeling of the brain's intellectual processing capabilities	3.4	3.4	2025 2032	14%
ICT	A neurosynaptic system with ten billion neurons and one hundred trillion synapses with an information processing capability equivalent to a human brain	3.3	3.2	2024 2030	23%
Frontier	A space elevator connecting a ground (or offshore) station with a station in geostionary orbit	3.3	2.6	2040 2040	41%
Environment and resources	A space-based solar power generation system.	3.3	2.6	2030 2038	37%

∗ Uncertainty/Importance: Responses are coded (Very high=4, High=3, Low=2, Very low=1)
∗ When to be achieved: Top=Technology achievement, Bottom=Real-world implementation

Example：Top-rated Topics in “Discontinuity”

- Includes new architecture in ICT and analytics field.

Field	Topic	Discontinuity	Importance	When to be achieved	% of “Not achievable”
ICT	Post-John von Neumann HPC: Development of superconductive single-flux quantum circuits (SFQ), carbon nanotube and spintronics devices, and post-sillicon devices such as memristors, and the use of these items to enable new processor architechture technologies, the application of quantum computers to HPC computing and the establishment of computing utilizing models that mimic the neuron model of human brain function	3.6	3.3	2026 2033	8%
ICT	A gate-type quantum computer that can achieve coherence across 10,000 qubits to solve problems difficult for conventional computation methods at high speed	3.6	2.9	2030 2038	33%
Material	Room-temperature superconducting materials that make use of strongly-correlated electron systems	3.4	3.4	2030 2040	27%
Health	An artificial uterus which enables the growth of a fetus	3.3	2.8	2030 2040	20%
Health	Polymer medical materials capable of selectively enveloping and treating cancer tissues when they are administered	3.2	3.5	2020 2025	15%
Material	A portable device which can reduce radioactivity through artificial transmutation	3.2	3.3	2030 2035	36%
ICT	A robot which first possesses infant-level intelligence, physical, and learning abilities, then through human education and external information develops until it obtains adult-level work skills	3.2	3.1	2030 2037	23%
Frontier	A space elevator connecting a ground (or offshore) station with a station in geostionary orbit	3.2	2.6	2040 2040	41%
ICT	Clarification of the human brain's capability through the theoretical understanding and modeling of the brain’s intellectual processing capabilities	3.2	3.4	2025 2032	14%
Material	Storage technology that stores 1 bit of data as a single atom or molecule and is capable of high-speed storage and retrieval of large amounts of data	3.2	3.3	2028 2035	15%

∗ Discontinuity/Importance: Responses are coded (Very high=4, High=3, Low=2, Very low=1)
∗ When to be achieved: Top=Technology achievement, Bottom=Real-world implementation

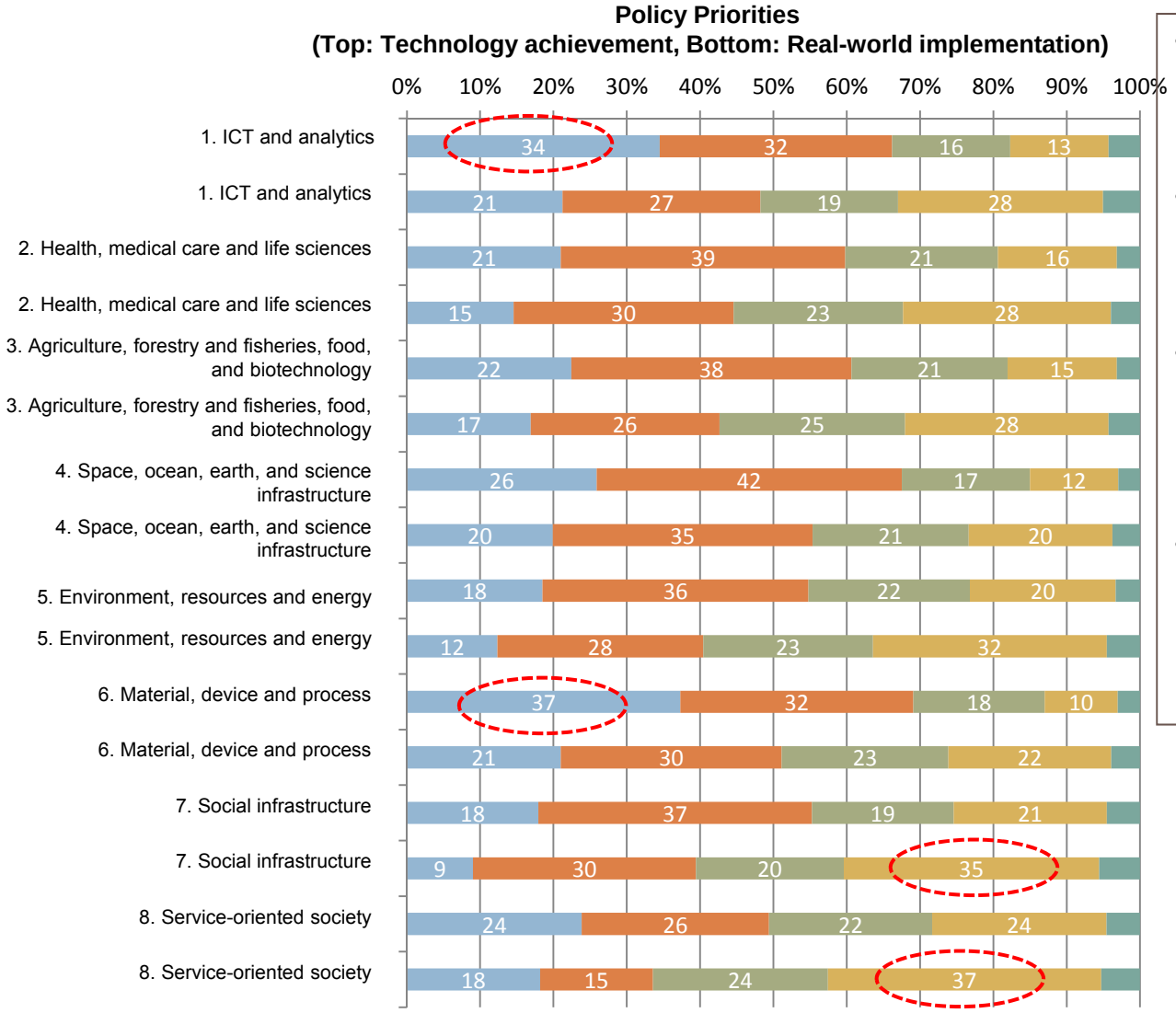
Example: Top-Rated Topics in "Morality"

- Top topics come from "ICT and analytics", "Health, medical care and life sciences", and "Service-oriented society".

Field	Topic	Morality	Importance	When to be achieved
Health	An infertility treatment that uses reproductive cells that have been induced to differentiate from human iPS cells	3.9	2.9	2025 2036
Service	To achieve a healthy aging society, information about the hobbies, health, medical records, and daily activity of elderly people will be managed and analyzed in a single database	3.7	3.3	2020 2025
Service	Development of a system that can automatically determine the relationships between employees from their behavioral histories	3.7	2.5	2025 2026
Service	New businesses that manage customers' personal behavior information in a manner similar to credit card companies and banks will emerge and become commonly used by the public.	3.6	2.6	2018 2021
Health	An artificial uterus which enables the growth of a fetus	3.6	2.8	2030 2040
Health	Organs for transplant derived from human stem cells but produced by animal embryos (in other words, produced from chimeric embryos based on animal embryos injected with human cells)	3.6	3.0	2022 2032
Health	Regenerative medicine technologies using the transplantation of embryonic stem cells	3.6	3.0	2020 2025
ICT	A service to provide predictive and preventive medicine based on analysis of various personal data such as health, diet, and exercise	3.5	3.5	2021 2025
ICT	Technology that integrates evidential information such as provenance into data utilized for big data analytics to allow for safe analysis and the protection of personal data	3.5	3.6	2020 2024
ICT	Social consensus about the relationship between machines (e.g. robots) and humans (By establishing a new "three laws of robotics", legal developments will proceed, and we will achieve a stable society and economy where humans and robots cooperatively coexist). As a result, the contribution of robots to the economy will reach 40%	3.5	3.4	2025 2030

∗ Morality/Importance: Responses are coded (Very high=4, High=3, Low=2, Very low=1)
∗ When to be achieved: Top=Technology achievement, Bottom=Real-world implementation

Policies to be focused



- Technology achievement prioritizes human resource strategy and resource allocation.
- Real-world implementation prioritizes collaboration/cooperation and environment enhancement.
- Fields that need to focus on human resource strategy for technology achievement: ICT and analytics, Material, device and process.
- Fields that need to focus on environment enhancement for real-world implementation: Social infrastructure, Service-oriented society

Example:
Top-rated Topic in "Policy: Human Resource Strategy" (Technology Achievement)

◆ Software and theory in ICT field, as well as modeling and simulation in material field.

Field	Topic	Selection ratio*1	Importance *2	When to be achieved*3
ICT	Development of a new computation model to understand the difficulty of calculations: A theoretically solvable model for computationally difficult problems (i.e. interactive computing, quantum computing, probabilistic proof verification model, etc.) as the foundation for construction of a realistic and marginal problem solving platform (including theoretical exploration of innovative model building)	80% (47%)	3.5	2027 2035
ICT	Improved scalability of the problem-solving paradigm using mathematical programming (Developing mathematical programming technology to solve global-level optimization problems in real time)	65% (43%)	3.5	2022 2025
Material	Dynamic simulation technology that allows for the analysis of the selection rates, environmental effects (temperature, etc.), and many-body effects in catalytic reactions	65% (47%)	3.3	2025 2029
ICT	Development of the algorithmic theory for computing systems which learn from their own experiences	65% (32%)	3.3	2025 2030
ICT	Development of data utilization techniques with theoretically guaranteed preservation of privacy (Technological achievement: Development of a theoretically valid method to use data without leaking private information to achieve secure e-voting and electronic medical record sharing / Real-world implementation: Encouraging a safe society through theoretically informed data standards and regulations and the development of society based on the utilization of data in accordance with those laws)	59% (25%)	3.7	2020 2025
Material	Simulation technology not only for material design but also dynamic process design that is based on quantum theory	59% (42%)	3.4	2025 2030
ICT	Technology which assists average developers to write comprehensive specifications for large-scale software and provides error-free code validation	58% (43%)	3.4	2025 2025
ICT	Technology which automatically inspects and fixes minor bugs in large-scale software	58% (47%)	3.5	2024 2025
ICT	Verification technology which can be used for large-scale software and takes into account stochastic behavior (such as responses to hardware failures or fluctuations in the environment, the use of stochastic or random number algorithms, etc.)	57% (40%)	3.4	2024 2030
ICT	Software development technology that reduces the frequency of bugs occurring in code to less than one per million lines of code	57% (52%)	3.4	2025 2025

Example:
Top-rated Topics in "Policy: Human Resource Strategy"(Real-world Implementation)

- Software and theory in ICT field as well as modeling and simulation in material field. Half of topics overwrap with technological achievement.

Field	Topic	Selection ratio*1	Importance *2	When to be achieved*3
ICT	Software development technology that reduces the frequency of bugs occurring in code to less than one per million lines of code	52% (57%)	3.4	2025 2025
ICT	Development of a new computation model to understand the difficulty of calculations: A theoretically solvable model for computationally difficult problems (i.e. interactive computing, quantum computing, probabilistic proof verification model, etc.) as the foundation for construction of a realistic and marginal problem solving platform (including theoretical exploration of innovative model building)	47% (80%)	3.5	2027 2035
ICT	Technology which automatically inspects and fixes minor bugs in large-scale software	47% (58%)	3.5	2024 2025
Material	Dynamic simulation technology that allows for the analysis of the selection rates, environmental effects (temperature, etc.), and many-body effects in catalytic reactions	47% (65%)	3.3	2025 2029
ICT	Technology which ensures that widely used compilers, OSes, or basic libraries operate in accordance with specifications	47% (55%)	3.5	2025 2029
Environment and resource	Establishment of a two-way risk communication process to enable consensus on energy supply technologies and systems	46% (44%)	3.4	2022 2025
Material	Technology to estimate the structure or creation process of materials through materials science inverse problems by applying statistical mechanics techniques for information such as Bayesian estimation and neural networks	46% (56%)	3.2	2025 2029
Material	Multiscale simulation technology to project how chemical reactions at the electron-scale affect macro-scale physical properties, functions, degradation, and destruction of substances	44% (57%)	3.4	2025 2030
Agriculture, forestry and fisheries	Evaluation of toxicity caused by the interaction of multiple harmful factors in food	44% (31%)	3.4	2020 2023
ICT	Improved scalability of the problem-solving paradigm using mathematical programming (Developing mathematical programming technology to solve global-level optimization problems in real time)	43% (65%)	3.5	2022 2025

*1: Parentheses represent percentages for selecting "human resource strategy" as a policy focus for technology achievement
*2: Importance: Responses are coded (Very high=4, High=3, Low=2, Very low=1)
*3: Top=Technology achievement, Bottom=Real-world implementation

Example:
Top-rated Topics in "Policy: Resource Allocation" (Technology Achievement)

- Includes common diseases in "Health, medical, and life sciences" as well as oceanic observation in "Space, ocean, earth and science infrastructure" (Frontier).

Field	Topic	Selection ratio*1	Importance *2	When to be achieved*3
Health	Immunomodulator drugs which work for specific allergic diseases and don't affect other biological defense mechanisms	74% (47%)	3.3	2025 2035
Health	A diagnostic method for the risk of developing cancer and incurable diseases by monitoring the regulation of epigenetic gene expression	73% (42%)	3.3	2025 2030
Frontier	Manned submersibles capable of descending to 11,000m	73% (53%)	3.0	2024 2025
Health	Allotransplantation technology which doesn't require an immunosuppressant	70% (40%)	2.9	2025 2029
Health	Radiation therapies to enable cancer treatment within a short period without disturbing daily life by using a small system for irradiation of intensity modulated particle beam.	69% (31%)	3.5	2025 2030
Health	New anti-fibrosis drugs which enable the recovery of organ function	68% (47%)	3.0	2025 2028
Health	Preventative medicines which inhibit the development of carcinogenesis from a precancerous state	67% (43%)	3.7	2025 2030
Health	Recovery of visual function from traumatic ocular injuries through full eye ball transplants	67% (33%)	3.0	2025 2030
Frontier	Technology for fixed-point time series observations at sea without using berthing ropes	67% (53%)	3.5	2025 2025
Social infrastructure	A radio communication system capable of video communication without causing congestion that is not disrupted in the event of a disaster	67% (38%)	3.4	2020 2025

*1: Parentheses represent percentages for selecting "resource allocation" as a policy focus for real-world implementation
*2: Importance: Responses are coded (Very high=4, High=3, Low=2, Very low=1)
*3: Top=Technology achievement, Bottom=Real-world implementation

Example:
Top-rated Topics in "Policy: Resource Allocation" (Real-world Implementation)

- Fields coincide with those of technology achievement; however, top-rated topics are different.

Field	Topics	Selection ratio*1	Importance *2	When to be achieved*3
Social Infrastructure	Fault displacement measurement technology for linear structures (such as tunnels and shafts)	61% (53%)	3.2	2022 2025
Frontier	Buoy-type technology to observe crustal deformation and tsunami formation at sea without laying submarine cables	58% (60%)	3.5	2020 2025
Environment and resources	Technology to smelt titanium at less than 50% of the cost of current methods	58% (46%)	3.3	2025 2030
Frontier	Technology to conduct fully automated long-term (i.e. for several months) oceanographic surveys via autonomous unmanned vehicle (AUV)	57% (51%)	3.3	2025 2025
Health	Effective prevention methods for locomotive syndrome based on clarification of the mechanism underlying sarcopenia	56% (65%)	3.2	2022 2025
Frontier	A supercomputer with a computing speed exceeding 10 exaflops (10^19 operations per second)	56% (62%)	3.5	2022 2025
Health	A method to prevent the onset of idiopathic hematopoietic disorders (e.g. aplastic anemia, myelodysplastic syndrome)	56% (56%)	3.1	2023 2030
Health	Development of molecular targeted drugs based on an understanding of the pathogenesis of chronic pain	56% (53%)	3.1	2025 2028
Health	Technology to rapidly prepare neutralizing antibodies for new pathogens and then mass produce them	55% (64%)	3.5	2025 2030
ICT	A backbone router which reduces the electricity consumed per unit of data transferred to 1/10 of the current consumption level	54% (60%)	3.2	2020 2023

*1: Parentheses represent percentages for selecting "resource allocation" as a policy focus for technology achievement
*2: Importance: Responses are coded (Very high=4, High=3, Low=2, Very low=1)
*3: Top=Technology achievement, Bottom=Real-world implementation

Example:
Top-rated Topics in “Policy: Collaboration and Cooperation” (Technology Achievement)

- Shared equally by Agriculture, forestry and fisheries, food and biotechnology and Service-oriented society.
- Top-rated: Fisheries and environment-related topics in Agriculture; and, Product service system in Service-oriented society.

Field	Topics	Selection ratio*1	Importance *2	When to be achieved*3
Agriculture, forestry and fisheries	Water environment purification and chemical/biofuel coproduction system by aquatic biomass plantations	55% (27%)	2.9	2025 2025
Agriculture, forestry and fisheries	Development of food demand prediction system which takes into account trends in the increase of the global population, economic development, and crop production technologies	53% (56%)	3.5	2025 2028
Service	A digital pipeline will be developed by computerizing the entire design, development, production, quality control, and manufacturing process, and the unified format will intensify open innovation both inside and outside companies	50% (47%)	3.5	2025 2026
Agriculture, forestry and fisheries	Development and promotion of the use of completely infertile cultured fish	46% (50%)	3.1	2025 2030
Agriculture, forestry and fisheries	Recycling-oriented local communities where cities and villages cooperate to make the nitrogen cycle work effectively and reduce nitorogen's impact on the watershed	44% (47%)	3.1	2025 2032
Service	Construction of a system to check whether proposed services are conform to laws of each country and specify the conditions for providing services by country based on legal information searches	44% (53%)	3.1	2024 2025
Service	Contract design methods and contract design support tools that support various forms of contracts between service providers and recipients through a product service system will be developed and maintained	43% (36%)	3.1	2020 2025
Health	A prediction and alert system for infectious disease epidemics based on a comprehensive infectious disease surveillance system that utilizes medical data such as EMR system data, test results, and prescription records along with various kinds of web data	42% (33%)	3.5	2020 2022
Social Infrastructure	Centralized network control and operation technology which manages information from a large number of moving vehicles (automobiles, bullet trains, airplanes, ships, etc.) to contribute to the reduction of the load on the environment	41% (33%)	3.2	2020 2025
Service	Business Case Analysis for product service system providers and comprehensive risk management methods based on the results will be maintained	40% (30%)	3.1	2022 2028

*1: Parentheses represent percentages for selecting “collaboration and cooperation” as a policy focus for real-world implementation
*2: Importance: Responses are coded (Very high=4, High=3, Low=2, Very low=1)
*3: Top=Technology achievement, Bottom=Real-world implementation

Example:
Top-rated Topics in “Policy: Collaboration and Cooperation” (Real-world Implementation)

- Agriculture, forestry and fisheries, food and biotechnology consists more than half of the list; top topics include information and data management/utilization as well as environment-related issues.

Field	Topics	Selection ratio*1	Importance *2	When to be achieved*3
Agriculture, forestry and fisheries	Development of food demand prediction system which takes into account trends in the increase of the global population, economic development, and crop production technologies	56% (53%)	3.5	2025 2028
Service	Construction of a system to check whether proposed services are conform to laws of each country and specify the conditions for providing services by country based on legal information searches	53% (44%)	3.1	2024 2025
Agriculture, forestry and fisheries	Development and promotion of the use of completely infertile cultured fish	50% (46%)	3.1	2025 2030
Agriculture, forestry and fisheries	Construction of a database of seaweed and marine plant resources suitable for coastal area environments (including islands) for sustainable use of such resources	50% (33%)	3.3	2023 2025
Agriculture, forestry and fisheries	Creation of a database of international research results that takes an approach which integrates cognitive science, linguistics, and chemistry considering taste, scent, and texture to reproduce flavors easily	50% (33%)	2.8	2025 2030
Service	A digital pipeline will be developed by computerizing the entire design, development, production, quality control, and manufacturing process, and the unified format will intensify open innovation both inside and outside companies	47% (50%)	3.5	2025 2026
Agriculture, forestry and fisheries	Observation and evaluation technology for to prevent the destruction of rainforests and assist related reforestation activities	47% (37%)	3.6	2024 2027
Agriculture, forestry and fisheries	Recycling-oriented local communities where cities and villages cooperate to make the nitrogen cycle work effectively and reduce nitorogen's impact on the watershed	47% (44%)	3.1	2025 2032
Agriculture, forestry and fisheries	Establishment and demonstration of a market-oriented business model for sustainable agriculture through the vertical integration of primary, secondary, and tertiary industries to generate added value and growth for the agricultural, forestry, and fisheries industries	47% (36%)	3.2	2020 2025
Agriculture, forestry and fisheries	A system which proposes a meal menu (including necessary ingredients and cooking method) based on and individual's health data and his/her preferences	46% (29%)	3.4	2020 2025

*1: Parentheses represent percentages for selecting “collaboration and cooperation” as a policy focus for technology achievement
*2: Importance: Responses are coded (Very high=4, High=3, Low=2, Very low=1)
*3: Top=Technology achievement, Bottom=Real-world implementation

Example:
Top-rated Topics in "Policy: Environment Enhancement"(Technology Achievement)

◆ Topic from service-oriented society occupy more than half of the list; topics include improvement of information and data management/utilization.

Field	Topic	Selection ratio*1	Importance *2	When to be achieved*3
Environment and resources	Widespread power generation using geothermal energy at hot spring areas in Japan	57% (62%)	2.8	2022 2025
Service	Matchmaking services that assist people in meeting others while pretending it was a natural encounter by using data from sensors worn by people or deployed around town will spread	57% (58%)	2.2	2019 2023
Service	New businesses that manage customers' personal behavior information (such as sensor information and purchase histories)in a manner similar to credit card companies and banks will emerge and become commonly used by the public	56% (56%)	2.6	2018 2021
Social Infrastructure	Efficient commercial agriculture which enables Japan to produce more than half its crops domestically	51% (55%)	3.1	2025 2025
Health	A system to record and store all measurement and image data generated by research activities as well as authenticate and guarantee the original raw data in order to prove the authenticity of research results	50% (49%)	3.1	2020 2022
Service	The current structure in which neighbors cooperate to solve local issues will be expanded and become more open, allowing people from outside the region with consciousness of a problem to volunteer to help resolve the problem through social networking sites as part of a lifestyle assistance system	50% (39%)	3.2	2021 2025
Service	People will manage personal profiles including individual sensor data, and by carrying their profiles in portable terminals they will be able to receive some degree of customized service even when they visit a store for the first time	50% (55%)	3.0	2019 2020
Environment and resources	A system able to control electricity supply and distribution for households and consumers using fuel cells and storage batteries installed in automobiles	50% (62%)	2.9	2020 2025
Service	More than half of all companies start using a new index to evaluate their employees which takes into account their long-term relationship with customers and their contributions to customer lifetime value or to society	49% (43%)	3.2	2024 2025
Social Infrastructure	A road usage fee system where a fee is charged based on the location of the road and time of usage (or the state of congestion)	48% (65%)	2.8	2020 2025

*1: Parentheses represent percentages for selecting "environment enhancement" as a policy focus for real-world implementation
*2: Importance: Responses are coded (Very high=4, High=3, Low=2, Very low=1)
*3: Top=Technology achievement, Bottom=Real-world implementation

Example:
Top-rated Topics in “Policy: Environment Enhancement” (Real-world Implementation)

◆ Many top-rated topics are related to power (production, transmission, and distribution) as well as road and transportation.

Field	Topics	Selection ratio*1	Importance *2	When to be achieved*3
Service	Automatic driving technology becomes widespread and the number of roads on which people do not have to drive manually increase, resulting in dramatically improved logistical efficiency	78% (42%)	3.5	2020 2028
Environment and resource	Fuel cell vehicles account for over 10% of new car sales	69% (44%)	3.1	2025 2030
Health	An artificial uterus which enables the growth of a fetus	67% (33%)	2.8	2030 2040
Agriculture, forestry and fisheries	Foreign gene expression technology for organisms insusceptible to transformation by full control of activated recombinants (eukaryotic plants, eukaryotic algae, etc.)	67% (17%)	3.1	2020 2025
Social Infrastructure	A road usage fee system where a fee is charged based on the location of the road and time of usage (or the state of congestion)	65% (48%)	2.8	2020 2025
ICT	Cooperative transportation system which supports communication between humans and vehicles so that all traffic signals can be eliminated	63% (33%)	3.2	2025 2030
Environment and resource	A system able to control electricity supply and distribution for households and consumers using fuel cells and storage batteries installed in automobiles	62% (50%)	2.9	2020 2025
Environment and resource	Widespread power generation using geothermal energy at hot spring areas in Japan	62% (57%)	2.8	2022 2025
Material	Replacement of more than 80% of the national power transmission and distribution network with a direct current smart grid system	62% (47%)	3.0	2030 2035
Health	Preventive and therapeutic treatments for infertility through the prevention of aging and functional rejuvenation of egg cells (i.e. preservation of ovarian functions, anti-aging drugs, etc.)	62% (43%)	3.4	2025 2031

*1: Parentheses represent percentages for selecting “environment enhancement” as a policy focus for technology achievement
*2: Importance: Responses are coded (Very high=4, High=3, Low=2, Very low=1)
*3: Top=Technology achievement, Bottom=Real-world implementation

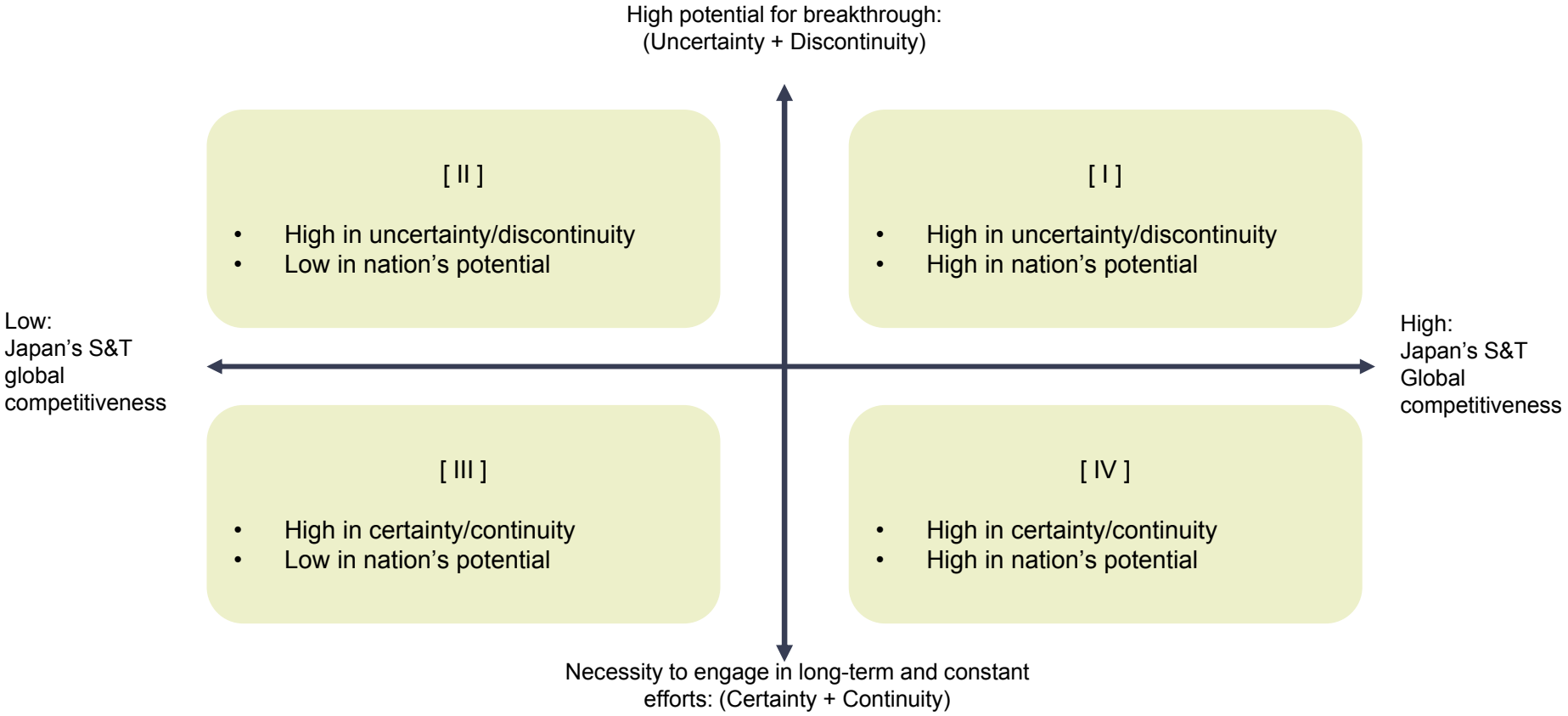
Example:
Topics That Are Expected To Be Implemented Within 10 Years

Field	Topic	Technology achievement	Importance
ICT	Innovation through the application of exabyte- to zettabyte-scale high performance computing and big data analytics technologies to social phenomena, science, and advanced production	2022	3.8
ICT	Development of data utilization techniques with theoretically guaranteed preservation of privacy	2020	3.7
Health	Technology to detect tumors among cells transplanted as part of regenerative medical procedures utilizing stem cells such as iPS cells.	2020	3.6
Health	Therapeutic medicines for refractory cancer which target cancer stem cells	2022	3.6
Agriculture, forestry and fisheries	Observation and evaluation technology for to prevent the destruction of rainforests and assist related reforestation activities	2024	3.6
Agriculture, forestry and fisheries	Technology to preserve perishable goods for about one week without refrigeration for use in logistics	2023	3.6
Frontier	Technology to analyze the structure and chemical state of highly radioactive substances or samples from a highly radioactive environment necessary for the development of hydro-processing catalysts for improved nuclear safety and fuel debris composition and state analysis for reactor decommissioning	2020	3.6
Frontier	Technology to observe atmospheric conditions such as water vapor, precipitation, cloud aerosols, etc. with high precision and high sensitivity at a global-scale via satellites	2021	3.6
Environment and resource	Technology to predict sudden, localized rainstorms (precipitation of 100mm of rain per hour called "guerrilla rainstorms" in Japan) with a 100m mesh observation network	2022	3.5
Environment and resource	Large-scale combined power generation with high efficiency, large-scale gas turbines (inlet temperature of over 1700℃).	2021	3.4
Material	Practical power semiconductors for electrical use which have lower losses than silicon carbide (SiC) or gallium nitride (GaN)	2024	3.5
Material	Model optimization technology that connects the local and macro physical properties of materials by assimilating simulation data and measured data to achieve more precisely predictive models.	2024	3.4
Social Infrastructure	Diagnostic technology for typical structures using sensors suitable for long-term use to monitor environmental factors involved in the degradation or deterioration of the structure, the history of external forces acting on the structure, and changes in the state of the structure	2024	3.6
Social Infrastructure	Robots capable of successfully rescuing people from rubble or providing emergency transport inside buildings	2024	3.6
Service	Laws on agricultural corporations will be amended, opening the door to the creation of new agricultural businesses such as fully automated robot farm work (return of domestic agriculture to ensure food safety)	2022	3.5
Service	Development of a practical design navigation tool that consistently guides the product design service system from upstream to downstream elements	2020	3.4

Importance: Responses are coded (Very high=4, High=3, Low=2, Very low=1)

Classification of Items With High Importance

- Examined 312 items with high importance (top 1/3 items on importance score)
- Combined scores for uncertainty and discontinuity to extract items within top 10% (30 items) and bottom 10% (30 items)
- Global competitiveness was then taken into account to finalize the ranking of top 10% and bottom 10%



Scale: Responses are coded (Very High=4, High=3, Low=2, Very low=1)

Classification of Items with High Importance: Category I

- Category I: High in uncertainty and discontinuity as well as nation's potential.
  - Regenerative medicine, fuel cell and rechargeable battery for automobiles, earthquake forecasting, etc.

Field	Items	Importance	Uncertainty	Discontinuity	Competitiveness	When to be achieved*
ICT and analytics	A network node that uses technology such as nanophotonics to reduce the electricity consumed per unit of data transferred to 1/1000 of the current consumption level	3.5	3.0	2.9	3.2	2025 2030
Health, medical care and life sciences	A comprehensive understanding of the reprogramming mechanism of differentiated cells	3.5	2.9	2.9	3.4	2023 2025
Health, medical care and life sciences	Technology to create stem cells such as iPS cells from differentiated cells regardless of genetic transfer	3.5	3.0	2.9	3.2	2020 2025
Agriculture, forestry and fisheries, food and biotechnology	Technology to preserve perishable goods for about one week without refrigeration for use in logistics	3.6	3.0	2.8	3.3	2023 2025
Space, ocean, earth and science infrastructure	Prediction technologies for the timing (within a one year horizon), scale, affected regions, and damage of earthquakes greater than magnitude 7 on the Richter scale	3.5	3.6	2.9	3.1	2030 2032
Space, ocean, earth and science infrastructure	Technology to predict the occurrence of large-scale earthquakes greater than magnitude 8 on the Richter scale through the analysis of strain distribution on the Earth's crust and the history of past earthquakes.	3.5	3.5	2.7	3.2	2030 2030
Material, device and process	Room-temperature superconducting materials that make use of strongly-correlated electron systems	3.4	3.4	3.4	3.2	2030 2040
Material, device and process	Solar cell with a conversion efficiency of more than 50%	3.5	3.0	2.8	3.1	2025 2030
Material, device and process	A rechargeable automotive battery capable of a range of 500km (energy density of more than 1kWh/kg, and specific power of more than 1kW/kg) while maintaining the size and weight of current batteries	3.6	2.8	2.9	3.3	2025 2030
Material, device and process	High-efficiency fuel cells for motor vehicles which do not use rare metals	3.6	3.0	3.0	3.3	2025 2030

*Top=Technology achievement, Bottom=Real-World implementation

Classification of Items with High Importance: Category II

- Classification II: High in uncertainty and discontinuity; low in nation's potential
  - Cybersecurity, mental disease, infectious disease, etc.

Field	Topic	Importance	Uncertainty	Discontinuity	Competitiveness	When to be achieved*
ICT and analytics	Development of a new computation model to understand the difficulty of calculations: A theoretically solvable model for computationally difficult problems as the foundation for construction of a realistic and marginal problem solving platform	3.5	3.0	3.0	2.9	2027 2035
ICT and analytics	Defense technology that recognizes dynamic changes in the pattern of an attacker's attacks and automatically implements the most effective defense	3.6	3.0	2.9	2.7	2020 2022
ICT and analytics	Technology to prevent illegal activities by people who are authorized to access to a specific system	3.6	3.1	2.8	2.7	2020 2024
Health, medical care and life sciences	Pharmaceuticals based on new functional molecules to follow after pharmaceuticals based on low molecular weight compounds, antibodies, and nucleic acids	3.5	3.0	3.0	2.8	2024 2025
Health, medical care and life sciences	A new antipsychotic drug based on the pathogenesis of schizophrenia in the brain that has fewer side effects than current drugs and leads to the social reintegration of patients	3.5	3.0	2.8	2.7	2027 2031
Health, medical care and life sciences	A new antidepressant therapy that is fast-acting and prevents the recurrence of depression based on the diagnostic classification of subtypes of depression according to the pathology of depression in the brain	3.5	3.0	3.0	2.7	2025 2029
Health, medical care and life sciences	A new mood stabilizer based on the pathogenesis of bipolar disorder in the brain with fewer side effects than current drugs and the possibility of preventing the recurrence of symptoms	3.5	3.0	2.8	2.8	2028 2030
Health, medical care and life sciences	Therapies and intervention methods based on the pathogenesis of autistic spectrum disorders in the brain that enable an independent social life	3.4	3.1	2.9	2.6	2025 2030
Health, medical care and life sciences	Flu vaccines which don't cause antigenic variations in the virus and can provide lifelong protection against infection through only a few vaccinations	3.4	3.3	3.0	2.5	2025 2030
Material, device and process	Simulation technology that does not predict functions and physical properties based on structural information but rather predicts the structure itself using the desired functions and physical properties as inputs	3.5	3.0	2.9	2.9	2025 2030

Classification of Items with High Importance: Category III

- Classification III: High in certainty and continuity; low in nation's potential
  - Network technology, utilization of medical data, forestry, surveillance, etc.

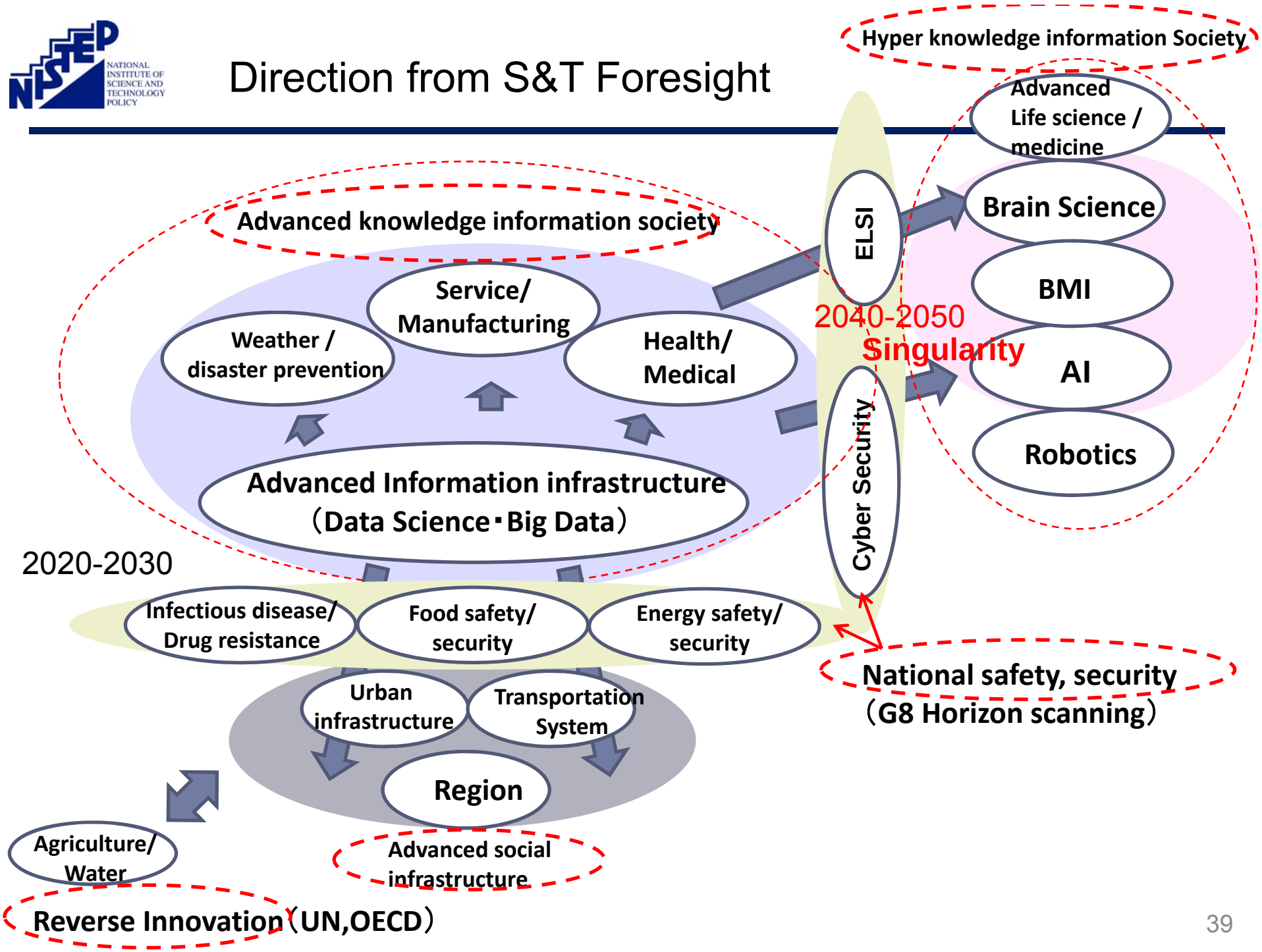
Field	Topic	Importance	Uncertainty	Discontinuity	Competitiveness	When to be achieved*
ICT and analytics	Automatic configuration technology for integrated wired/wireless networks that provides uninterrupted access to a network without the user being aware of configuration changes as the status of the network changes over time	3.4	2.3	2.3	2.9	2020 2022
ICT and analytics	A highly reliable network which provides services without disruption by using network virtualization technology that dynamically adjusts based on operating conditions internal and external to the system	3.4	2.3	2.4	2.9	2020 2020
Health, medical care and life sciences	Disease preventation methods based on the utilization of big data methods to analyze lifestyle data	3.4	2.3	2.3	2.7	2020 2025
Health, medical care and life sciences	A prediction and alert system for infectious disease epidemics based on a comprehensive infectious disease surveillance system that utilizes medical data such as EMR system data, test results, and prescription records along with various kinds of web data	3.5	2.3	2.2	2.5	2020 2022
Health, medical care and life sciences	Technology for the separation and identification of unknown pathogens by utilizing a pathogen database	3.5	2.4	2.3	2.7	2022 2025
Agriculture, forestry and fisheries, food and biotechnology	Establishment of methods for assessing the safety of genetically-modified crops and animals	3.6	2.3	2.3	2.7	2024 2025
Agriculture, forestry and fisheries, food and biotechnology	Woodland creation technology corresponding to the period from forest thinning to final clear cutting to ensure the reproduction of the forest following the harvest	3.5	2.3	2.0	2.3	2021 2025
Agriculture, forestry and fisheries, food and biotechnology	Development of high strength wood members and fire resistant wood structures for the construction of low-rise and high-rise wooden buildings such as office buildings	3.4	2.2	2.3	2.6	2020 2025
Space, ocean, earth and science infrastructure	A 24-hour high precision homeland monitoring system based on satellites to ensure public safety and security and provide data for industrial use	3.5	2.2	2.2	2.9	2025 2025
Social infrastructure	Unmanned aircraft for low-attitude autonomous flight to be used for surveillance of territorial waters, disaster monitoring, and rescue support	3.4	2.3	2.3	2.9	2020 2025

Classification of Items with High Importance: Category IV

- Classification IV: High in certainty and continuity as well as nation's potential.
  - Beam application (material, treatment), highly-efficient power generation, recycling of resources, etc.

Field	Items	Importance	Uncertainty	Discontinuity	Competitiveness	When to be achieved*
Health, medical care and life sciences	Radiation therapies to enable cancer treatment within a short period without disturbing daily life by using a small system for irradiation of intensity modulated particle beam	3.5	2.2	2.2	3.3	2025 2030
Space, ocean, earth and science infrastructure	Buoy-type technology to observe crustal deformation and tsunami formation at sea without laying submarine cables	3.5	2.2	2.3	3.4	2020 2025
Space, ocean, earth and science infrastructure	A medium-size high-intensity synchrotron radiation facility surpassing Spring-8 in the soft X-ray area (electron energy 3 GeV, horizontal emmitance of 1.2nmrad or less, brilliance of 10^20 phs/s/mm^2/mrad^2/0.1%BW or more).	3.6	2.0	2.6	3.4	2020 2020
Space, ocean, earth and science infrastructure	Technology for the in situ observation of functional materials and structural materials using neutrons and X-rays to visualize the three-dimensional stress and strain distribution of the materials during the production process	3.5	2.2	2.4	3.2	2020 2022
Space, ocean, earth and science infrastructure	Communications and networking technologies based on fiberoptic network and frequency link technologies with high-precision standards, reference signals, location information, etc. that works equally well in remote areas (i.e. optical carrier frequency fiber link technology, optical comb transmission technology, high stability GPS technology through timing synchronization, and ultra-high-precision technology, etc.)	3.4	2.2	2.4	3.2	2021 2025
Environment, resources and energy	720℃ level supercritical pressure thermal power generation that can achieve 46% efficiency (HHV standard)	3.4	2.4	2.2	3.3	2022 2025
Environment, resources and energy	Large-scale combined power generation with high efficiency, large-scale gas turbines (inlet temperature of over 1700℃)	3.4	2.3	2.2	3.2	2021 2025
Environment, resources and energy	Technology for the rational recovery and utilization of rare metals from sewage, sludge, incinerator fly ash, waste, and small electronic devices	3.4	2.4	2.2	3.2	2022 2026
Environment, resources and energy	Technology for the purification and recycling of contaminated water that is economical and generally available in developing countries	3.6	2.3	2.1	3.2	2020 2025
Service-oriented society	Popularization of supervision terminal technology that can be worn naturally by general consumers to monitor people such as dementia sufferers who might wander off	3.5	2.2	2.3	3.2	2020 2022

Direction from S&T Foresight



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Thank you for your kind attention.