6. Frontier field

6.1. Overview

(1) The role of science and technology related to the frontier field

A characteristic of the relationship between modern society and science and technology is that the fruits of science and technology penetrate every corner of human life, while at the same time the future of that life is threatened by the products of science and technology. Whatever the fate of human life on Earth may be, it is unimaginable without some relationship with science and technology.

In particular, science and technology related to the frontier field, which developed radically in the 20th century, speaks eloquently of the fact that life on Earth is the product of a cosmogony that has played out over the few billion years since the Big Bang. In that sense, the frontier field influences human life (in each of its senses) on the largest scale and with the longest vision.

This comprehensiveness, broadness, long-term perspective, and leadership held by the frontier field brings a needed inevitability to fundamental measures on various problems facing today's society, and requires a corresponding degree of national support based on a long-term vision.

(2) The future shape of Japan's frontier field

In the survey, the fields of energy and resources, environment, information and communications, life science, social technology, and nanotechnology and materials all receive high support, with slight variation, as fields with which the frontier field should seek to integrate and collaborate into the future. This reflects and suggests that the frontier field is formed by integrating the elemental technologies of other science and technology fields and plays a leadership role by providing a foundation for the perspective of modern outlooks on the universe and the Earth, thus giving other fields a strategic basis for development. Forecasting the world 30 years from now, the fact that "unmanned space exploration," "manned space activities," "human activity in ocean spaces," and "human activity in underground spaces" all received the answer "Will be more active than now" speaks of the high expectations for the frontier field.

(3) Expected impacts from the frontier field

For current expected impacts, the response was "Large" or "Somewhat large" for increased intellectual assets in each of the frontier field's 11 areas, demonstrating a consciousness that these are essential topics for increasing Japan's intellectual presence. The highest expectations are for the areas of space, ocean, and Earth technology for a safe and secure society; technology for high precise observation of Earth environments and for prediction of change; and space, ocean, and Earth technology that drives science and technology innovation.

Results for expected impact at the medium term were roughly equivalent to those for current expected impacts. This tells us that the frontier field is already deeply connected to our lives, and that it is leading technology that will open the way to the future in comprehensive, long-term manner.

As for contributing to the creation of new industries and business, we wish to draw attention to basic technology for space transportation and manned space activity, planetary exploration, and ocean and deep ocean floor observation research technology as areas with high expectations shifting from the present to the medium term. These areas are likely to open new worlds of curiosity, and humanity looks to Japan to contribute the results to the world's intellectual pursuits.

Taking a comprehensive look at the history of 20th century science and technology, the frontier field is the basic science field that has made the most fundamental contribution to the creation of new industries and businesses. Of course, the current age, which some call the Information Revolution, would not have begun if its most basic theory, quantum mechanics, had not been established and if innumerable particle experiments had not been performed in order to prove it.

A country striving to base itself on creating science and technology must stand firmly on the foundation of the long-range revolution brought by basic science.

(4) Japan's R&D level

In comparison with the USA, and the countries of Europe and Asia, on average Japan is "somewhat behind" the USA and Europe while "leading" Asia in every sector. Areas where Japan is about even with or ahead of the USA include space and particle research, technology for high precise observation of Earth environments and for prediction of change, ocean and deep ocean floor observation research technology, deep Earth observation technology, and space, ocean, and Earth technology for a safe and secure society. The R&D level five years ago showed approximately the same results. Even in areas in which Japan trails Europe and the USA, planetary exploration for example, Japan leads in several technologies for individual topics, such as sample-and-return exploration of solid planets.

(5) Degrees of importance of individual foresight topics

The following topics ranked highest in terms of the degree of importance to Japan index.

- The topic to construct a risk management system that utilizes disaster observation satellites, communications satellites, and so on
- The topic to forecast volcanic eruptions by observing and assessing magma conditions inside volcanoes that are likely to erupt
- The topic to precisely forecast the earthquakes of magnitude 7 or greater

Of the top 10 topics in terms of the degree of importance index, 6 deal with predicting or managing disasters such as earthquakes, volcanoes, and torrential rainfall. The other 4 are reaching agreement on greenhouse gas regulation, predicting climate change, underground disposal of radioactive waste, and an integrated, digital, national land management and use system that covers all of Japan.

By area, space, ocean, and Earth technology for a safe and secure society had the highest score on the degree of importance index.

(6) Technological realization

The overwhelming majority of respondents believe that time of realization for the frontier field will be between 2011 and 2015. Most believe that government involvement in the field is necessary, with the total of those selecting either "high" or "moderate" reaching 93 percent. Space, ocean, and Earth technology for a safe and secure society was the area for which the highest number of responses said government involvement is most necessary, followed by the planetary exploration technology area. The strength of interest in these topics underlies these responses on necessity of government. The frontier field includes many nationally-promoted projects around the world, and if we are to truly pioneer this field, the important measures that the government should take are research and development funding and human resources development.

(7) Social application

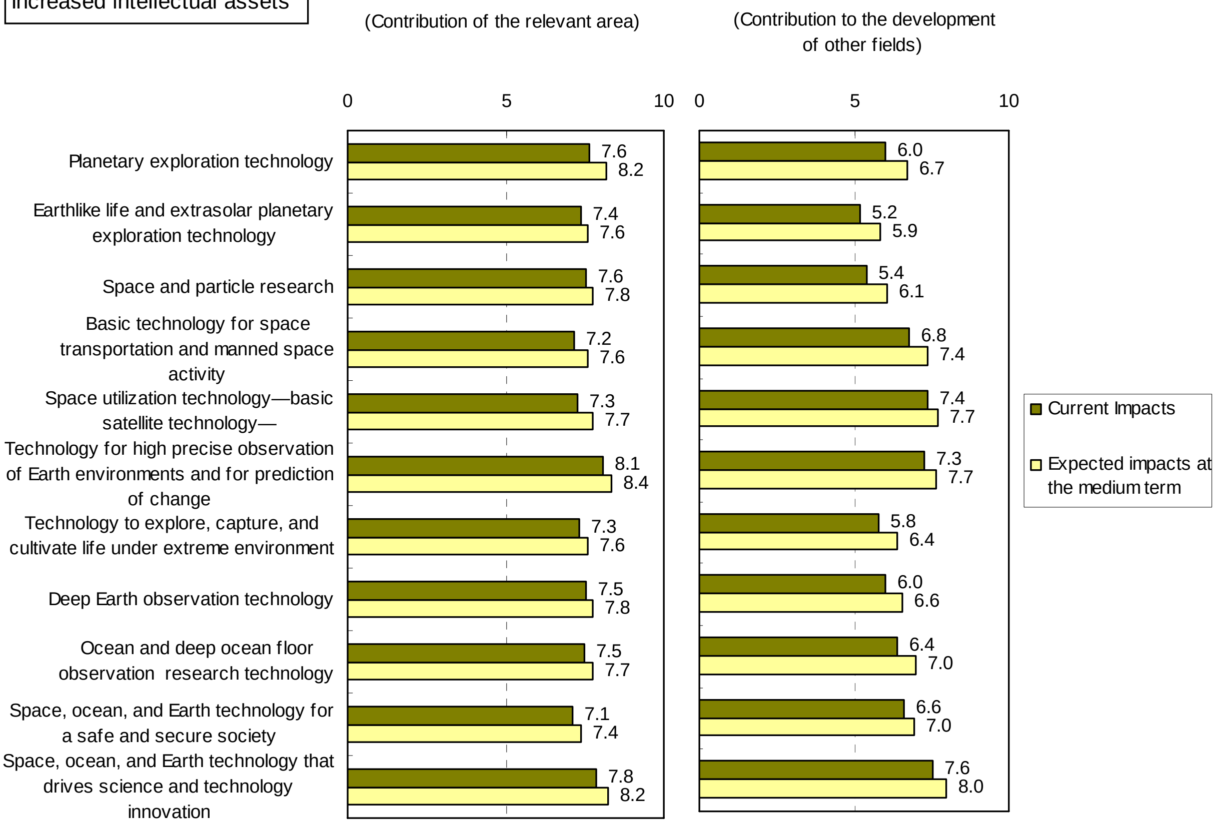
Social application in the frontier field is predicted between 2021 and 2025, gently curving to a peak. Ten years is seen as the average time from technological realization to social application. Because these are very advanced technologies, perhaps respondents imagine the necessity of a long technological ordeal until social application, but actually, once the technologies of the frontier field achieve technological realization, most of them will be rapidly applied to civil life. Barcodes, which began as technology for quality control in space programs, are an example of this phenomenon.

(MATOGAWA Yasunori)

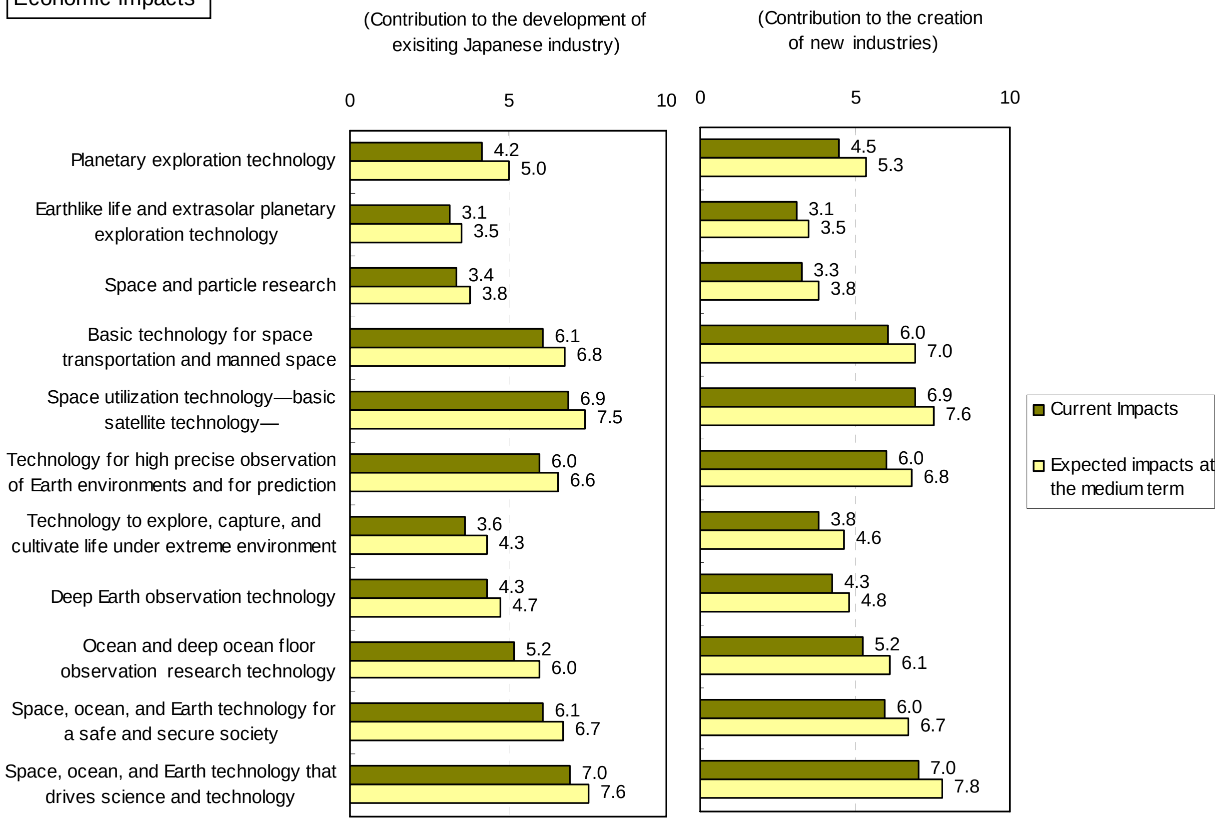
6.2. Main results

A. Impacts

Increased intellectual assets

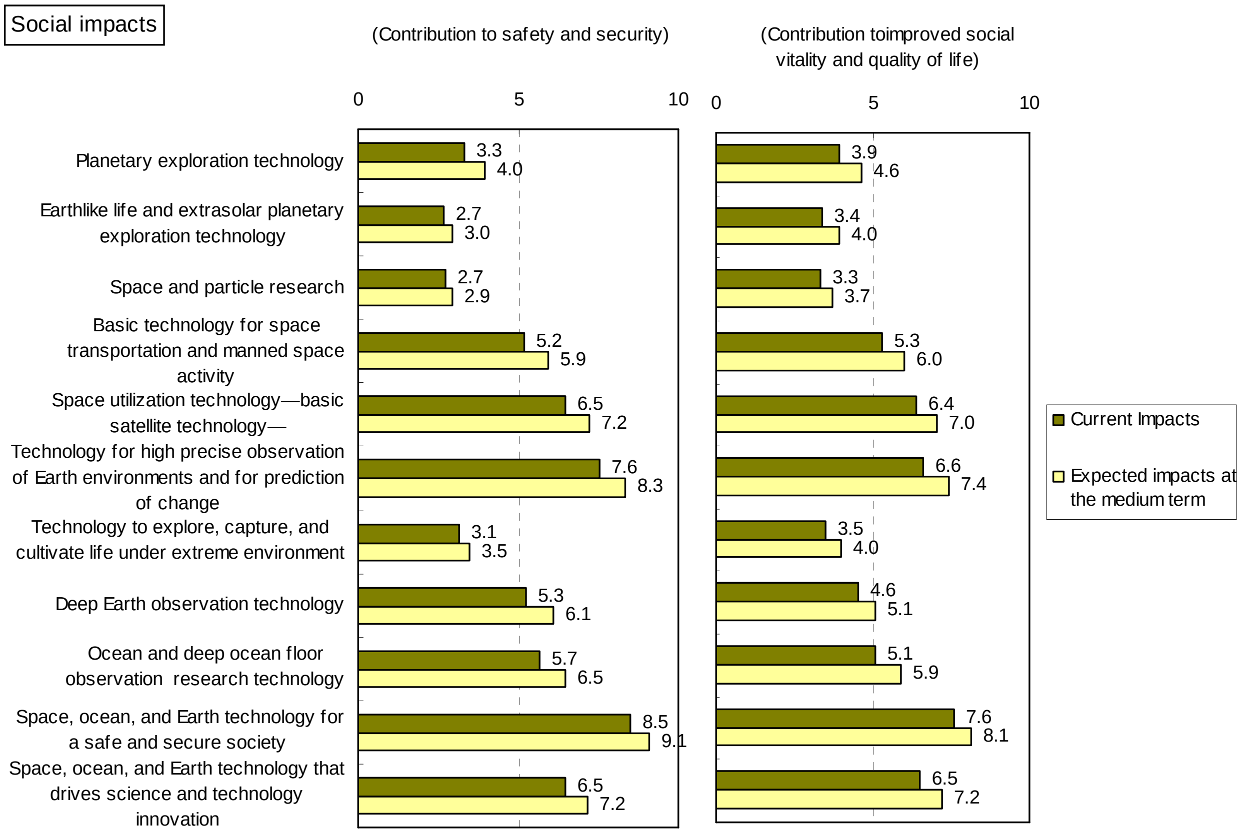


Economic impacts



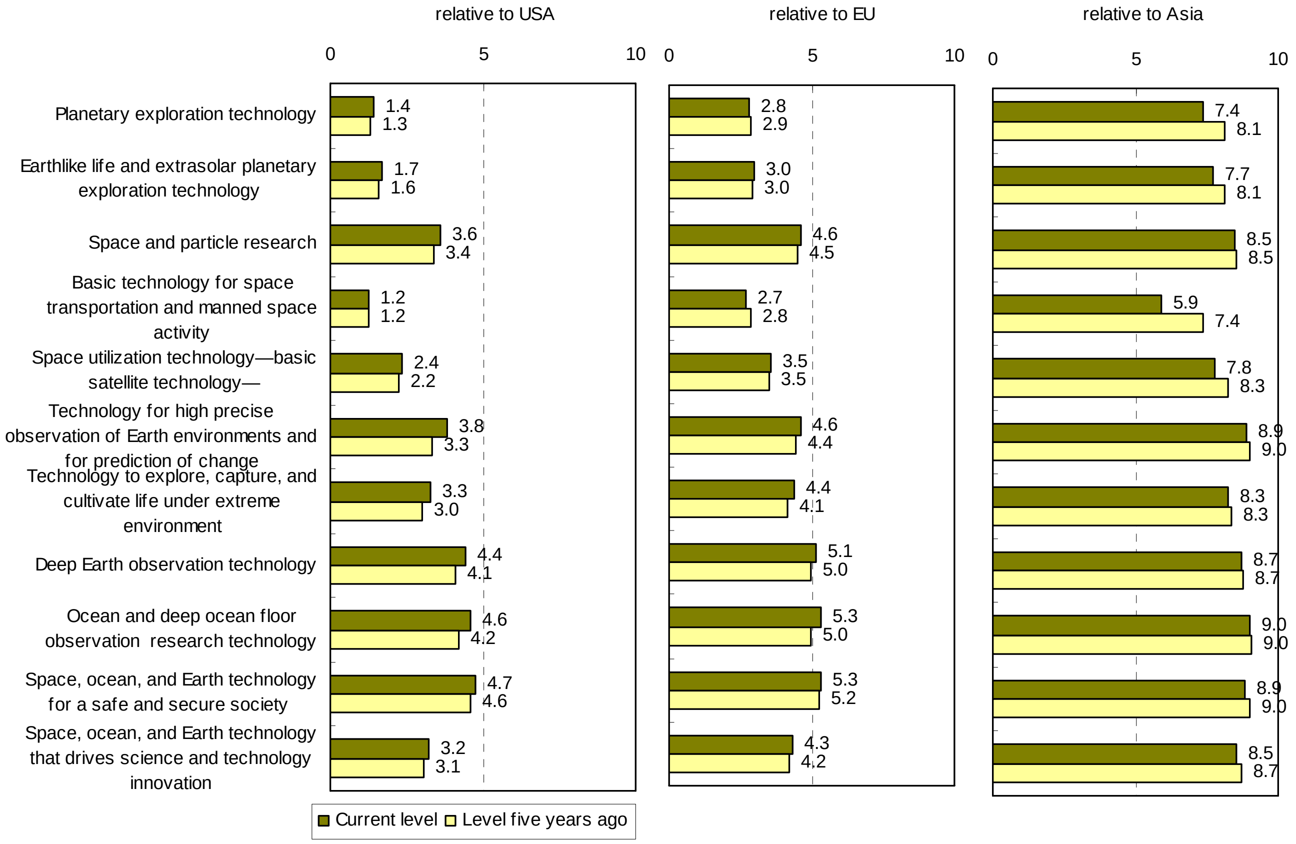
*Responses are indexed on a 10-point scale.

Social impacts



*Responses are indexed on a 10-point scale.

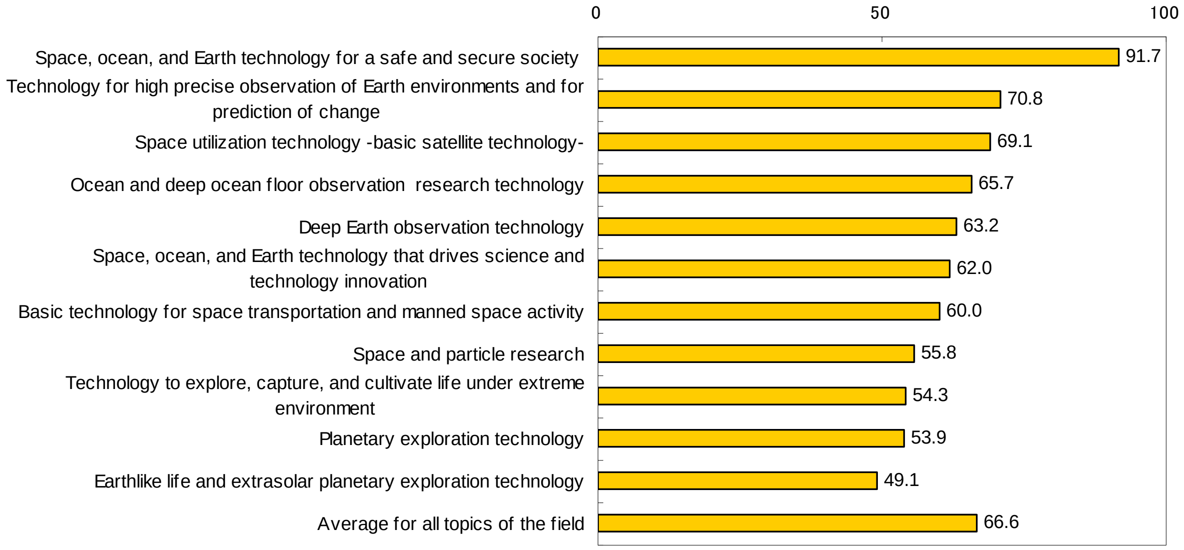
B. Japan's R&D Level



*Responses are indexed on a 10-point scale.

C. Importance to Japan

Average importance index by area



The most important 10 topics

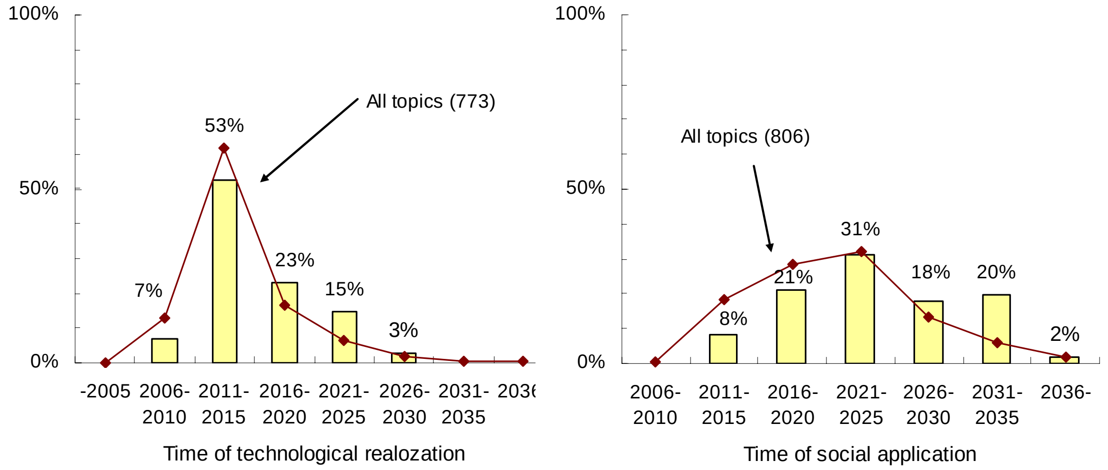
	Topic	Index	Year T*	Year S*
1	52: A risk management system that utilizes disaster observation satellites, communications satellites, GPS, unmanned aircraft, and so on to observe disasters, understand situations after disasters occur, and respond swiftly (send the necessary information where it is needed).	98	2009	2014
2	58: Technology to forecast the timing and scale of volcanic eruptions by observing and assessing in real time magma conditions inside volcanoes that are likely to erupt.	98	2014	2022
3	57: Technology to precisely forecast the imminence (place and time period) of earthquakes (plate boundary earthquakes and inland earthquakes) of magnitude 7 or greater that are likely to cause damage, helping mitigate human disasters.	98	2021	2030
4	60: Technology to evenly and densely place comprehensive earthquake/crust change observation equipment in major cities, mountainous areas, continental shelves, and so on in order to predict earthquakes.	96	2010	2016
5	59: Formation of a worldwide consensus, including developing countries, on international regulations on the output of carbon dioxide and other greenhouse gases.	96	-	2014
6	61: Elucidation of the mechanisms of rainfall, snow accumulation, torrential rain, and so on.	95	2013	2020
7	45: Technology that makes it possible to measure regional stress fields in the Earth's crust on a region-wide scale in earthquake zones.	95	2015	2026
8	23: Forecasting technology for year-to-year variation of climate system.	94	2014	2022
9	55: Technology to assess the safety of geologic disposal of high-level radioactive waste.	93	2013	2021
10	53: An integrated national land management and use system (using Earth observation satellite data, GPS, communications satellites, GIS, and so on to digitize land use, ocean data, maps, etc.) that covers all of Japan, including the sea.	93	2009	2014

Year T: Time of technological realization　Year S: Time of social application

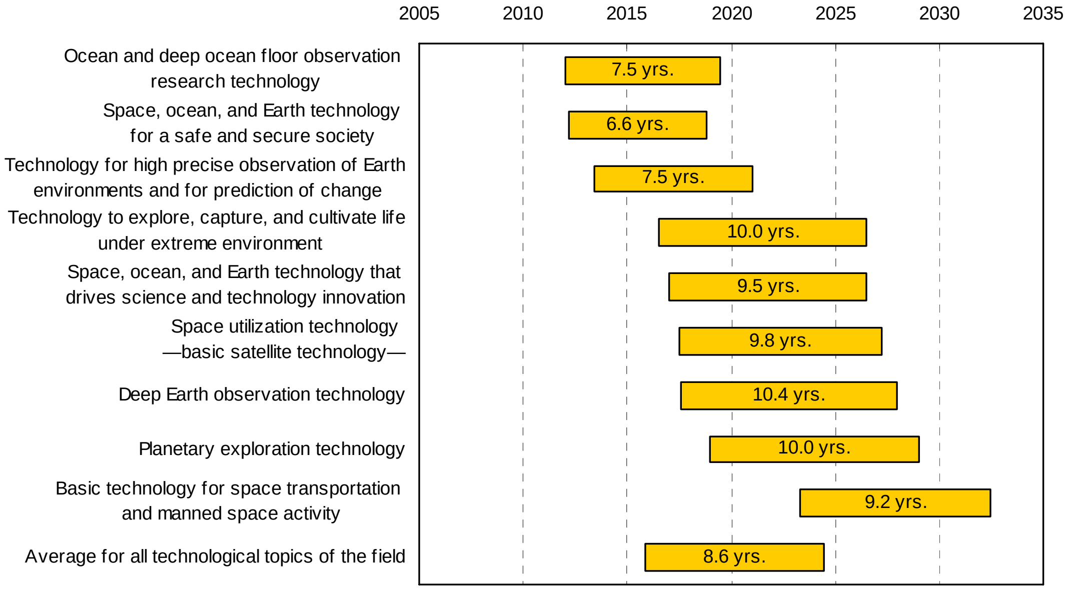
*Responses were indexed on a 100-point scale.

D. Time of realization

Distributions of forecasted realization time



Gap between technological realization and social application



Topics with short or long periods until social application

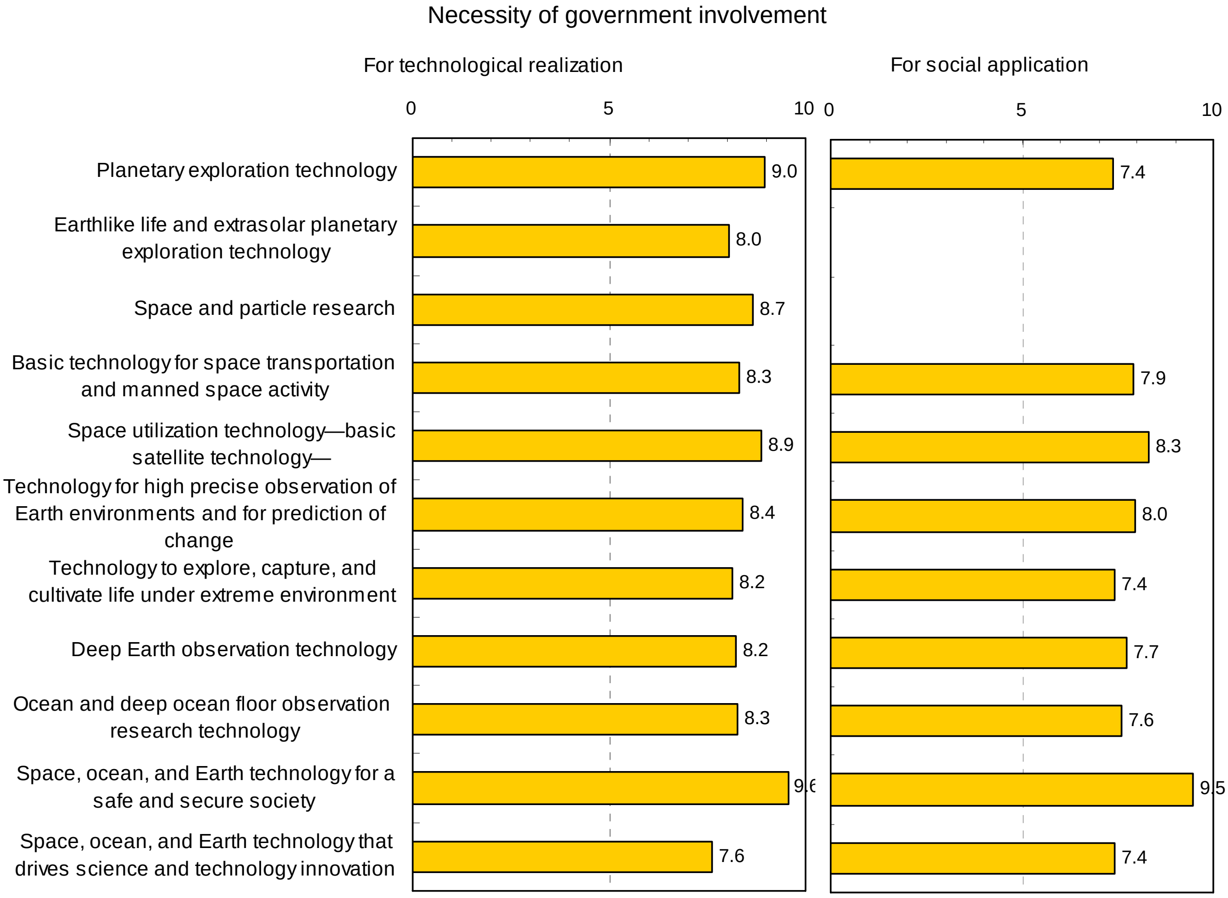
Topic	Year T*	Period*	Area
42: Technology to statically achieve samples of a size of a few centimeters or more from the high-temperature, high-pressure conditions near the center of the Earth.	2016	12	Deep Earth observation technology
43: Technology to use satellite magnetic field observation and surface observation to estimate the core's current dynamo action and future changes in the magnetic field.	2016	12	Deep Earth observation technology
13: Japan's own reusable space vessels that travel between the Earth and Earth orbit.	2020	11	Basic technology for robotic and manned space activity
38: Exploration technology to seek the extraterrestrial life on the other planets (including satellites) within the solar system.	2021	11	Technology to explore, capture, and keep extreme life forms
44: Technology sensitive enough to detect shifts in matter of a few centimeters a year deep inside the Earth.	2020	11	Deep Earth observation technology

Topic	Year T*	Period*	Area
45: Technology that makes it possible to measure regional stress fields in the Earth's crust on a region-wide scale in earthquake zones.	2015	11	Deep Earth observation technology
63: Solar photoelectric power generation plants in space that transmit electricity to the ground with microwaves or lasers.	2022	11	Space, ocean, and Earth technology that drives science and technology innovation
74: Saltwater engines that remove oxygen and hydrogen form seawater and generate energy.	2021	11	Space, ocean, and Earth technology that drives science and technology innovation

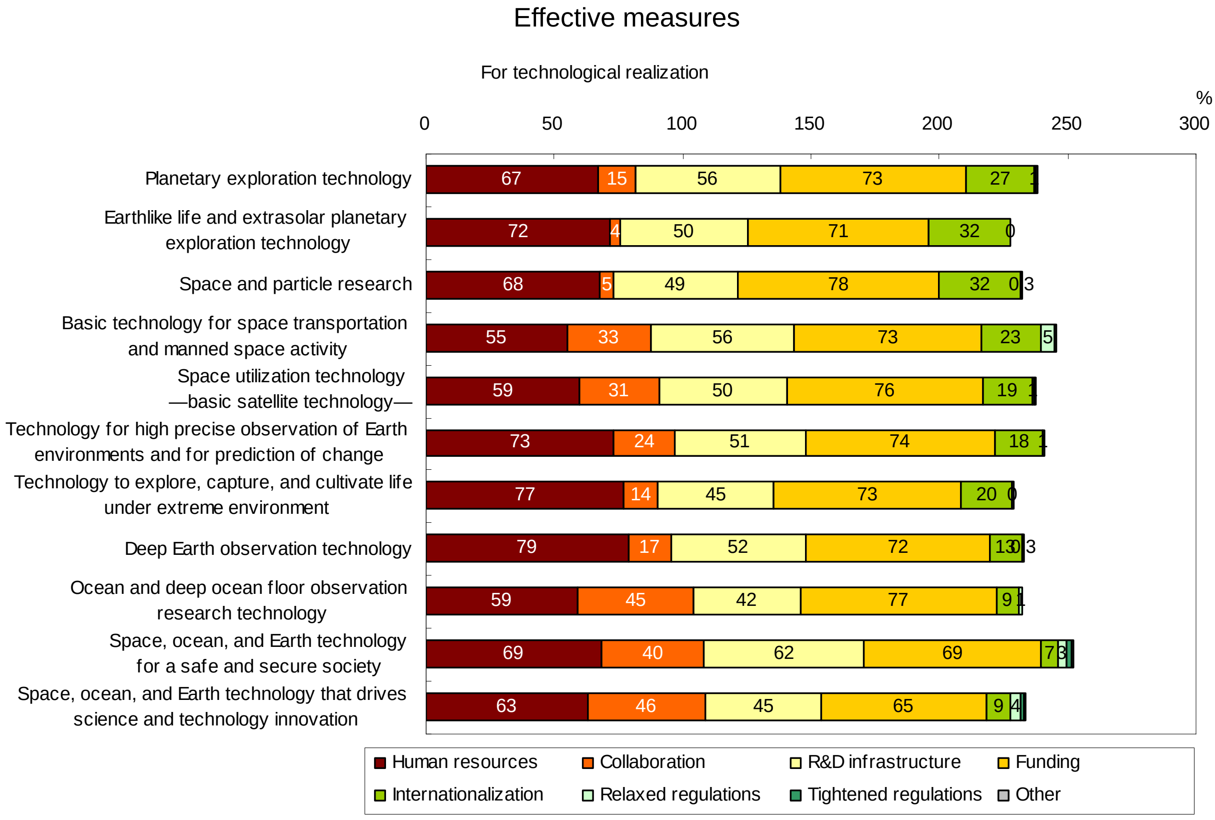
Topic	Year T*	Period*	Area
52: A risk management system that utilizes disaster observation satellites, communications satellites, GPS, unmanned aircraft, and so on to observe disasters, understand situations after disasters occur, and respond swiftly (send the necessary information where it is needed).	2009	5	Space, ocean, and Earth technology for a safe and secure society
53: An integrated national land management and use system (using Earth observation satellite data, GPS, communications satellites, GIS, and so on to digitize land use, ocean data, maps, etc.) that covers all of Japan, including the sea.	2009	5	Space, ocean, and Earth technology for a safe and secure society
54: Integrated usage and conservation technology for entire bays such as Tokyo Bay and Osaka Bay that are densely used.	2010	5	Space, ocean, and Earth technology for a safe and secure society
33: Three-dimensional image analysis systems that can distinguish tiny ocean organisms (microorganisms, plankton, etc.).	2012	6	Technology for highly accurate observation of Earth environments and prediction of change
49: High-tech survey vessels with a single specialized function.	2008	6	Ocean and deep ocean floor observation research technology
56: Technology that uses monitoring technology on moment-to-moment characteristics of falling and accumulated snow to predict the scale of surface avalanches, degree of risk, and so on over wide areas.	2011	6	Space, ocean, and Earth technology for a safe and secure society
60: Technology to evenly and densely place comprehensive earthquake/crust change observation equipment in major cities, mountainous areas, continental shelves, and so on in order to predict earthquakes.	2010	6	Space, ocean, and Earth technology for a safe and secure society

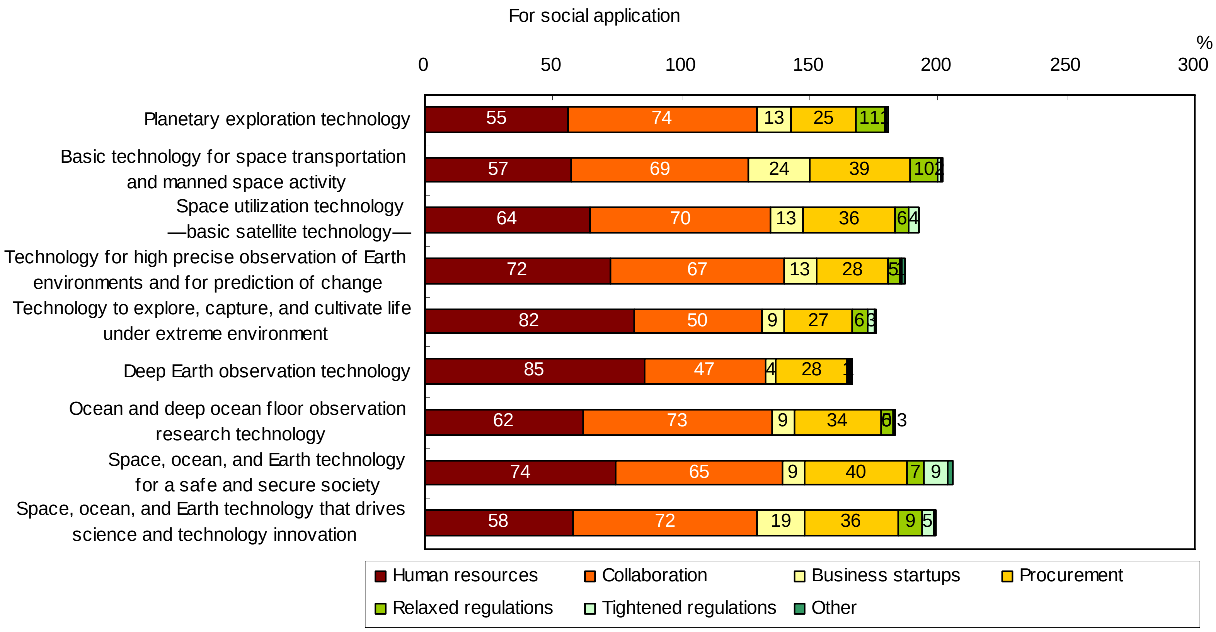
*Year T: Time of technological realization　Period: Period until social application (years)

E. Effective measures that should taken by government



*Responses were indexed on a 10-point scale





F. Time-line of topics

Technological realization

Year	Topic
2008	49: High-tech survey vessels with a single specialized function.
2009	52: A risk management system that utilizes disaster observation satellites, communications satellites, GPS, unmanned aircraft, and so on to observe disasters, understand situations after disasters occur, and respond swiftly (send the necessary information where it is needed).
	53: An integrated national land management and use system (using Earth observation satellite data, GPS, communications satellites, GIS, and so on to digitize land use, ocean data, maps, etc.) that covers all of Japan, including the sea.
2010	54: Integrated usage and conservation technology for entire bays such as Tokyo Bay and Osaka Bay that are densely used.
	60: Technology to evenly and densely place comprehensive earthquake/crust change observation equipment in major cities, mountainous areas, continental shelves, and so on in order to predict earthquakes.
2011	31: Automatic observation systems in the open ocean that monitor water temperature, salinity, and chemical tracers with high reliability while going for long periods without maintenance.
	56: Technology that uses monitoring technology on moment-to-moment characteristics of falling and accumulated snow to predict the scale of surface avalanches, degree of risk, and so on over wide areas.
	75: Three-dimensional autonomous navigation systems for water vessels.
2012	01: Technology to orbit Mercury, Venus, and Mars and observe their surfaces.
	33: Three-dimensional image analysis systems that can distinguish tiny ocean organisms (microorganisms, plankton, etc.).
	37: Technology to isolate and cultivate life forms that inhabit extreme Earth environments.
	47: Automatic observation systems in the open ocean that can monitor oceanographic phenomena and conditions from a depth of 6,000 m to near the surface for a long period of time (about 5 years).
	50: Robots that autonomously perform heavy duty work in the deep ocean.
2013	03: Sample returns from planets.
	05: Become able to directly image Jupiter-type planets orbiting nearby stars outside the solar system by using technology such as negative-type interferometers and coronagraphs.
	26: Systems to observe clouds and aerosol all over the Earth from satellites with high precision, resolution, and frequency.
	27: Stationary satellite observation (vertical resolution 500 m to 1 km, horizontal resolution 1–5 km) of water vapor distribution.
	32: Ocean observation systems that use various flight vehicles to agilely perform sample collection and instrument set up and collection.

Year	Topic
	34: Sensors that can distinguish body shapes underwater from a distance of several hundred meters.
	35: Microwave radiometers loaded on satellites to measure at a spatial resolution of 1 km or less worldwide water, soil moisture, salt deposition density, and snow and ice distribution on land.
	36: Methods to accurately calculate heat transfer in the water cycle such as from a water vapor to clouds and clouds to rain .
	39: Technology to place permanent geophysical observation bases on the deep ocean floor and radically increase the precision of exploration of the Earth's interior by networking them.
	48: Fuel cells that are closed systems (no atmospheric exposure), portable, and can provide 10 kilowatt output for one year with a single fueling.
	51: Probes that can penetrate 10 km below the sea floor.
	55: Technology to assess the safety of geologic disposal of high-level radioactive waste.
	61: Elucidation of the mechanisms of rainfall, snow accumulation, torrential rain, and so on.
	69: Offshore cities (bases for transportation, communications, research, production, leisure activities) with structures with legs or that float.
	76: Wireless communications technology that works over several horizontal kilometers in seawater to enable smooth performance of underwater work.
2014	23: Forecasting technology for year-to-year variation of climate system.
	25: Technology to precisely observe carbon dioxide gas emission and absorption within country, using space technology.
	28: High-precision Earth environment models with about 100–500 m resolution for a short-range forecasting that can distinguish buildings and predict air pollution, and urban flooding.
	46: Technology that precisely estimates the contributions of deep-sea chemical ecosystems to oceanic matter and energy.
	58: Technology to forecast the timing and scale of volcanic eruptions by observing and assessing in real time magma conditions inside volcanoes that are likely to erupt.
	67: Technology for the creation of recreational water-use areas through the development of seawater cleaning systems such as cleaning blocks and biofilters.
	72: Technology to grow bacteria that break down chemical substances that disrupt endocrines and other environmental pollutants.
	73: Establishment of quantitative models for ocean ecosystems.
2015	10: Multi-wavelength observations (in infrared, visible light, ultraviolet, x-rays, gamma rays, etc.), conducted by scientific satellites from outside the atmosphere, attain sensitivity improvements by two orders of magnitude.
	11: Technology to explore difficult-to-detect particles such as cosmic neutrinos, ultrahigh-energy gamma rays, and dark matter particles will markedly improve, leading to major developments.
	21: To respond to the increase in satellite-based communications volume accompanying the growth of Earth-based communications volume, a system of multiple stationary platforms with transmission capacities in the several terabits/second class, linked by optical intersatellite communications.
	29: Climate change simulations for the Earth's history, including the Snowball Earth and the ice age cycle.
	45: Technology that makes it possible to measure regional stress fields in the Earth's crust on a region-wide scale in earthquake zones.
	68: Technology to fix carbon dioxide to the seafloor.
	70: Marine farms that carry out optimal environmental management by adopting biology technology as well as a broad array of engineering technology.
	71: Methane hydrate mining utilization technology.
2016	42: Technology to statically achieve samples of a size of a few centimeters or more from the high-temperature, high-pressure conditions near the center of the Earth.
	43: Technology to use satellite magnetic field observation and surface observation to estimate the core's current dynamo action and future changes in the magnetic field.
2017	19: Satellite systems whose maintenance, repair, and functional upgrade may be performed by robots in orbit.
2018	08: High-precision space positioning technology utilizing multi-satellite formation flight will become available, with the goal of realizing gravitational wave detectors and ultrahigh-angle-resolution submillimeter interferometers.
	09: Various space observatories that utilize the lunar surface and Sun-Earth Lagrangian points will be realized, enabling far-infrared telescopes, ultrahigh-resolution visible light telescopes, and other technologies which cannot be achieved via Earth-based observations.

Year	Topic
	20: Operation of semi-permanent large platforms (a system in which mission apparatuses can appropriately exchanged and maintenance, inspection, and repair can be performed in orbit) in order to effectively utilize the limited stationary orbits available.
	24: Earth environment change forecasting technology with a scale of several decades by Earth system models that handle the composition of the atmosphere and oceans, ecosystems, and the material cycles within them.
2019	02: Quantum communications technology that is 1 million times faster than current optical communications for high-capacity communications with planetary exploration satellites and so on.
	04: Observation technology for satellites orbiting planets beyond Jupiter.
	12: Particle accelerator technology will advance markedly, leading to breakthroughs in human understanding of the natural world (the origins of the universe, the asymmetry between matter and antimatter, the origins of elements, etc.).
	62: Construction of computer life form models based on advances in system biology.
2020	06: Find Earthlike planets orbiting nearby stars outside the solar system by greatly improving exploration technology for extrasolar planets.
	07: Find environments suitable for life or subtle signs of biological activity on extrasolar planets by carrying out spectroscopic analysis of their atmospheres and surface compositions using remote sensing in infrared and visible wavelengths.
	13: Japan's own reusable space vessels that travel between the Earth and Earth orbit.
	22: Drastic technical measures (debris-free space systems, collection of debris already left, disposal by injection into the atmosphere, etc.) against the debris problem.
	44: Technology sensitive enough to detect shifts in matter of a few centimeters a year deep inside the Earth.
	64: Self-repairing space vessels.
2021	17: Geostationary orbital bases that can be used comprehensively for Earth observation and as space factories and communications bases.
	38: Exploration technology to seek the extraterrestrial life on the other planets (including satellites) within the solar system.
	41: Technology to extract mantle matter by deep drilling into the Earth from any location.
	57: Technology to precisely forecast the imminence (place and time period) of earthquakes (plate boundary earthquakes and inland earthquakes) of magnitude 7 or greater that are likely to cause damage, helping mitigate human disasters.
	74: Saltwater engines that remove oxygen and hydrogen form seawater and generate energy.
2022	16: Life support technology that utilizes closed ecosystems for self-supply of foods such as vegetables, grains, and animal protein in space.
	40: Technology to extract matter from the Earth's core in order to identify the light elements included there.
	63: Solar photoelectric power generation plants in space that transmit electricity to the ground with microwaves or lasers.
	66: Satellite-borne computers that operate on the level of thermal noise energy.
2023	15: Space tourism (including education and cultural activities) in Earth orbit.
2024	14: Japan's own manned space vessels.
2026	65: Space and planetary exploration technology using robots with overall decision-making ability equivalent to that of human beings.
2030	18: Permanent manned moon surface bases (scientific observation from the moon, lunar science, development of technology to utilize resources, etc.).

Social application

Year	Topic
2014	49: High-tech survey vessels with a single specialized function.
	52: A risk management system that utilizes disaster observation satellites, communications satellites, GPS, unmanned aircraft, and so on to observe disasters, understand situations after disasters occur, and respond swiftly (send the necessary information where it is needed).
	53: An integrated national land management and use system (using Earth observation satellite data, GPS, communications satellites, GIS, and so on to digitize land use, ocean data, maps, etc.) that covers all of Japan, including the sea.
	59: Formation of a worldwide consensus, including developing countries, on international regulations on the output of carbon dioxide and other greenhouse gases.

Year	Topic
2015	54: Integrated usage and conservation technology for entire bays such as Tokyo Bay and Osaka Bay that are densely used.
2016	60: Technology to evenly and densely place comprehensive earthquake/crust change observation equipment in major cities, mountainous areas, continental shelves, and so on in order to predict earthquakes.
2017	56: Technology that uses monitoring technology on moment-to-moment characteristics of falling and accumulated snow to predict the scale of surface avalanches, degree of risk, and so on over wide areas.
2018	31: Automatic observation systems in the open ocean that monitor water temperature, salinity, and chemical tracers with high reliability while going for long periods without maintenance.
	33: Three-dimensional image analysis systems that can distinguish tiny ocean organisms (microorganisms, plankton, etc.).
2019	30: Establishment of corporate management methods based on precise seasonal forecasts.
	47: Automatic observation systems in the open ocean that can monitor oceanographic phenomena and conditions from a depth of 6,000 m to near the surface for a long period of time (about 5 years).
	50: Robots that autonomously perform heavy duty work in the deep ocean.
	75: Three-dimensional autonomous navigation systems for water vessels.
2020	26: Systems to observe clouds and aerosol all over the Earth from satellites with high precision, resolution, and frequency.
	32: Ocean observation systems that use various flight vehicles to agilely perform sample collection and instrument set up and collection.
	34: Sensors that can distinguish body shapes underwater from a distance of several hundred meters.
	48: Fuel cells that are closed systems (no atmospheric exposure), portable, and can provide 10 kilowatt output for one year with a single fueling.
	61: Elucidation of the mechanisms of rainfall, snow accumulation, torrential rain, and so on.
2021	27: Stationary satellite observation (vertical resolution 500 m to 1 km, horizontal resolution 1–5 km) of water vapor distribution.
	35: Microwave radiometers loaded on satellites to measure at a spatial resolution of 1 km or less worldwide water, soil moisture, salt deposition density, and snow and ice distribution on land.
	37: Technology to isolate and cultivate life forms that inhabit extreme Earth environments.
	39: Technology to place permanent geophysical observation bases on the deep ocean floor and radically increase the precision of exploration of the Earth's interior by networking them.
	55: Technology to assess the safety of geologic disposal of high-level radioactive waste.
2022	23: Forecasting technology for year-to-year variation of climate system.
	25: Technology to precisely observe carbon dioxide gas emission and absorption within country, using space technology.
	28: High-precision Earth environment models with about 100–500 m resolution for a short-range forecasting that can distinguish buildings and predict air pollution, and urban flooding.
	51: Probes that can penetrate 10 km below the sea floor.
	58: Technology to forecast the timing and scale of volcanic eruptions by observing and assessing in real time magma conditions inside volcanoes that are likely to erupt.
	67: Technology for the creation of recreational water-use areas through the development of seawater cleaning systems such as cleaning blocks and biofilters.
	76: Wireless communications technology that works over several horizontal kilometers in seawater to enable smooth performance of underwater work.
2023	46: Technology that precisely estimates the contributions of deep-sea chemical ecosystems to oceanic matter and energy.
	69: Offshore cities (bases for transportation, communications, research, production, leisure activities) with structures with legs or that float.
	72: Technology to grow bacteria that break down chemical substances that disrupt endocrines and other environmental pollutants.
2025	21: To respond to the increase in satellite-based communications volume accompanying the growth of Earth-based communications volume, a system of multiple stationary platforms with transmission capacities in the several terabits/second class, linked by optical intersatellite communications.
	68: Technology to fix carbon dioxide to the seafloor.
	70: Marine farms that carry out optimal environmental management by adopting biology technology as well as a broad array of engineering technology.

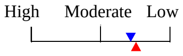
Year	Topic
	71: Methane hydrate mining　utilization technology.
2026	19: Satellite systems whose maintenance, repair, and functional upgrade may be performed by robots in orbit.
	45: Technology that makes it possible to measure regional stress fields in the Earth's crust on a region-wide scale in earthquake zones.
2027	24: Earth environment change forecasting technology with a scale of several decades by Earth system models that handle the composition of the atmosphere and oceans, ecosystems, and the material cycles within them.
2028	20: Operation of semi-permanent large platforms (a system in which mission apparatuses can appropriately exchanged and maintenance, inspection, and repair can be performed in orbit) in order to effectively utilize the limited stationary orbits available.
	42: Technology to statically achieve samples of a size of a few centimeters or more from the high-temperature, high-pressure conditions near the center of the Earth.
2028	43: Technology to use satellite magnetic field observation　and surface observation to estimate the core's current dynamo action and future changes in the magnetic field.
2029	02: Quantum communications technology that is 1 million times faster than current optical communications for high-capacity communications with planetary exploration satellites and so on.
2030	17: Geostationary orbital bases that can be used comprehensively for Earth observation and as space factories and communications bases.
	22: Drastic technical measures (debris-free space systems, collection of debris already left, disposal by injection into the atmosphere, etc.) against the debris problem.
	57: Technology to precisely forecast the imminence (place and time period) of earthquakes (plate boundary earthquakes and inland earthquakes) of magnitude 7 or greater that are likely to cause damage, helping mitigate human disasters.
	64: Self-repairing space vessels.
2031	13: Japan's own reusable space vessels that travel between the Earth and Earth orbit.
	40: Technology to extract matter from the Earth's core in order to identify the light elements included there.
	41: Technology to extract mantle matter by deep drilling into the Earth from any location.
	44: Technology sensitive enough to detect shifts in matter of a few centimeters a year deep inside the Earth.
	66: Satellite-borne computers that operate on the level of thermal noise energy.
2032	15: Space tourism (including education and cultural activities) in Earth orbit.
	16: Life support technology that utilizes closed ecosystems for self-supply of foods such as vegetables, grains, and animal protein in space.
	38: Exploration technology to seek the extraterrestrial life on the other planets (including satellites) within the solar system.
	74: Saltwater engines that remove oxygen and hydrogen form seawater and generate energy.
2033	14: Japan's own manned space vessels.
	63: Solar photoelectric power generation plants in space that transmit electricity to the ground with microwaves or lasers.
2034	65: Space and planetary exploration technology using robots with overall decision-making ability equivalent to that of human beings.
2036-	18: Permanent manned moon surface bases (scientific observation from the moon, lunar science, development of technology to utilize resources, etc.).

Appendix: Results of R1 and R2

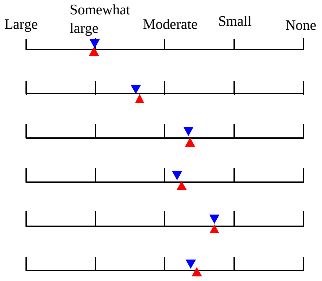
I. Planetary exploration technology

1. Questions regarding the relevant area

1) Degree of expertise in the area



2) Current impacts

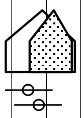
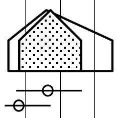
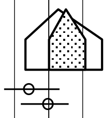
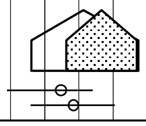


[Increased intellectual assets]
- Contribution of the relevant area itself to increased intellectual assets
- Contribution to the development of other fields

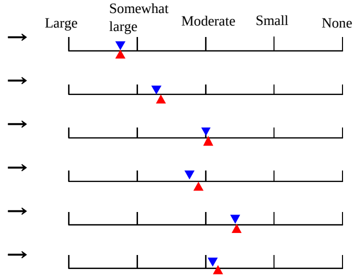
[Economic impacts]
- Contribution to the development of existing Japanese industry
- Contribution to the creation of new industries or businesses

[Social impacts]
- Contribution to safety and security
- Contribution to improved social vitality and quality of life

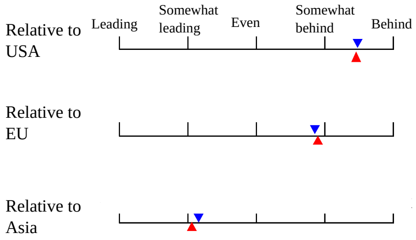
2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan (%)					Time of technological realization						(%)	
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
1	Technology to orbit Mercury, Venus, and Mars and observe their surfaces.	1	186	15	27	58	-	59	28	51	20	1							0	2
		2	171	13	21	66	-	53	15	68	16	1							0	2
		E	23	100	0	0	-	78	57	43	0	0							0	0
2	Quantum communications technology that is 1 million times faster than current optical communications for high-capacity communications with planetary exploration satellites and so on.	1	124	7	16	77	-	69	44	45	9	2							6	19
		2	131	4	13	83	-	61	27	66	5	2							0	7
		E	5	100	0	0	-	90	80	20	0	0							0	0
3	Sample returns from planets.	1	183	16	20	64	-	62	36	44	18	2							1	7
		2	170	13	20	67	-	57	22	63	14	1							1	2
		E	22	100	0	0	-	88	77	18	5	0							0	0
4	Observation technology for satellites orbiting planets beyond Jupiter.	1	157	14	24	62	-	50	20	42	35	3							2	10
		2	156	11	15	74	-	45	8	55	36	1							2	4
		E	17	100	0	0	-	65	35	53	12	0							0	0

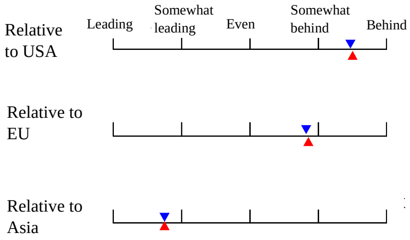
3) Expected impacts at the medium term



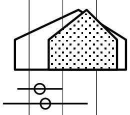
4) Japan's current R&D level



5) Japan's R&D level five years ago



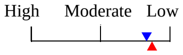
*Relative to EU and Asia means relative to their most advanced countries.

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)						
0	100	0	0	0	75	18	6	1	56	23	56	67	41	2	1	1																		
0	100	0	0	0	82	16	2	0	73	11	58	73	35	0	0	0																		
0	100	0	0	0	100	0	0	0	87	4	70	83	35	0	0	0																		
11	85	3	0	1	52	34	12	2	46	39	51	63	15	4	2	2						5	22	38	36	18	8	47	56	20	33	16	3	3
2	95	2	1	0	58	36	6	0	61	33	52	71	10	1	0	1						0	13	32	61	3	4	55	74	13	25	11	1	1
0	100	0	0	0	60	40	0	0	80	20	60	40	40	0	0	0						0	0	40	40	20	0	80	60	40	40	40	0	0
7	92	1	0	0	69	23	6	2	50	17	50	71	40	3	0	1																		
2	97	0	1	0	82	15	3	0	65	10	57	75	31	1	0	0																		
10	90	0	0	0	95	5	0	0	68	0	55	86	32	5	0	0																		
0	99	1	0	0	61	23	15	1	55	18	51	67	41	3	0	1																		
0	99	1	0	0	75	17	7	1	69	6	56	71	31	1	0	0																		
0	100	0	0	0	94	6	0	0	76	0	59	82	29	6	0	0																		

II. Earthlike life and extrasolar planetary exploration technology

1. Questions regarding the relevant area

1) Degree of expertise in the area

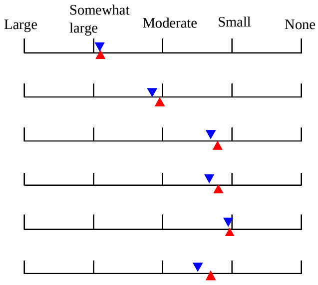


2) Current impacts

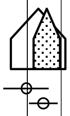
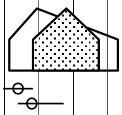
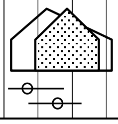
[Increased intellectual assets]
Contribution of the relevant area itself to increased intellectual assets
Contribution to the development of other fields

[Economic impacts]
Contribution to the development of existing Japanese industry
Contribution to the creation of new industries or businesses

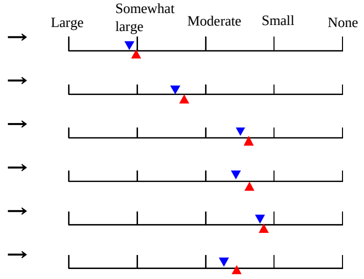
[Social impacts]
Contribution to safety and security
Contribution to improved social vitality and quality of life



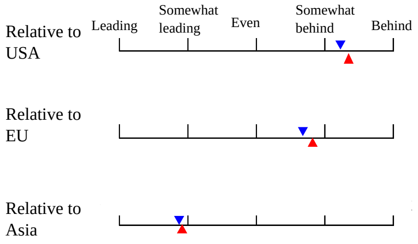
2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise				Importance to Japan					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
				(%)					(%)										(%)	
5	Become able to directly image Jupiter-type planets orbiting nearby stars outside the solar system by using technology such as negative-type interferometers and coronagraphs.	1	**104**	**10**	**30**	**60**	-	**56**	**26**	**51**	**19**	**4**							**1**	**14**
		2	**116**	**4**	**17**	**79**	-	**49**	**11**	**65**	**22**	**2**							**1**	**10**
		E	**5**	**100**	**0**	**0**	-	**80**	**60**	**40**	**0**	**0**							**0**	**0**
6	Find Earthlike planets orbiting nearby stars outside the solar system by greatly improving exploration technology for extrasolar planets.	1	**134**	**10**	**28**	**62**	-	**53**	**23**	**47**	**25**	**5**							**5**	**18**
		2	**140**	**4**	**16**	**80**	-	**48**	**11**	**64**	**21**	**4**							**2**	**12**
		E	**5**	**100**	**0**	**0**	-	**80**	**60**	**40**	**0**	**0**							**0**	**0**
7	Find environments suitable for life or subtle signs of biological activity on extrasolar planets by carrying out spectroscopic analysis of their atmospheres and surface compositions using remote sensing in infrared and visible wavelengths.	1	**144**	**12**	**24**	**64**	-	**56**	**26**	**49**	**21**	**4**							**1**	**18**
		2	**147**	**5**	**18**	**77**	-	**50**	**13**	**65**	**19**	**3**							**1**	**10**
		E	**7**	**100**	**0**	**0**	-	**79**	**57**	**43**	**0**	**0**							**0**	**0**

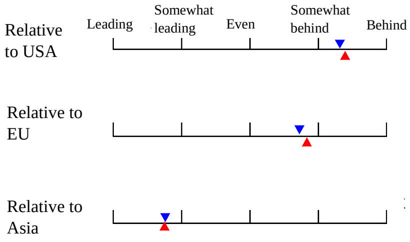
3) Expected impacts at the medium term



4) Japan's current R&D level



5) Japan's R&D level five years ago



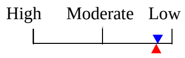
*Relative to EU and Asia means relative to their most advanced countries.

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)						
3	91	3	0	3	44	34	17	5	57	11	50	67	32	0	0	0																		
0	100	0	0	0	49	39	8	4	73	6	49	72	30	0	0	0																		
0	100	0	0	0	80	20	0	0	80	0	60	80	40	0	0	0																		
2	94	2	0	2	49	27	21	3	58	10	46	64	38	2	0	1																		
0	98	2	0	0	62	27	9	2	73	3	49	70	35	0	0	0																		
0	100	0	0	0	100	0	0	0	80	0	60	80	60	0	0	0																		
2	96	0	0	2	46	31	19	4	60	11	46	63	35	0	0	0																		
0	100	0	0	0	59	30	8	3	70	4	51	70	31	0	0	0																		
0	100	0	0	0	86	14	0	0	71	0	57	71	57	0	0	0																		

III. Space and particle research

1. Questions regarding the relevant area

1) Degree of expertise in the area

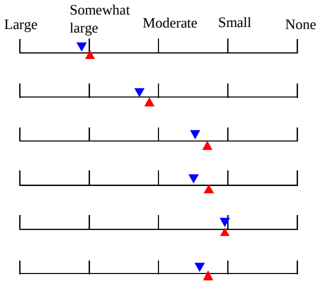


2) Current impacts

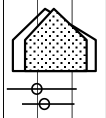
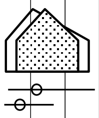
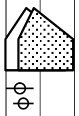
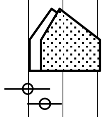
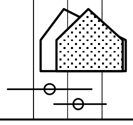
[Increased intellectual assets]
Contribution of the relevant area itself to increased intellectual assets
Contribution to the development of other fields

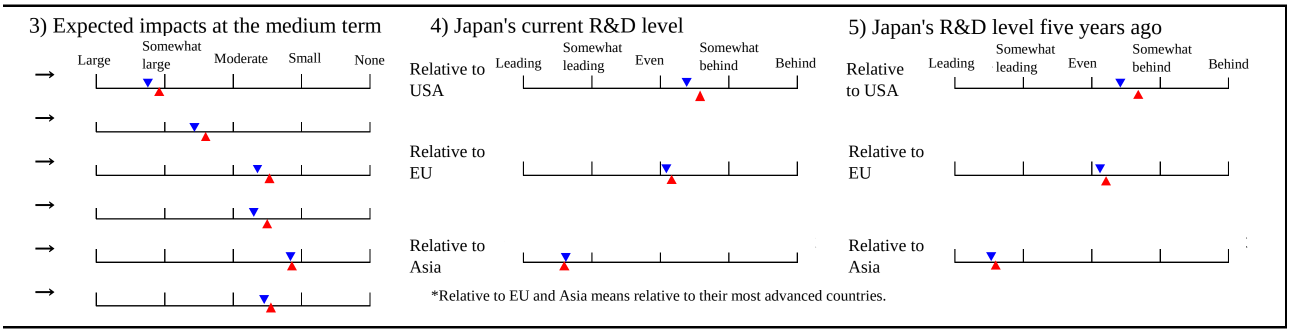
[Economic impacts]
Contribution to the development of existing Japanese industry
Contribution to the creation of new industries or businesses

[Social impacts]
Contribution to safety and security
Contribution to improved social vitality and quality of life



2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise High (%)	Degree of expertise Moderate (%)	Degree of expertise Low (%)	Degree of expertise None (%)	Importance to Japan Index	Importance to Japan High (%)	Importance to Japan Moderate (%)	Importance to Japan Low (%)	Importance to Japan None (%)	Time of technological realization Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized (%)	Do not know (%)
8	High-precision space positioning technology utilizing multi-satellite formation flight will become available, with the goal of realizing gravitational wave detectors and ultrahigh-angle-resolution submillimeter interferometers.	1	**128**	**12**	**30**	**58**	-	**55**	**25**	**52**	**18**	**5**							**2**	**7**
		2	**139**	**12**	**20**	**68**	-	**54**	**15**	**70**	**14**	**1**							**0**	**4**
		E	**16**	**100**	**0**	**0**	-	**69**	**38**	**62**	**0**	**0**							**0**	**0**
9	Various space observatories that utilize the lunar surface and Sun-Earth Lagrangian points will be realized, enabling far-infrared telescopes, ultrahigh-resolution visible light telescopes, and other technologies which cannot be achieved via Earth-based observations.	1	**136**	**14**	**28**	**58**	-	**62**	**34**	**48**	**17**	**1**							**1**	**7**
		2	**145**	**12**	**23**	**65**	-	**58**	**22**	**68**	**10**	**0**							**0**	**3**
		E	**17**	**100**	**0**	**0**	-	**75**	**53**	**41**	**6**	**0**							**0**	**0**
10	Multi-wavelength observations (in infrared, visible light, ultraviolet, x-rays, gamma rays, etc.), conducted by scientific satellites from outside the atmosphere, attain sensitivity improvements by two orders of magnitude.	1	**120**	**12**	**30**	**58**	-	**65**	**37**	**48**	**14**	**1**							**0**	**6**
		2	**134**	**13**	**13**	**74**	-	**56**	**18**	**72**	**10**	**0**							**0**	**2**
		E	**17**	**100**	**0**	**0**	-	**74**	**47**	**53**	**0**	**0**							**0**	**0**
11	Technology to explore difficult-to-detect particles such as cosmic neutrinos, ultrahigh-energy gamma rays, and dark matter particles will markedly improve, leading to major developments.	1	**104**	**9**	**18**	**73**	-	**61**	**32**	**50**	**17**	**1**							**0**	**11**
		2	**129**	**6**	**14**	**80**	-	**54**	**16**	**70**	**13**	**1**							**0**	**6**
		E	**8**	**100**	**0**	**0**	-	**69**	**38**	**62**	**0**	**0**							**0**	**0**
12	Particle accelerator technology will advance markedly, leading to breakthroughs in human understanding of the natural world (the origins of the universe, the asymmetry between matter and antimatter, the origins of elements, etc.).	1	**101**	**8**	**15**	**77**	-	**60**	**30**	**51**	**17**	**2**							**2**	**21**
		2	**121**	**5**	**13**	**82**	-	**56**	**18**	**72**	**9**	**1**							**1**	**5**
		E	**6**	**100**	**0**	**0**	-	**54**	**17**	**66**	**17**	**0**							**17**	**0**



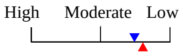
*Relative to EU and Asia means relative to their most advanced countries.

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
		(%)				(%)						(%)										(%)			(%)						(%)			
5	83	10	0	2	51	35	11	3	51	14	46	78	34	0	0	0																		
0	97	3	0	0	67	25	6	2	67	8	52	79	35	1	0	0																		
0	94	6	0	0	75	19	6	0	69	13	38	81	44	0	0	0																		
5	93	2	0	0	55	35	8	2	52	13	48	81	40	1	0	0																		
3	96	1	0	0	68	25	6	1	64	6	51	76	36	0	0	0																		
12	88	0	0	0	70	24	6	0	76	29	59	82	71	0	0	0																		
26	71	3	0	0	52	36	12	0	53	9	47	79	35	1	0	0																		
12	88	0	0	0	69	25	6	0	70	4	48	79	30	0	0	0																		
29	71	0	0	0	71	29	0	0	76	12	53	94	41	0	0	0																		
55	42	3	0	0	48	37	14	1	59	9	44	75	29	0	0	1																		
63	35	2	0	0	68	26	6	0	70	4	47	81	28	0	0	0																		
87	13	0	0	0	49	38	13	0	75	0	25	75	25	0	0	0																		
21	58	21	0	0	50	32	14	4	54	10	49	68	42	1	0	1																		
9	87	4	0	0	67	25	6	2	68	4	45	76	31	0	0	0																		
17	66	17	0	0	33	33	17	17	80	0	40	60	40	0	0	0																		

IV. Basic technology for space transportation and manned space activity

1. Questions regarding the relevant area

1) Degree of expertise in the area

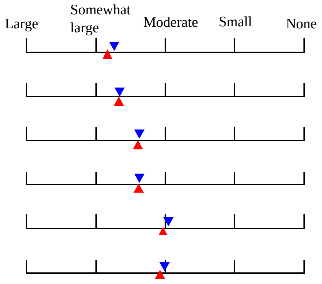


2) Current impacts

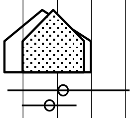
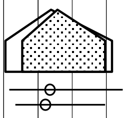
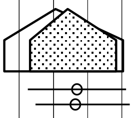
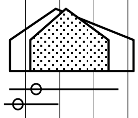
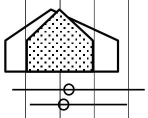
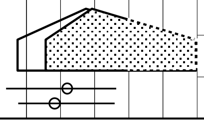
[Increased intellectual assets]
Contribution of the relevant area itself to increased intellectual assets
Contribution to the development of other fields

[Economic impacts]
Contribution to the development of existing Japanese industry
Contribution to the creation of new industries or businesses

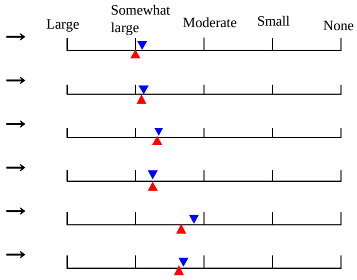
[Social impacts]
Contribution to safety and security
Contribution to improved social vitality and quality of life



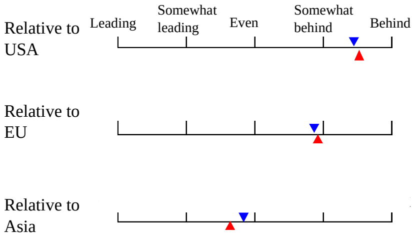
2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise				Importance to Japan					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
				(%)					(%)										(%)	
13	Japan's own reusable space vessels that travel between the Earth and Earth orbit.	1	171	15	25	60	-	65	42	39	14	5							6	8
		2	165	10	17	73	-	69	45	42	12	1							2	3
		E	17	100	0	0	-	88	76	24	0	0							0	0
14	Japan's own manned space vessels.	1	169	13	21	66	-	54	33	29	27	11							12	13
		2	165	10	18	72	-	59	36	31	28	5							6	8
		E	16	100	0	0	-	72	63	6	25	6							6	6
15	Space tourism (including education and cultural activities) in Earth orbit.	1	163	13	17	70	-	46	22	33	31	14							4	11
		2	160	9	13	78	-	46	18	38	36	8							4	8
		E	15	100	0	0	-	75	59	27	7	7							7	0
16	Life support technology that utilizes closed ecosystems for self-supply of foods such as vegetables, grains, and animal protein in space.	1	137	10	18	72	-	52	23	47	20	10							4	11
		2	147	5	9	86	-	53	21	53	21	5							1	7
		E	8	100	0	0	-	78	62	25	13	0							0	0
17	Geostationary orbital bases that can be used comprehensively for Earth observation and as space factories and communications bases.	1	181	18	26	56	-	69	46	41	10	3							3	6
		2	168	8	27	65	-	75	54	38	7	1							1	2
		E	14	100	0	0	-	84	72	21	7	0							0	0
18	Permanent manned moon surface bases (scientific observation from the moon, lunar science, development of technology to utilize resources, etc.).	1	178	15	26	59	-	57	32	39	23	6							7	12
		2	166	9	23	68	-	58	28	50	19	3							4	8
		E	15	100	0	0	-	83	74	13	13	0							0	0

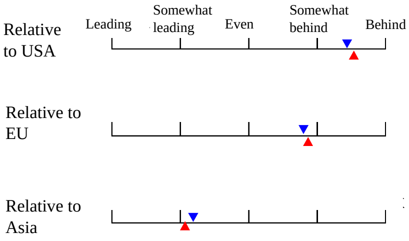
3) Expected impacts at the medium term



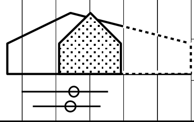
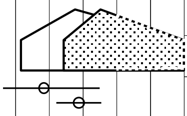
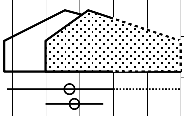
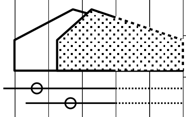
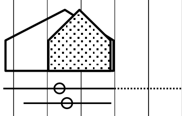
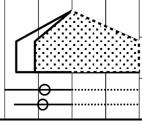
4) Japan's current R&D level



5) Japan's R&D level five years ago



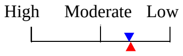
*Relative to EU and Asia means relative to their most advanced countries.

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
		(%)					(%)					(%)										(%)				(%)					(%)			
1	98	0	0	1	69	21	6	4	51	43	54	73	21	6	0	1						8	13	49	34	11	6	51	56	26	43	18	2	3
0	100	0	0	0	85	13	2	0	56	36	64	78	14	3	0	0						4	10	71	26	2	1	62	74	17	47	8	0	1
0	100	0	0	0	94	6	0	0	63	25	50	81	19	13	0	0						6	0	94	6	0	0	59	71	24	59	24	0	0
1	96	0	0	3	66	15	8	11	53	40	52	68	21	7	1	2						12	21	51	28	10	11	55	57	22	40	16	4	4
1	98	0	0	1	79	15	2	4	58	29	60	77	14	1	0	0						9	12	71	21	3	5	61	75	15	43	8	0	0
6	88	0	0	6	93	0	0	7	57	29	50	86	21	7	0	0						13	13	86	0	0	14	58	75	25	58	17	0	0
1	91	0	0	8	26	24	25	25	38	45	36	45	27	24	6	1						9	19	21	24	26	29	34	40	45	32	33	11	3
0	98	1	0	1	25	28	30	17	38	52	39	50	25	23	1	0						6	15	23	27	34	16	33	52	52	31	29	6	1
0	93	0	0	7	50	29	0	21	55	55	55	64	18	27	0	0						20	0	57	29	0	14	33	67	50	50	42	0	0
6	90	2	0	2	40	37	15	8	48	35	52	67	28	7	0	0						7	22	33	35	22	10	49	57	28	34	14	2	2
2	96	1	0	1	56	33	9	2	55	30	56	74	18	3	0	1						2	10	38	47	12	3	55	70	27	35	6	0	1
13	87	0	0	0	87	13	0	0	50	13	50	75	38	0	0	0						0	0	86	14	0	0	57	57	29	29	0	0	0
2	94	1	0	3	64	24	8	4	50	36	49	66	32	5	1	1						5	12	47	34	14	5	52	57	27	41	13	3	3
0	100	0	0	0	85	10	4	1	57	32	55	81	31	1	1	1						1	7	70	27	2	1	63	74	19	43	7	1	1
0	100	0	0	0	77	15	8	0	69	38	38	62	38	0	0	0						0	0	77	23	0	0	69	77	23	31	15	8	0
1	96	1	0	2	61	26	8	5	54	29	51	65	42	6	0	1						10	20	45	36	11	8	63	56	19	36	14	5	2
0	99	0	0	1	76	12	8	4	65	19	60	75	37	1	0	1						7	16	66	25	5	4	69	66	13	38	5	2	1
0	100	0	0	0	72	21	7	0	71	14	43	71	50	0	0	7						7	13	69	23	0	8	75	58	17	25	0	0	0

V. Space utilization technology—basic satellite technology—

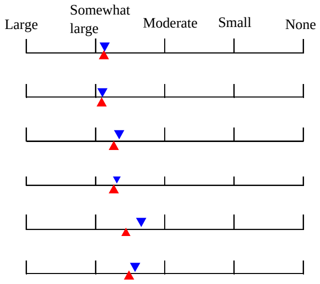
1. Questions regarding the relevant area

1) Degree of expertise in the area

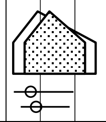
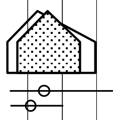
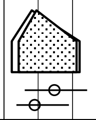
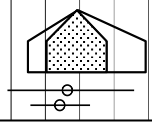


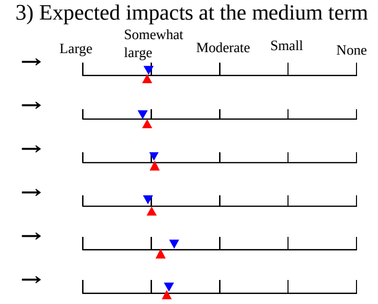
2) Current impacts

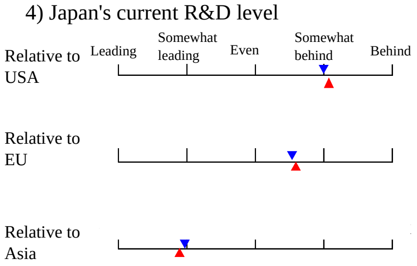
[Increased intellectual assets]	Contribution of the relevant area itself to increased intellectual assets
	Contribution to the development of other fields
[Economic impacts]	Contribution to the development of existing Japanese industry
	Contribution to the creation of new industries or businesses
[Social impacts]	Contribution to safety and security
	Contribution to improved social vitality and quality of life

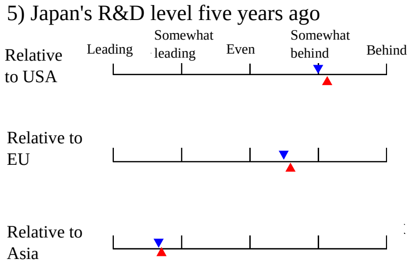


2. Questions regarding topics

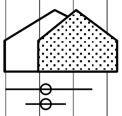
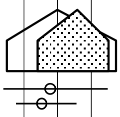
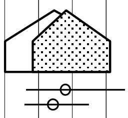
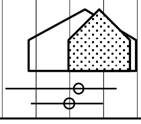
No	Topic	Questionnaire	Respondents (persons)	Degree of expertise				Importance to Japan					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
				(%)					(%)										(%)	
19	Satellite systems whose maintenance, repair, and functional upgrade may be performed by robots in orbit.	1	**140**	**17**	**31**	**52**	**-**	**71**	**45**	**47**	**7**	**1**							**1**	**4**
		2	**147**	**12**	**24**	**64**	**-**	**69**	**41**	**54**	**5**	**0**							**0**	**3**
		E	**18**	**100**	**0**	**0**	**-**	**86**	**72**	**28**	**0**	**0**							**0**	**0**
20	Operation of semi-permanent large platforms (a system in which mission apparatuses can appropriately exchanged and maintenance, inspection, and repair can be performed in orbit) in order to effectively utilize the limited stationary orbits available.	1	**147**	**20**	**25**	**55**	**-**	**68**	**41**	**48**	**10**	**1**							**1**	**5**
		2	**150**	**11**	**24**	**65**	**-**	**67**	**37**	**58**	**5**	**0**							**0**	**1**
		E	**17**	**100**	**0**	**0**	**-**	**85**	**71**	**29**	**0**	**0**							**0**	**0**
21	To respond to the increase in satellite-based communications volume accompanying the growth of Earth-based communications volume, a system of multiple stationary platforms with transmission capacities in the several terabits/second class, linked by optical intersatellite communications.	1	**146**	**19**	**31**	**50**	**-**	**69**	**46**	**41**	**10**	**3**							**2**	**7**
		2	**145**	**11**	**25**	**64**	**-**	**73**	**50**	**44**	**5**	**1**							**1**	**2**
		E	**16**	**100**	**0**	**0**	**-**	**80**	**63**	**31**	**6**	**0**							**0**	**6**
22	Drastic technical measures (debris-free space systems, collection of debris already left, disposal by injection into the atmosphere, etc.) against the debris problem.	1	**133**	**21**	**28**	**51**	**-**	**66**	**40**	**45**	**13**	**2**							**4**	**10**
		2	**136**	**12**	**23**	**65**	**-**	**67**	**37**	**56**	**7**	**0**							**2**	**2**
		E	**16**	**100**	**0**	**0**	**-**	**80**	**63**	**31**	**6**	**0**							**0**	**0**


3) Expected impacts at the medium term


4) Japan's current R&D level


5) Japan's R&D level five years ago

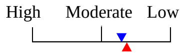
*Relative to EU and Asia means relative to their most advanced countries.

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
		(%)				(%)						(%)										(%)			(%)						(%)			
15	80	1	0	4	50	42	7	1	49	41	45	66	22	3	0	1						1	8	40	42	15	3	50	56	20	42	10	2	1
7	93	0	0	0	68	28	3	1	65	31	47	76	17	0	0	0						0	2	55	42	3	0	67	72	15	35	3	0	0
17	83	0	0	0	94	6	0	0	83	28	56	89	22	0	0	0						0	0	82	18	0	0	82	82	12	35	6	0	0
4	92	1	0	3	57	37	5	1	45	36	46	66	25	6	1	1						1	8	43	42	13	2	49	54	19	37	13	4	1
1	99	0	0	0	74	23	2	1	58	27	52	76	18	1	0	1						0	5	57	39	3	1	61	75	9	37	5	1	0
0	100	0	0	0	94	6	0	0	65	41	53	82	12	0	0	0						0	0	76	24	0	0	71	76	0	35	12	0	0
10	85	4	0	1	50	36	13	1	41	49	40	64	20	9	2	1						0	13	35	37	24	4	46	58	26	33	16	5	2
3	96	1	0	0	66	30	3	1	53	42	47	77	14	4	0	0						1	4	47	42	10	1	58	72	16	36	12	3	0
6	94	0	0	0	75	19	0	6	60	53	27	73	7	0	0	0						0	6	81	13	6	0	63	69	13	31	19	0	0
5	89	2	0	4	58	35	6	1	48	30	50	59	36	5	5	0						6	13	52	36	9	3	55	53	15	33	9	15	3
1	98	0	0	1	73	23	4	0	62	26	53	76	27	0	2	0						1	5	64	33	2	1	71	62	11	34	3	11	0
6	94	0	0	0	88	6	6	0	75	38	50	88	31	0	13	0						0	0	94	0	6	0	81	69	13	31	0	25	0

VI. Technology for high precise observation of Earth environments and for prediction of change

1. Questions regarding the relevant area

1) Degree of expertise in the area

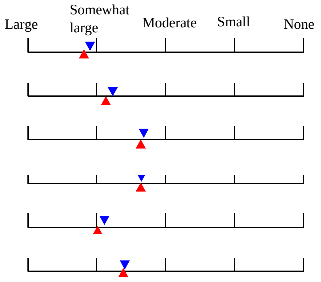


2) Current impacts

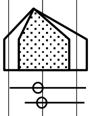
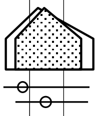
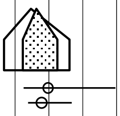
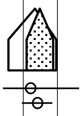
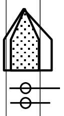
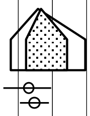
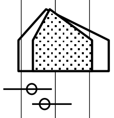
[Increased intellectual assets]
Contribution of the relevant area itself to increased intellectual assets
Contribution to the development of other fields

[Economic impacts]
Contribution to the development of existing Japanese industry
Contribution to the creation of new industries or businesses

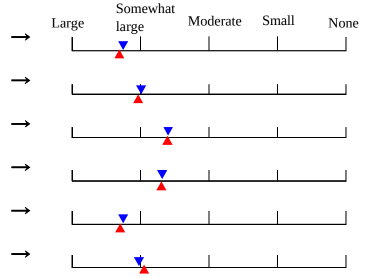
[Social impacts]
Contribution to safety and security
Contribution to improved social vitality and quality of life



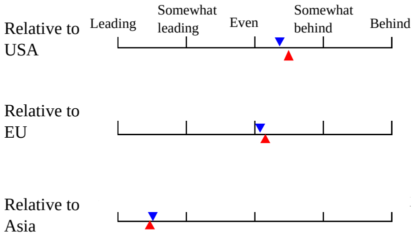
2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise				Importance to Japan					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
					(%)					(%)									(%)	
23	Forecasting technology for year-to-year variation of climate system.	1	**192**	**17**	**30**	**53**	**-**	**85**	**71**	**26**	**3**	**0**							**3**	**9**
		2	**170**	**12**	**34**	**54**	**-**	**94**	**88**	**11**	**1**	**0**							**3**	**2**
		E	**20**	**100**	**0**	**0**	**-**	**98**	**95**	**5**	**0**	**0**							**0**	**0**
24	Earth environment change forecasting technology with a scale of several decades by Earth system models that handle the composition of the atmosphere and oceans, ecosystems, and the material cycles within them.	1	**199**	**19**	**31**	**50**	**-**	**80**	**61**	**34**	**4**	**1**							**5**	**12**
		2	**176**	**11**	**33**	**56**	**-**	**90**	**81**	**18**	**1**	**0**							**2**	**4**
		E	**20**	**100**	**0**	**0**	**-**	**95**	**90**	**10**	**0**	**0**							**0**	**0**
25	Technology to precisely observe carbon dioxide gas emission and absorption within country, using space technology.	1	**185**	**11**	**28**	**61**	**-**	**75**	**54**	**40**	**5**	**1**							**4**	**12**
		2	**171**	**8**	**25**	**67**	**-**	**83**	**68**	**30**	**2**	**0**							**2**	**5**
		E	**14**	**100**	**0**	**0**	**-**	**93**	**86**	**14**	**0**	**0**							**0**	**0**
26	Systems to observe clouds and aerosol all over the Earth from satellites with high precision, resolution, and frequency.	1	**190**	**15**	**25**	**60**	**-**	**72**	**48**	**46**	**6**	**0**							**0**	**6**
		2	**169**	**10**	**25**	**65**	**-**	**78**	**57**	**42**	**1**	**0**							**0**	**3**
		E	**17**	**100**	**0**	**0**	**-**	**94**	**88**	**12**	**0**	**0**							**0**	**0**
27	Stationary satellite observation (vertical resolution 500 m to 1 km, horizontal resolution 1–5 km) of water vapor distribution.	1	**177**	**16**	**21**	**63**	**-**	**69**	**44**	**45**	**10**	**1**							**2**	**11**
		2	**161**	**11**	**27**	**62**	**-**	**75**	**51**	**47**	**2**	**0**							**1**	**4**
		E	**18**	**100**	**0**	**0**	**-**	**86**	**72**	**28**	**0**	**0**							**0**	**0**
28	High-precision Earth environment models with about 100–500 m resolution for a short-range forecasting that can distinguish buildings and predict air pollution, and urban flooding.	1	**165**	**10**	**24**	**66**	**-**	**77**	**58**	**34**	**7**	**1**							**1**	**9**
		2	**159**	**6**	**22**	**72**	**-**	**85**	**71**	**26**	**3**	**0**							**1**	**3**
		E	**10**	**100**	**0**	**0**	**-**	**90**	**80**	**20**	**0**	**0**							**0**	**0**
29	Climate change simulations for the Earth's history, including the Snowball Earth and the ice age cycle.	1	**157**	**10**	**31**	**59**	**-**	**54**	**23**	**48**	**28**	**1**							**3**	**14**
		2	**147**	**7**	**31**	**62**	**-**	**52**	**13**	**69**	**17**	**1**							**2**	**7**
		E	**10**	**100**	**0**	**0**	**-**	**63**	**30**	**60**	**10**	**0**							**0**	**0**
30	Establishment of corporate management methods based on precise seasonal forecasts.	1	**100**	**10**	**16**	**74**	**-**	**66**	**43**	**40**	**13**	**4**								
		2	**114**	**6**	**10**	**84**	**-**	**61**	**29**	**56**	**14**	**1**								
		E	**7**	**100**	**0**	**0**	**-**	**79**	**57**	**43**	**0**	**0**								

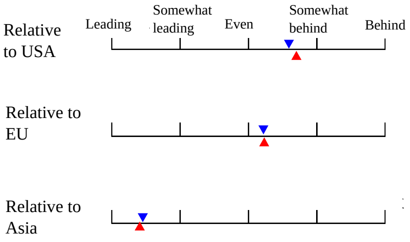
3) Expected impacts at the medium term



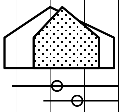
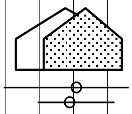
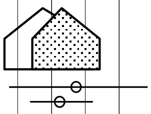
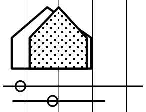
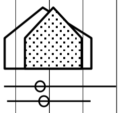
4) Japan's current R&D level



5) Japan's R&D level five years ago



*Relative to EU and Asia means relative to their most advanced countries.

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
		(%)				(%)							(%)									(%)			(%)						(%)			
24	67	8	0	1	63	31	5	1	71	29	50	64	37	3	1	1						2	13	51	33	11	5	77	53	16	25	9	6	2
15	81	4	0	0	88	10	1	1	85	15	59	76	26	0	0	0						2	7	83	13	3	1	84	62	11	32	4	1	0
10	60	30	0	0	90	10	0	0	95	15	65	75	10	0	0	0						0	0	90	5	5	0	90	75	15	30	10	0	0
16	76	7	0	1	60	32	6	2	73	26	55	65	39	3	0	1						6	19	50	34	13	3	76	54	15	25	8	4	3
11	87	2	0	0	83	15	1	1	84	14	61	76	25	1	0	0						2	6	77	19	3	1	86	66	8	27	3	2	0
11	84	5	0	0	94	6	0	0	100	11	67	78	22	0	0	0						0	5	80	10	5	5	89	68	11	26	16	0	0
15	73	8	0	4	57	35	5	3	52	32	51	65	38	2	1	2						3	14	53	34	9	4	58	52	15	32	9	11	2
7	91	2	0	0	81	17	1	1	69	22	64	74	27	0	0	0						2	8	76	21	2	1	75	66	9	34	2	3	0
29	64	7	0	0	100	0	0	0	79	21	71	79	50	0	0	0						0	0	100	0	0	0	79	86	14	29	0	7	0
11	83	5	0	1	56	37	6	1	55	31	53	68	39	2	0	1						1	10	47	39	12	2	62	51	13	31	9	5	2
4	95	1	0	0	75	22	2	1	71	16	62	79	28	0	0	0						1	5	72	25	2	1	81	67	8	30	1	1	1
6	94	0	0	0	100	0	0	0	76	12	65	82	41	0	0	0						0	0	100	0	0	0	88	76	0	29	0	0	6
7	90	2	0	1	52	39	8	1	53	30	52	66	33	2	0	1						2	14	45	39	13	3	59	54	14	30	9	3	2
2	97	1	0	0	72	25	3	0	71	17	55	79	21	1	0	0						1	6	68	28	3	1	77	69	6	28	1	1	1
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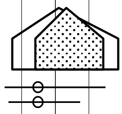
25	69	3	0	3	51	40	8	1	59	44	54	56	22	4	2	1						4	11	42	44	12	2	63	57	24	29	11	7	1
20	78	1	0	1	74	23	2	1	74	33	60	73	13	1	1	1						1	6	64	31	4	1	77	71	12	30	3	3	1
30	60	0	0	10	100	0	0	0	90	50	60	50	0	0	0	0						0	0	100	0	0	0	90	60	10	30	0	0	0
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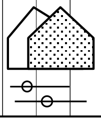
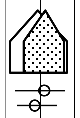
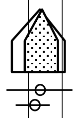
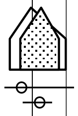
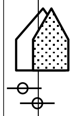
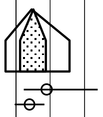
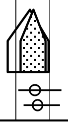
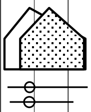
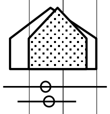
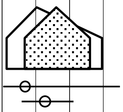
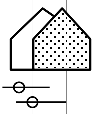
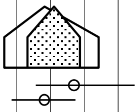
22	78	0	0	0	56	44	0	0	100	0	33	56	0	0	0	0																		
																						1	13	17	37	37	9	56	57	41	28	16	4	2
																						2	7	7	56	31	6	57	66	29	16	16	1	2
																						0	0	14	72	14	0	57	57	14	14	0	0	14

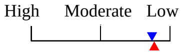
No	Topic	Questionnaire	Respondents (persons)	Degree of expertise				Importance to Japan					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
				(%)					(%)										(%)	
31	Automatic observation systems in the open ocean that monitor water temperature, salinity, and chemical tracers with high reliability while going for long periods without maintenance.	1	**156**	**26**	**26**	**48**	-	**72**	**47**	**46**	**7**	**0**							**0**	**6**
		2	**152**	**16**	**26**	**58**	-	**74**	**50**	**48**	**2**	**0**							**0**	**3**
		E	**25**	**100**	**0**	**0**	-	**90**	**80**	**20**	**0**	**0**							**0**	**0**
32	Ocean observation systems that use various flight vehicles to agilely perform sample collection and instrument set up and collection.	1	**148**	**19**	**29**	**52**	-	**62**	**32**	**52**	**15**	**1**							**2**	**6**
		2	**147**	**12**	**24**	**64**	-	**61**	**26**	**67**	**7**	**0**							**0**	**3**
		E	**17**	**100**	**0**	**0**	-	**71**	**47**	**41**	**12**	**0**							**0**	**0**
33	Three-dimensional image analysis systems that can distinguish tiny ocean organisms (microorganisms, plankton, etc.).	1	**136**	**10**	**23**	**67**	-	**55**	**22**	**56**	**21**	**1**							**0**	**8**
		2	**137**	**9**	**20**	**71**	-	**53**	**11**	**78**	**11**	**0**							**0**	**4**
		E	**12**	**100**	**0**	**0**	-	**67**	**33**	**67**	**0**	**0**							**0**	**0**
34	Sensors that can distinguish body shapes underwater from a distance of several hundred meters.	1	**117**	**9**	**22**	**69**	-	**57**	**24**	**56**	**18**	**2**							**2**	**11**
		2	**132**	**5**	**21**	**74**	-	**56**	**20**	**63**	**16**	**1**							**1**	**5**
		E	**6**	**100**	**0**	**0**	-	**70**	**40**	**60**	**0**	**0**							**0**	**0**
35	Microwave radiometers loaded on satellites to measure at a spatial resolution of 1 km or less worldwide water, soil moisture, salt deposition density, and snow and ice distribution on land.	1	**145**	**16**	**26**	**58**	-	**66**	**37**	**54**	**9**	**0**							**2**	**9**
		2	**146**	**8**	**27**	**65**	-	**64**	**30**	**67**	**3**	**0**							**0**	**6**
		E	**12**	**100**	**0**	**0**	-	**79**	**58**	**42**	**0**	**0**							**0**	**0**
36	Methods to accurately calculate heat transfer in the water cycle such as from a water vapor to clouds and clouds to rain .	1	**142**	**15**	**22**	**63**	-	**67**	**40**	**48**	**12**	**0**							**0**	**14**
		2	**139**	**7**	**21**	**72**	-	**65**	**33**	**61**	**6**	**0**							**1**	**4**
		E	**10**	**100**	**0**	**0**	-	**80**	**60**	**40**	**0**	**0**							**0**	**0**

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)						
25	**74**	**1**	**0**	**0**	**46**	**42**	**11**	**1**	**51**	**40**	**47**	**72**	**33**	**5**	**1**	**0**						**3**	**9**	**39**	**43**	**15**	**3**	**54**	**60**	**19**	**41**	**12**	**4**	**1**
18	**82**	**0**	**0**	**0**	**61**	**36**	**3**	**0**	**66**	**30**	**41**	**79**	**19**	**2**	**0**	**0**						**0**	**4**	**42**	**53**	**5**	**0**	**63**	**71**	**9**	**31**	**7**	**1**	**1**
4	**96**	**0**	**0**	**0**	**84**	**8**	**8**	**0**	**76**	**40**	**52**	**80**	**24**	**4**	**0**	**0**						**0**	**0**	**68**	**24**	**8**	**0**	**56**	**72**	**12**	**56**	**12**	**0**	**0**
10	**87**	**3**	**0**	**0**	**41**	**41**	**17**	**1**	**47**	**36**	**57**	**69**	**28**	**8**	**0**	**0**						**3**	**9**	**32**	**44**	**20**	**4**	**55**	**57**	**21**	**34**	**15**	**4**	**2**
7	**92**	**0**	**0**	**1**	**48**	**46**	**5**	**1**	**62**	**33**	**56**	**78**	**16**	**3**	**0**	**0**						**1**	**4**	**33**	**60**	**6**	**1**	**67**	**74**	**12**	**29**	**7**	**1**	**1**
7	**93**	**0**	**0**	**0**	**56**	**38**	**6**	**0**	**69**	**50**	**56**	**75**	**31**	**13**	**0**	**0**						**0**	**0**	**60**	**27**	**13**	**0**	**67**	**67**	**27**	**67**	**33**	**7**	**0**
21	**70**	**7**	**0**	**2**	**24**	**47**	**27**	**2**	**58**	**38**	**40**	**61**	**18**	**1**	**1**	**2**						**1**	**13**	**17**	**43**	**35**	**5**	**58**	**48**	**28**	**30**	**3**	**1**	**2**
11	**89**	**0**	**0**	**0**	**24**	**63**	**12**	**1**	**68**	**26**	**38**	**70**	**6**	**0**	**0**	**0**						**0**	**4**	**18**	**61**	**20**	**1**	**67**	**59**	**15**	**22**	**3**	**1**	**1**
33	**67**	**0**	**0**	**0**	**42**	**58**	**0**	**0**	**75**	**8**	**42**	**42**	**17**	**0**	**0**	**0**						**0**	**0**	**42**	**58**	**0**	**0**	**67**	**42**	**17**	**25**	**8**	**8**	**0**
15	**82**	**1**	**0**	**2**	**31**	**41**	**23**	**5**	**51**	**49**	**37**	**61**	**14**	**3**	**0**	**1**						**2**	**18**	**21**	**44**	**30**	**5**	**54**	**54**	**23**	**35**	**2**	**1**	**2**
4	**95**	**0**	**0**	**1**	**33**	**53**	**14**	**0**	**66**	**47**	**35**	**74**	**6**	**0**	**0**	**0**						**0**	**5**	**24**	**57**	**19**	**0**	**67**	**66**	**17**	**28**	**2**	**0**	**1**
17	**83**	**0**	**0**	**0**	**83**	**17**	**0**	**0**	**67**	**50**	**17**	**50**	**0**	**0**	**0**	**0**						**0**	**0**	**67**	**33**	**0**	**0**	**67**	**50**	**0**	**50**	**0**	**0**	**0**
12	**85**	**2**	**0**	**1**	**45**	**42**	**11**	**2**	**52**	**39**	**49**	**65**	**30**	**1**	**0**	**0**						**4**	**15**	**31**	**46**	**20**	**3**	**56**	**59**	**16**	**33**	**3**	**2**	**3**
7	**92**	**1**	**0**	**0**	**54**	**42**	**4**	**0**	**68**	**34**	**50**	**78**	**16**	**1**	**0**	**1**						**1**	**6**	**30**	**62**	**8**	**0**	**68**	**71**	**15**	**30**	**4**	**0**	**2**
17	**83**	**0**	**0**	**0**	**92**	**8**	**0**	**0**	**67**	**33**	**50**	**75**	**8**	**8**	**0**	**0**						**8**	**0**	**75**	**25**	**0**	**0**	**75**	**75**	**17**	**42**	**0**	**0**	**0**
17	**74**	**7**	**0**	**2**	**38**	**47**	**13**	**2**	**67**	**24**	**44**	**59**	**23**	**1**	**0**	**0**																		
5	**94**	**1**	**0**	**0**	**38**	**56**	**5**	**1**	**80**	**17**	**44**	**68**	**12**	**0**	**0**	**0**																		
0	**100**	**0**	**0**	**0**	**50**	**50**	**0**	**0**	**90**	**0**	**30**	**70**	**0**	**0**	**0**	**0**																		

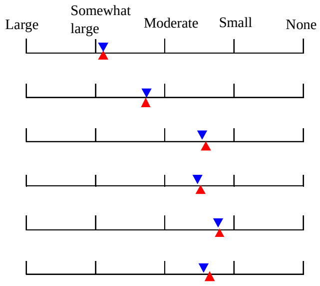
VII. Technology to explore, capture, and cultivative life under extreme environment

1. Questions regarding the relevant area

1) Degree of expertise in the area



2) Current impacts

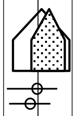
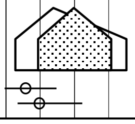


[Increased intellectual assets]
Contribution of the relevant area itself to increased intellectual assets
Contribution to the development of other fields

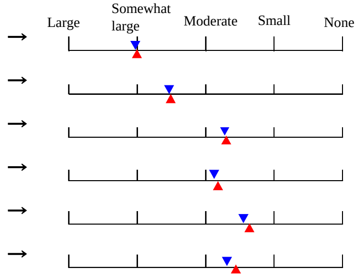
[Economic impacts]
Contribution to the development of existing Japanese industry
Contribution to the creation of new industries or businesses

[Social impacts]
Contribution to safety and security
Contribution to improved social vitality and quality of life

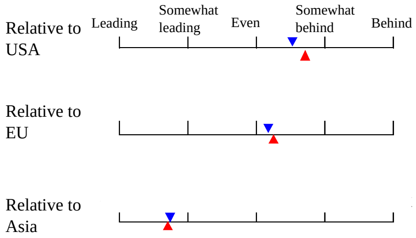
2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan (%)					Time of technological realization						(%)	
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
37	Technology to isolate and cultivate life forms that inhabit extreme Earth environments.	1	**106**	**13**	**30**	**57**	-	**65**	**39**	**45**	**14**	**2**							**2**	**8**
		2	**119**	**10**	**18**	**72**	-	**58**	**24**	**62**	**12**	**2**							**1**	**4**
		E	**12**	**100**	**0**	**0**	-	**75**	**55**	**36**	**9**	**0**							**0**	**0**
38	Exploration technology to seek the extraterrestrial life on the other planets (including satellites) within the solar system.	1	**136**	**10**	**21**	**69**	-	**52**	**26**	**35**	**34**	**5**							**5**	**16**
		2	**129**	**8**	**14**	**78**	-	**50**	**14**	**60**	**25**	**1**							**1**	**7**
		E	**10**	**100**	**0**	**0**	-	**78**	**60**	**30**	**10**	**0**							**0**	**0**

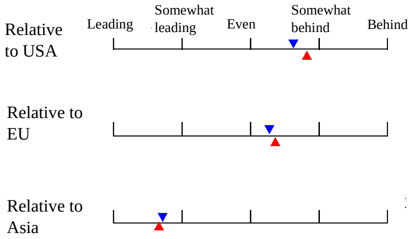
3) Expected impacts at the medium term



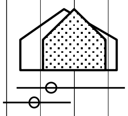
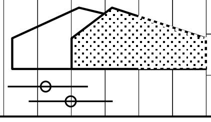
4) Japan's current R&D level



5) Japan's R&D level five years ago



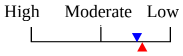
*Relative to EU and Asia means relative to their most advanced countries.

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)						
28	62	8	0	2	49	38	11	2	63	31	46	76	26	6	0	1						9	11	35	37	23	5	60	59	21	30	12	3	1
24	74	2	0	0	46	46	6	2	76	18	43	76	12	0	0	0						1	9	31	48	19	2	77	57	12	28	9	3	0
59	33	8	0	0	50	42	8	0	75	42	42	58	8	0	0	0						0	8	34	33	25	8	73	64	18	27	9	0	0
1	95	2	0	2	48	27	18	7	67	21	48	62	35	2	0	1						17	22	40	23	23	14	71	45	13	26	6	5	2
0	100	0	0	0	68	20	10	2	77	10	46	70	28	0	0	2						10	13	57	25	16	2	86	42	5	26	3	2	2
0	100	0	0	0	90	10	0	0	100	20	60	90	40	0	0	0						0	0	70	20	10	0	100	70	10	20	10	0	0

VIII. Deep Earth observation technology

1. Questions regarding the relevant area

1) Degree of expertise in the area

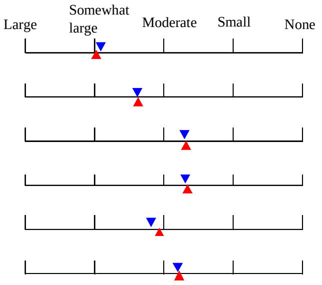


2) Current impacts

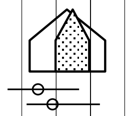
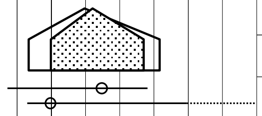
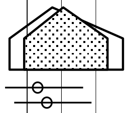
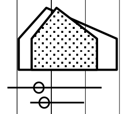
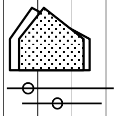
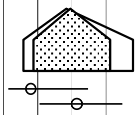
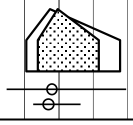
[Increased intellectual assets]
Contribution of the relevant area itself to increased intellectual assets
Contribution to the development of other fields

[Economic impacts]
Contribution to the development of existing Japanese industry
Contribution to the creation of new industries or businesses

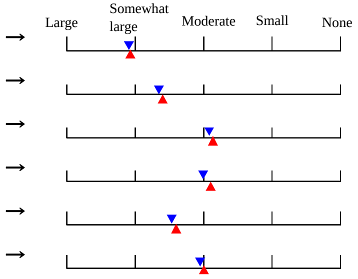
[Social impacts]
Contribution to safety and security
Contribution to improved social vitality and quality of life



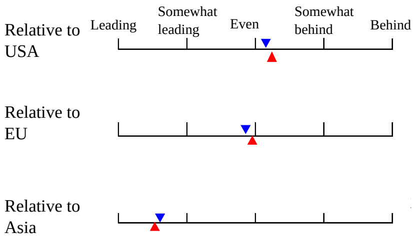
2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise				Importance to Japan					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
				(%)					(%)										(%)	
39	Technology to place permanent geophysical observation bases on the deep ocean floor and radically increase the precision of exploration of the Earth's interior by networking them.	1	147	20	27	53	-	72	49	43	6	2							1	6
		2	141	15	24	61	-	77	57	38	5	0							0	4
		E	21	100	0	0	-	83	71	19	10	0							0	0
40	Technology to extract matter from the Earth's core in order to identify the light elements included there.	1	109	9	27	64	-	46	13	51	31	5							10	26
		2	116	7	21	72	-	48	8	70	21	1							3	9
		E	8	100	0	0	-	54	14	72	14	0							0	0
41	Technology to extract mantle matter by deep drilling into the Earth from any location.	1	122	15	30	55	-	56	26	48	24	2							4	13
		2	119	12	28	60	-	53	15	65	19	1							3	3
		E	14	100	0	0	-	66	36	57	7	0							7	0
42	Technology to statically achieve samples of a size of a few centimeters or more from the high-temperature, high-pressure conditions near the center of the Earth.	1	114	10	29	61	-	54	25	44	26	5							4	12
		2	115	9	24	67	-	51	14	65	18	3							1	4
		E	10	100	0	0	-	63	30	60	10	0							0	0
43	Technology to use satellite magnetic field observation and surface observation to estimate the core's current dynamo action and future changes in the magnetic field.	1	130	13	28	59	-	54	20	58	20	2							2	14
		2	127	11	21	68	-	55	15	75	10	0							1	6
		E	14	100	0	0	-	57	21	65	14	0							7	0
44	Technology sensitive enough to detect shifts in matter of a few centimeters a year deep inside the Earth.	1	116	16	25	59	-	60	31	47	19	3							8	17
		2	121	12	23	65	-	62	30	60	8	2							4	3
		E	14	100	0	0	-	73	58	21	21	0							7	0
45	Technology that makes it possible to measure regional stress fields in the Earth's crust on a region-wide scale in earthquake zones.	1	135	21	23	56	-	89	79	18	2	1							2	13
		2	130	15	25	60	-	95	90	8	2	0							0	2
		E	20	100	0	0	-	96	95	0	5	0							0	0

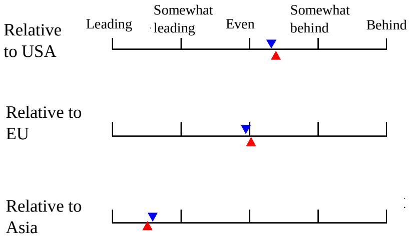
3) Expected impacts at the medium term



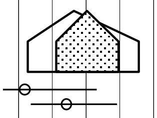
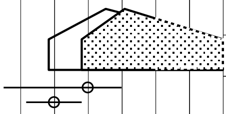
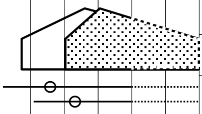
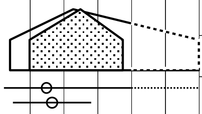
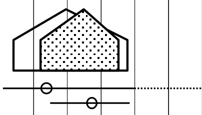
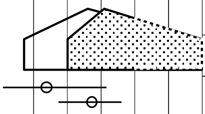
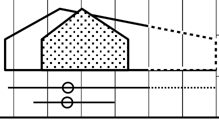
4) Japan's current R&D level



5) Japan's R&D level five years ago



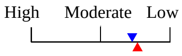
*Relative to EU and Asia means relative to their most advanced countries.

Countries at the leading edge					Regarding technological realization													Time of social application							Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
		(%)				(%)						(%)										(%)			(%)						(%)			
42	57	0	0	1	61	29	8	2	63	35	55	71	39	5	0	1						4	18	47	36	12	5	66	52	21	36	7	2	3
50	50	0	0	0	77	20	3	0	74	20	56	77	22	1	1	0						1	6	66	28	6	0	82	58	6	33	1	1	1
76	24	0	0	0	90	5	5	0	71	5	52	90	19	10	5	0						0	0	81	14	5	0	86	43	5	57	10	5	0
14	78	5	0	3	33	37	23	7	65	24	57	55	25	1	0	1						16	24	27	33	28	12	70	42	11	28	4	1	4
8	87	1	0	4	42	42	12	4	79	11	55	62	9	0	0	0						16	13	28	50	18	4	83	39	4	22	0	0	1
25	75	0	0	0	57	14	29	0	86	0	43	71	0	0	0	0						13	25	62	25	13	0	88	25	0	25	0	0	0
33	54	7	0	6	44	36	17	3	57	29	59	70	32	2	0	1						14	19	34	36	20	10	64	50	11	35	7	1	2
23	74	1	0	2	59	32	9	0	70	17	56	70	9	0	0	0						12	9	38	48	11	3	78	52	3	27	0	0	1
36	50	0	0	14	61	31	8	0	77	8	54	54	8	0	0	0						14	7	64	29	7	0	71	36	0	57	0	0	0
39	52	5	0	4	35	36	25	4	62	24	49	68	19	2	0	1						10	15	25	35	30	10	66	47	16	29	6	1	3
39	60	1	0	0	39	45	15	1	75	16	49	71	10	0	0	0						9	9	31	49	18	2	84	49	6	23	0	1	1
70	30	0	0	0	40	50	10	0	80	0	30	60	0	0	0	0						20	10	22	67	11	0	67	44	0	33	0	0	0
13	78	7	0	2	38	40	19	3	72	20	49	65	34	3	0	1						11	20	27	41	23	9	75	37	9	30	7	0	3
7	90	2	1	0	39	55	6	0	82	14	43	74	15	0	0	0						3	10	29	58	10	3	90	35	0	26	1	1	1
21	72	0	7	0	29	57	14	0	79	7	29	57	14	0	0	0						17	8	31	46	15	8	92	8	0	25	0	0	0
18	73	5	0	4	36	42	19	3	69	23	55	61	27	2	0	1						13	23	31	36	23	10	79	36	14	32	2	0	2
13	86	1	0	0	50	42	8	0	86	14	52	69	10	0	0	0						9	8	43	45	9	3	90	38	4	24	0	0	1
21	79	0	0	0	57	29	14	0	86	7	57	71	7	0	0	0						31	15	59	25	8	8	91	36	0	27	0	0	0
61	35	1	0	3	76	21	2	1	67	39	58	75	19	1	0	1						4	17	65	26	7	2	73	60	12	41	3	3	2
91	9	0	0	0	90	8	2	0	85	27	57	79	13	1	0	0						1	5	90	8	2	0	91	62	5	41	2	2	1
80	20	0	0	0	90	5	5	0	90	15	70	85	15	5	0	0						0	0	90	5	5	0	90	55	0	55	0	5	0

IX. Ocean and deep ocean floor observation research technology

1. Questions regarding the relevant area

1) Degree of expertise in the area

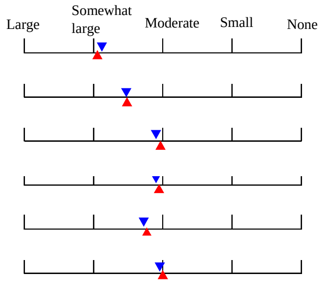


2) Current impacts

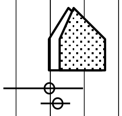
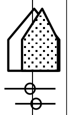
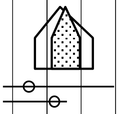
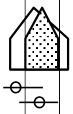
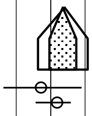
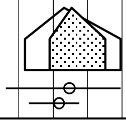
[Increased intellectual assets]
Contribution of the relevant area itself to increased intellectual assets
Contribution to the development of other fields

[Economic impacts]
Contribution to the development of existing Japanese industry
Contribution to the creation of new industries or businesses

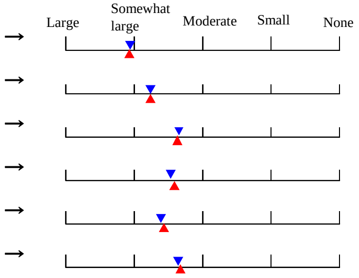
[Social impacts]
Contribution to safety and security
Contribution to improved social vitality and quality of life



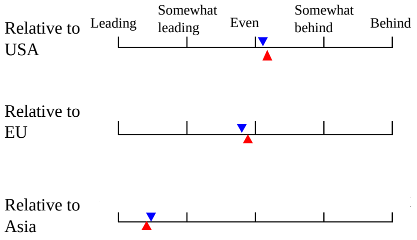
2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan (%)					Time of technological realization							(%)
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
46	Technology that precisely estimates the contributions of deep-sea chemical ecosystems to oceanic matter and energy.	1	**108**	**7**	**24**	**69**	-	**57**	**27**	**50**	**20**	**3**							**0**	**19**
		2	**120**	**5**	**18**	**77**	-	**53**	**13**	**73**	**14**	**0**							**1**	**8**
		E	**6**	**100**	**0**	**0**	-	**63**	**33**	**50**	**17**	**0**							**0**	**0**
47	Automatic observation systems in the open ocean that can monitor oceanographic phenomena and conditions from a depth of 6,000 m to near the surface for a long period of time (about 5 years).	1	**147**	**24**	**28**	**48**	-	**73**	**49**	**44**	**6**	**1**							**1**	**8**
		2	**151**	**17**	**21**	**62**	-	**78**	**57**	**42**	**1**	**0**							**1**	**2**
		E	**26**	**100**	**0**	**0**	-	**94**	**88**	**12**	**0**	**0**							**4**	**0**
48	Fuel cells that are closed systems (no atmospheric exposure), portable, and can provide 10 kilowatt output for one year with a single fueling.	1	**103**	**6**	**22**	**72**	-	**70**	**44**	**48**	**8**	**0**							**0**	**13**
		2	**109**	**3**	**17**	**80**	-	**72**	**47**	**48**	**5**	**0**							**0**	**5**
		E	**3**	**100**	**0**	**0**	-	**58**	**34**	**33**	**33**	**0**							**0**	**0**
49	High-tech survey vessels with a single specialized function.	1	**136**	**23**	**28**	**49**	-	**60**	**33**	**47**	**17**	**3**							**1**	**10**
		2	**147**	**18**	**20**	**62**	-	**63**	**29**	**63**	**8**	**0**							**0**	**3**
		E	**26**	**100**	**0**	**0**	-	**77**	**54**	**46**	**0**	**0**							**0**	**0**
50	Robots that autonomously perform heavy duty work in the deep ocean.	1	**127**	**12**	**21**	**67**	-	**68**	**40**	**51**	**9**	**0**							**0**	**6**
		2	**137**	**8**	**21**	**71**	-	**67**	**36**	**60**	**4**	**0**							**0**	**2**
		E	**11**	**100**	**0**	**0**	-	**85**	**70**	**30**	**0**	**0**							**0**	**0**
51	Probes that can penetrate 10 km below the sea floor.	1	**124**	**8**	**23**	**69**	-	**58**	**31**	**44**	**21**	**4**							**3**	**9**
		2	**133**	**9**	**18**	**73**	-	**61**	**29**	**59**	**11**	**1**							**0**	**2**
		E	**12**	**100**	**0**	**0**	-	**86**	**73**	**27**	**0**	**0**							**0**	**0**

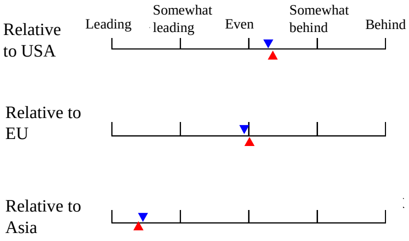
3) Expected impacts at the medium term



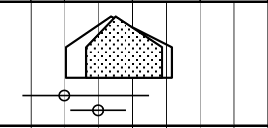
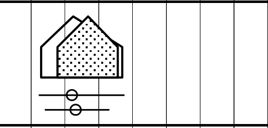
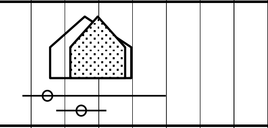
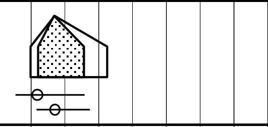
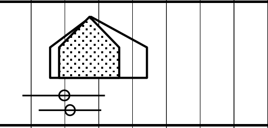
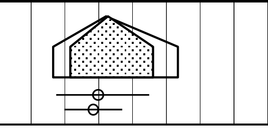
4) Japan's current R&D level



5) Japan's R&D level five years ago



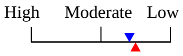
*Relative to EU and Asia means relative to their most advanced countries.

Countries at the leading edge					Regarding technological realization												Time of social application			Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't											Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010 2011–2015 2016–2025 2026–2035 2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)									(%)		(%)				(%)						
17	75	3	0	5	42	40	17	1	66	28	49	58	27	3	0	0		5	22	31	32	27	10	66	60	11	29	4	1	1
5	94	1	0	0	49	46	5	0	75	17	48	73	18	0	0	0		3	9	28	59	12	1	77	64	6	23	5	1	0
17	83	0	0	0	33	50	17	0	67	17	33	50	0	0	0	0		17	0	33	50	0	17	60	60	0	20	0	0	0
30	66	3	0	1	51	38	11	0	58	35	47	70	28	6	0	0		3	15	46	36	14	4	57	59	17	38	4	3	2
21	78	1	0	0	71	27	2	0	70	32	51	80	18	1	0	0		1	3	57	38	5	0	74	70	4	32	6	1	1
8	92	0	0	0	84	16	0	0	68	48	56	84	16	0	0	0		4	0	67	29	4	0	67	83	8	38	13	0	0
56	38	1	0	5	34	48	16	2	44	57	38	69	9	6	0	0		0	14	29	42	23	6	45	67	27	43	9	1	2
78	21	0	0	1	31	64	5	0	53	64	37	76	2	2	0	0		1	5	22	67	11	0	52	83	17	38	6	0	0
67	0	0	0	33	0	67	33	0	33	67	0	0	0	0	0	0		0	0	0	67	33	0	50	50	0	0	0	0	0
34	62	4	0	0	45	35	15	5	44	43	38	75	18	6	0	0		6	20	37	37	19	7	45	57	14	44	12	2	2
28	69	3	0	0	56	38	6	0	50	47	34	78	6	2	0	0		1	4	41	49	9	1	50	77	4	34	6	0	1
35	61	4	0	0	71	29	0	0	58	29	38	83	0	8	0	0		0	0	57	39	4	0	65	57	0	48	9	0	0
53	44	2	0	1	43	45	10	2	49	50	41	74	11	3	0	0		2	16	37	41	16	6	46	64	23	41	10	2	1
70	28	2	0	0	43	52	5	0	50	62	37	75	5	1	0	0		0	2	32	59	9	0	56	78	13	38	5	0	0
70	30	0	0	0	55	45	0	0	45	55	27	82	0	0	0	0		0	0	45	55	0	0	55	64	9	64	0	0	0
49	41	9	0	1	46	37	14	3	46	47	45	70	17	1	0	0		11	19	34	39	20	7	50	55	15	42	3	1	3
68	31	1	0	0	64	32	4	0	56	48	45	78	3	0	0	0		2	6	42	47	11	0	63	69	9	36	2	0	0
75	25	0	0	0	91	9	0	0	64	45	45	82	0	0	0	0		0	0	75	25	0	0	58	67	0	58	0	0	0

X. Space, ocean, and Earth technology for a safe and secure society

1. Questions regarding the relevant area

1) Degree of expertise in the area

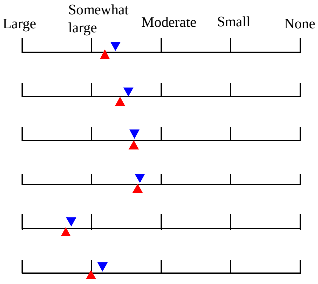


2) Current impacts

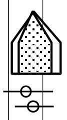
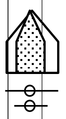
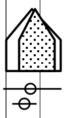
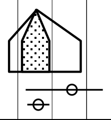
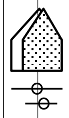
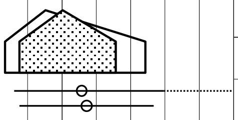
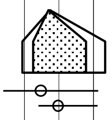
[Increased intellectual assets]
Contribution of the relevant area itself to increased intellectual assets
Contribution to the development of other fields

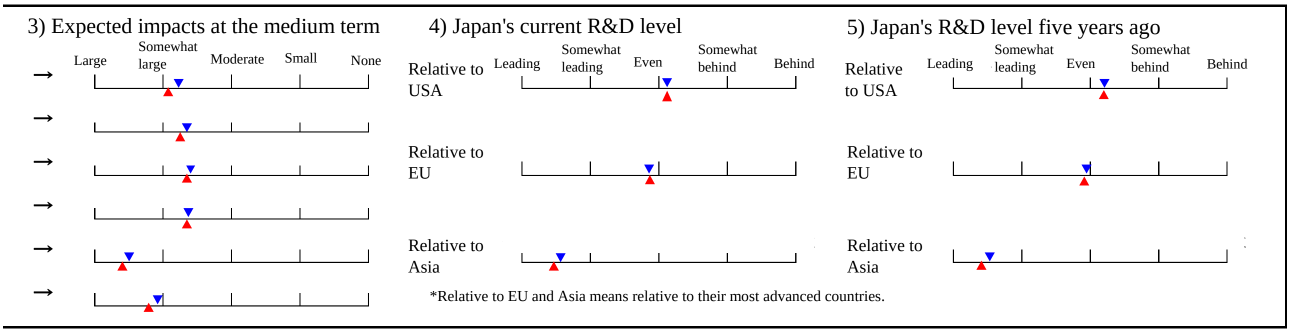
[Economic impacts]
Contribution to the development of existing Japanese industry
Contribution to the creation of new industries or businesses

[Social impacts]
Contribution to safety and security
Contribution to improved social vitality and quality of life

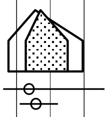
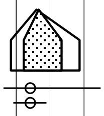


2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan (%)					Time of technological realization						(%)	
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
52	A risk management system that utilizes disaster observation satellites, communications satellites, GPS, unmanned aircraft, and so on to observe disasters, understand situations after disasters occur, and respond swiftly (send the necessary information where it is needed).	1	**189**	**19**	**30**	**51**	-	**89**	**78**	**21**	**1**	**0**							**0**	**2**
		2	**183**	**11**	**26**	**63**	-	**98**	**95**	**4**	**1**	**0**							**0**	**1**
		E	**21**	**100**	**0**	**0**	-	**98**	**95**	**5**	**0**	**0**							**0**	**0**
53	An integrated national land management and use system (using Earth observation satellite data, GPS, communications satellites, GIS, and so on to digitize land use, ocean data, maps, etc.) that covers all of Japan, including the sea.	1	**191**	**18**	**32**	**50**	-	**80**	**61**	**35**	**4**	**0**							**0**	**2**
		2	**186**	**9**	**28**	**63**	-	**93**	**86**	**14**	**0**	**0**							**0**	**1**
		E	**16**	**100**	**0**	**0**	-	**97**	**94**	**6**	**0**	**0**							**0**	**0**
54	Integrated usage and conservation technology for entire bays such as Tokyo Bay and Osaka Bay that are densely used.	1	**124**	**15**	**25**	**60**	-	**75**	**53**	**40**	**7**	**0**							**1**	**7**
		2	**134**	**8**	**19**	**73**	-	**84**	**70**	**28**	**2**	**0**							**0**	**2**
		E	**11**	**100**	**0**	**0**	-	**95**	**91**	**9**	**0**	**0**							**0**	**9**
55	Technology to assess the safety of geologic disposal of high-level radioactive waste.	1	**113**	**10**	**19**	**71**	-	**80**	**65**	**29**	**4**	**2**							**10**	**12**
		2	**117**	**5**	**18**	**77**	-	**93**	**87**	**11**	**1**	**1**							**4**	**3**
		E	**6**	**100**	**0**	**0**	-	**100**	**100**	**0**	**0**	**0**							**17**	**0**
56	Technology that uses monitoring technology on moment-to-moment characteristics of falling and accumulated snow to predict the scale of surface avalanches, degree of risk, and so on over wide areas.	1	**102**	**8**	**28**	**64**	-	**65**	**39**	**43**	**18**	**0**							**3**	**8**
		2	**117**	**7**	**12**	**81**	-	**67**	**37**	**57**	**6**	**0**							**0**	**3**
		E	**8**	**100**	**0**	**0**	-	**75**	**50**	**50**	**0**	**0**							**0**	**0**
57	Technology to precisely forecast the imminence (place and time period) of earthquakes (plate boundary earthquakes and inland earthquakes) of magnitude 7 or greater that are likely to cause damage, helping mitigate human disasters.	1	**154**	**23**	**25**	**52**	-	**92**	**86**	**11**	**3**	**0**							**9**	**17**
		2	**148**	**14**	**22**	**64**	-	**98**	**95**	**5**	**0**	**0**							**5**	**5**
		E	**21**	**100**	**0**	**0**	-	**100**	**100**	**0**	**0**	**0**							**0**	**10**
58	Technology to forecast the timing and scale of volcanic eruptions by observing and assessing in real time magma conditions inside volcanoes that are likely to erupt.	1	**138**	**17**	**27**	**56**	-	**89**	**78**	**20**	**2**	**0**							**1**	**11**
		2	**138**	**12**	**21**	**67**	-	**98**	**95**	**4**	**1**	**0**							**1**	**3**
		E	**16**	**100**	**0**	**0**	-	**94**	**87**	**13**	**0**	**0**							**0**	**0**
59	Formation of a worldwide consensus, including developing countries, on international regulations on the output of carbon dioxide and other greenhouse gases.	1	**139**	**10**	**21**	**69**	-	**88**	**77**	**20**	**3**	**0**								
		2	**138**	**4**	**13**	**83**	-	**96**	**91**	**9**	**0**	**0**								
		E	**6**	**100**	**0**	**0**	-	**92**	**83**	**17**	**0**	**0**								



*Relative to EU and Asia means relative to their most advanced countries.

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)						
24	72	3	0	1	80	19	1	0	50	54	54	66	16	12	2	0						0	4	73	24	3	0	54	65	23	48	19	7	2
11	87	1	0	1	97	3	0	0	64	56	60	76	8	7	1	0						0	2	91	8	1	0	67	74	11	52	9	5	1
24	66	5	0	5	95	5	0	0	67	43	48	67	5	0	0	0						0	0	81	19	0	0	67	62	14	48	5	10	0
27	71	1	0	1	62	29	9	0	48	57	56	56	11	12	1	1						1	5	50	37	11	2	49	66	29	41	20	6	1
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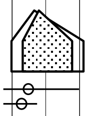
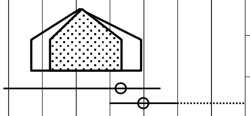
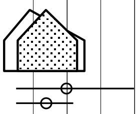
25	75	0	0	0	94	6	0	0	56	63	63	63	0	6	0	0						0	0	80	20	0	0	60	73	20	53	20	7	0
65	25	5	0	5	55	40	4	1	41	53	53	49	5	19	8	1						1	10	49	38	12	1	49	65	19	40	21	16	2
91	6	2	0	1	74	24	2	0	50	69	56	56	1	9	3	1						0	5	76	21	3	0	58	80	9	40	13	10	2
89	11	0	0	0	100	0	0	0	64	45	55	55	0	27	18	0						0	10	90	10	0	0	70	80	10	50	40	20	0
23	46	27	0	4	73	20	4	3	54	39	55	55	20	10	13	1						11	19	68	21	5	6	60	54	16	38	12	20	3
13	69	18	0	0	95	4	0	1	63	34	65	59	9	4	11	1						4	6	93	5	1	1	78	62	5	31	10	18	3
40	40	20	0	0	100	0	0	0	50	50	50	33	33	0	33	0						20	0	75	25	0	0	75	25	25	25	0	25	0
53	26	14	0	7	48	40	11	1	47	33	55	48	10	4	0	1						2	14	44	42	12	2	53	53	17	40	4	4	4
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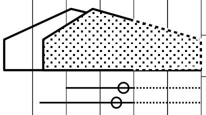
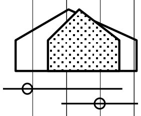
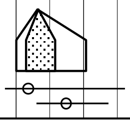
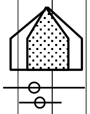
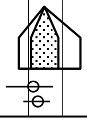
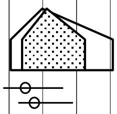
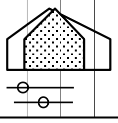
62	38	0	0	0	50	50	0	0	63	25	50	25	0	0	0	0						0	0	50	50	0	0	75	38	0	38	0	0	0
80	18	0	0	2	78	16	5	1	74	34	64	63	20	4	1	2						9	21	76	16	4	4	73	51	12	43	9	7	5
97	3	0	0	0	96	3	0	1	84	28	66	71	12	1	1	1						7	11	94	4	1	1	88	52	6	44	4	3	2
95	5	0	0	0	95	5	0	0	100	29	67	86	14	0	0	0						5	14	90	10	0	0	90	52	5	67	10	5	0
78	18	2	0	2	80	16	3	1	71	31	63	70	14	3	0	2						2	15	72	23	4	1	73	47	19	45	4	5	5
95	5	0	0	0	98	1	1	0	83	23	68	74	12	0	1	2						2	4	95	4	1	0	89	55	4	44	3	5	2
75	25	0	0	0	94	6	0	0	94	19	56	75	25	0	0	0						0	0	94	6	0	0	94	56	0	63	6	6	0
																						3	20	87	10	2	1	48	51	16	33	14	44	7
																						2	6	96	3	0	1	67	63	7	29	5	45	2
																						0	0	100	0	0	0	50	33	0	0	0	33	17

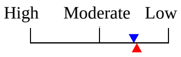
No	Topic	Questionnaire	Respondents (persons)	Degree of expertise				Importance to Japan					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
				(%)					(%)										(%)	
60	Technology to evenly and densely place comprehensive earthquake/crust change observation equipment in major cities, mountainous areas, continental shelves, and so on in order to predict earthquakes.	1	**148**	**21**	**21**	**58**	**-**	**84**	**69**	**28**	**3**	**0**							**1**	**8**
		2	**143**	**15**	**24**	**61**	**-**	**96**	**92**	**8**	**0**	**0**							**0**	**2**
		E	**22**	**100**	**0**	**0**	**-**	**95**	**91**	**9**	**0**	**0**							**0**	**0**
61	Elucidation of the mechanisms of rainfall, snow accumulation, torrential rain, and so on.	1	**122**	**17**	**27**	**56**	**-**	**87**	**74**	**26**	**0**	**0**							**1**	**9**
		2	**133**	**11**	**21**	**68**	**-**	**95**	**91**	**9**	**0**	**0**							**2**	**2**
		E	**14**	**100**	**0**	**0**	**-**	**96**	**93**	**7**	**0**	**0**							**0**	**0**

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)						
81	**18**	**0**	**0**	**1**	**76**	**20**	**3**	**1**	**58**	**39**	**57**	**72**	**14**	**3**	**1**	**0**						**3**	**15**	**70**	**25**	**4**	**1**	**54**	**52**	**24**	**44**	**8**	**4**	**7**
99	**1**	**0**	**0**	**0**	**96**	**4**	**0**	**0**	**74**	**30**	**60**	**81**	**6**	**2**	**1**	**0**						**0**	**6**	**95**	**4**	**0**	**1**	**82**	**65**	**8**	**48**	**4**	**2**	**2**
95	**5**	**0**	**0**	**0**	**95**	**5**	**0**	**0**	**82**	**32**	**59**	**77**	**9**	**5**	**0**	**0**						**0**	**0**	**91**	**9**	**0**	**0**	**91**	**55**	**0**	**68**	**14**	**0**	**0**
55	**38**	**5**	**0**	**2**	**64**	**32**	**4**	**0**	**67**	**37**	**57**	**60**	**12**	**3**	**1**	**2**						**1**	**14**	**59**	**34**	**5**	**2**	**70**	**55**	**19**	**30**	**7**	**2**	**3**
83	**17**	**0**	**0**	**0**	**87**	**13**	**0**	**0**	**87**	**26**	**60**	**73**	**9**	**1**	**0**	**0**						**1**	**5**	**86**	**13**	**0**	**1**	**88**	**61**	**10**	**30**	**2**	**1**	**1**
79	**21**	**0**	**0**	**0**	**93**	**7**	**0**	**0**	**71**	**7**	**43**	**64**	**7**	**0**	**0**	**0**						**0**	**0**	**86**	**14**	**0**	**0**	**79**	**36**	**7**	**21**	**0**	**0**	**0**

XI. Space, ocean, and Earth technology that drives science and technology innovation

1. Questions regarding the relevant area

1) Degree of expertise in the area

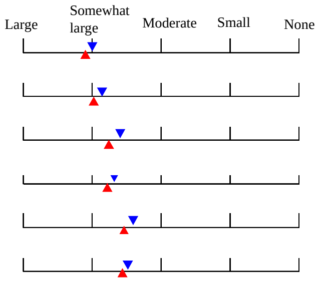


2) Current impacts

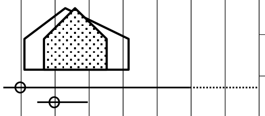
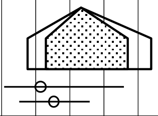
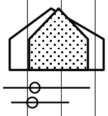
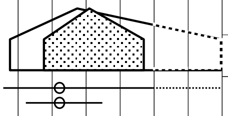
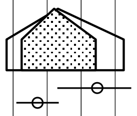
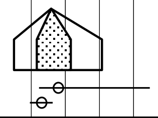
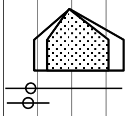
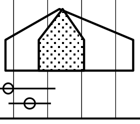
[Increased intellectual assets]
Contribution of the relevant area itself to increased intellectual assets
Contribution to the development of other fields

[Economic impacts]
Contribution to the development of existing Japanese industry
Contribution to the creation of new industries or businesses

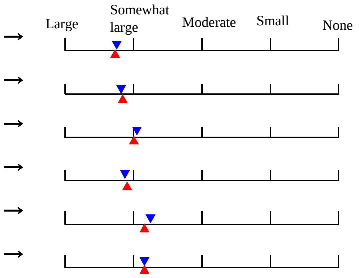
[Social impacts]
Contribution to safety and security
Contribution to improved social vitality and quality of life



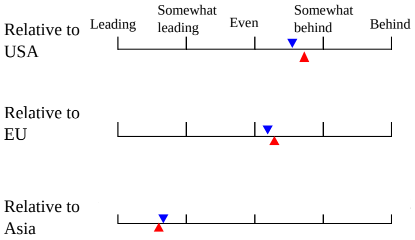
2. Questions regarding topics

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise (%)				Importance to Japan (%)					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized (%)	Do not know (%)
62	Construction of computer life form models based on advances in system biology.	1	**82**	**9**	**9**	**82**	**-**	**60**	**34**	**40**	**23**	**3**							**3**	**13**
		2	**92**	**2**	**13**	**85**	**-**	**51**	**13**	**69**	**15**	**3**							**2**	**8**
		E	**2**	**100**	**0**	**0**	**-**	**75**	**50**	**50**	**0**	**0**							**0**	**0**
63	Solar photoelectric power generation plants in space that transmit electricity to the ground with microwaves or lasers.	1	**158**	**19**	**25**	**56**	**-**	**56**	**36**	**28**	**28**	**8**							**13**	**10**
		2	**155**	**14**	**21**	**65**	**-**	**65**	**43**	**33**	**20**	**4**							**11**	**7**
		E	**21**	**100**	**0**	**0**	**-**	**80**	**66**	**24**	**5**	**5**							**10**	**0**
64	Self-repairing space vessels.	1	**128**	**11**	**29**	**60**	**-**	**62**	**32**	**53**	**13**	**2**							**2**	**12**
		2	**125**	**10**	**21**	**69**	**-**	**59**	**23**	**69**	**6**	**2**							**1**	**7**
		E	**13**	**100**	**0**	**0**	**-**	**81**	**62**	**38**	**0**	**0**							**0**	**0**
65	Space and planetary exploration technology using robots with overall decision-making ability equivalent to that of human beings.	1	**134**	**13**	**22**	**65**	**-**	**64**	**40**	**40**	**17**	**3**							**11**	**9**
		2	**139**	**12**	**15**	**73**	**-**	**63**	**33**	**55**	**10**	**2**							**4**	**8**
		E	**16**	**100**	**0**	**0**	**-**	**84**	**69**	**31**	**0**	**0**							**0**	**0**
66	Satellite-borne computers that operate on the level of thermal noise energy.	1	**97**	**9**	**14**	**77**	**-**	**60**	**33**	**44**	**20**	**3**							**3**	**20**
		2	**102**	**6**	**14**	**80**	**-**	**55**	**18**	**67**	**15**	**0**							**4**	**10**
		E	**6**	**100**	**0**	**0**	**-**	**54**	**17**	**66**	**17**	**0**							**17**	**0**
67	Technology for the creation of recreational water-use areas through the development of seawater cleaning systems such as cleaning blocks and biofilters.	1	**89**	**8**	**18**	**74**	**-**	**67**	**41**	**48**	**9**	**2**							**1**	**15**
		2	**100**	**5**	**15**	**80**	**-**	**62**	**28**	**66**	**4**	**2**							**1**	**4**
		E	**5**	**100**	**0**	**0**	**-**	**70**	**40**	**60**	**0**	**0**							**0**	**0**
68	Technology to fix carbon dioxide to the seafloor.	1	**130**	**7**	**31**	**62**	**-**	**66**	**44**	**35**	**16**	**5**							**10**	**17**
		2	**134**	**4**	**19**	**77**	**-**	**75**	**54**	**38**	**7**	**1**							**5**	**7**
		E	**5**	**100**	**0**	**0**	**-**	**75**	**50**	**50**	**0**	**0**							**0**	**0**
69	Offshore cities (bases for transportation, communications, research, production, leisure activities) with structures with legs or that float.	1	**91**	**8**	**18**	**74**	**-**	**54**	**27**	**40**	**27**	**6**							**6**	**11**
		2	**102**	**7**	**14**	**79**	**-**	**54**	**19**	**61**	**17**	**3**							**3**	**4**
		E	**7**	**100**	**0**	**0**	**-**	**79**	**57**	**43**	**0**	**0**							**0**	**0**

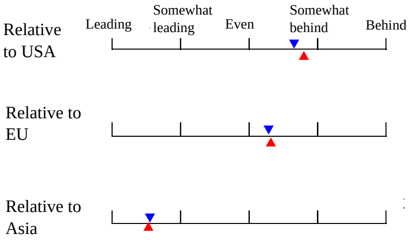
3) Expected impacts at the medium term



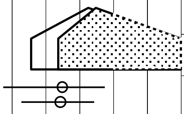
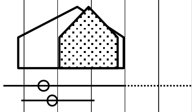
4) Japan's current R&D level



5) Japan's R&D level five years ago



*Relative to EU and Asia means relative to their most advanced countries.

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)						
10	87	0	0	3	34	31	27	8	68	37	43	53	13	3	3	1																		
2	98	0	0	0	29	50	18	3	81	27	42	53	6	0	1	0																		
0	100	0	0	0	50	50	0	0	100	0	50	50	0	0	0	0																		
33	64	1	0	2	45	30	14	11	51	44	44	63	28	8	2	2						16	17	41	26	20	13	47	58	28	45	17	9	3
19	81	0	0	0	58	25	13	4	64	43	45	71	21	4	1	2						15	13	57	22	13	8	64	66	13	48	13	5	1
38	62	0	0	0	66	24	5	5	65	55	35	75	15	10	0	0						14	0	66	24	0	10	63	74	26	42	32	11	0
6	90	2	0	2	46	39	14	1	61	42	48	66	20	3	0	0						3	14	40	36	22	2	63	55	22	37	7	2	1
2	98	0	0	0	57	39	3	1	71	38	47	74	13	2	0	0						1	9	46	46	6	2	72	68	12	33	4	1	0
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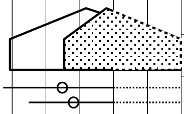
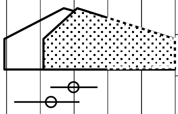
18	77	1	0	4	45	36	16	3	64	42	47	65	19	2	0	1						8	17	42	33	22	3	60	56	17	40	7	1	1
5	94	0	0	1	53	38	8	1	74	41	45	68	13	2	0	1						6	14	44	41	13	2	75	62	5	34	4	1	1
6	94	0	0	0	81	19	0	0	75	56	63	88	13	6	0	0						0	6	75	19	0	6	87	67	7	40	20	0	0
11	83	2	0	4	34	46	17	3	49	43	47	63	11	1	0	1						3	22	30	38	25	7	61	56	23	32	5	0	3
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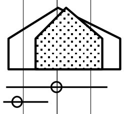
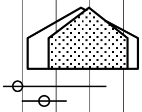
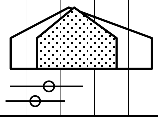
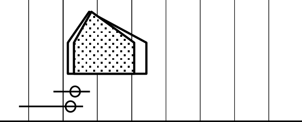
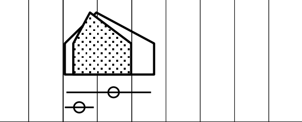
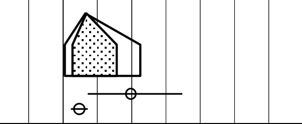
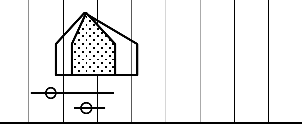
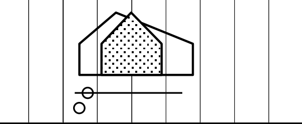
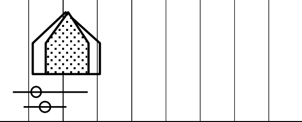
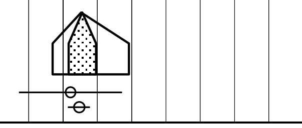
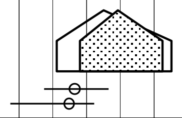
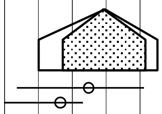
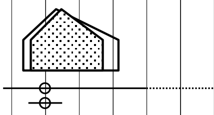
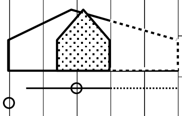
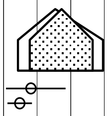
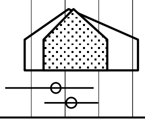
58	29	9	0	4	40	39	15	6	47	52	53	63	13	11	4	1						0	20	35	50	10	5	46	68	34	43	23	9	1
77	18	5	0	0	49	44	7	0	53	65	46	66	6	6	2	0						0	5	28	63	9	0	60	70	24	41	10	6	0
75	25	0	0	0	40	40	20	0	20	80	40	40	0	40	20	0						0	0	60	40	0	0	40	60	40	60	40	20	0
40	42	12	0	6	54	29	10	7	46	47	51	60	32	8	5	0						12	24	50	25	16	9	41	58	27	44	19	17	5
45	53	2	0	0	70	22	5	3	59	38	51	70	16	2	0	0						7	10	70	22	6	2	49	70	12	39	10	11	3
60	40	0	0	0	80	20	0	0	50	0	25	75	0	0	0	0						0	0	100	0	0	0	25	25	0	75	25	25	0
66	27	6	0	1	36	32	21	11	36	55	41	47	9	26	7	5						6	20	27	37	21	15	34	62	37	35	29	10	3
87	10	2	0	1	41	46	8	5	40	65	38	55	7	19	3	1						4	7	33	50	13	4	39	77	25	32	20	4	2
83	17	0	0	0	86	14	0	0	71	57	14	71	14	29	29	14						0	0	100	0	0	0	43	43	14	43	43	29	14

No	Topic	Questionnaire	Respondents (persons)	Degree of expertise				Importance to Japan					Time of technological realization							
				High	Moderate	Low	None	Index	High	Moderate	Low	None	Already realized	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be realized	Do not know
				(%)					(%)										(%)	
70	Marine farms that carry out optimal environmental management by adopting biology technology as well as a broad array of engineering technology.	1	**90**	**8**	**14**	**78**	**-**	**60**	**31**	**51**	**15**	**3**							**4**	**13**
		2	**108**	**3**	**18**	**79**	**-**	**63**	**30**	**61**	**9**	**0**							**0**	**1**
		E	**3**	**100**	**0**	**0**	**-**	**83**	**67**	**33**	**0**	**0**							**0**	**0**
71	Methane hydrate mining utilization technology.	1	**124**	**10**	**27**	**63**	**-**	**79**	**63**	**28**	**6**	**3**							**1**	**12**
		2	**118**	**5**	**24**	**71**	**-**	**88**	**78**	**17**	**4**	**1**							**3**	**2**
		E	**6**	**100**	**0**	**0**	**-**	**75**	**60**	**20**	**20**	**0**							**17**	**0**
72	Technology to grow bacteria that break down chemical substances that disrupt endocrines and other environmental pollutants.	1	**76**	**4**	**28**	**68**	**-**	**65**	**37**	**51**	**11**	**1**							**3**	**16**
		2	**89**	**3**	**17**	**80**	**-**	**63**	**30**	**63**	**7**	**0**							**0**	**5**
		E	**3**	**100**	**0**	**0**	**-**	**67**	**33**	**67**	**0**	**0**							**0**	**0**
73	Establishment of quantitative models for ocean ecosystems.	1	**122**	**12**	**24**	**64**	**-**	**62**	**34**	**47**	**18**	**1**							**3**	**13**
		2	**121**	**6**	**19**	**75**	**-**	**60**	**26**	**64**	**9**	**1**							**2**	**3**
		E	**7**	**100**	**0**	**0**	**-**	**86**	**71**	**29**	**0**	**0**							**0**	**0**
74	Saltwater engines that remove oxygen and hydrogen form seawater and generate energy.	1	**83**	**5**	**17**	**78**	**-**	**62**	**36**	**43**	**16**	**5**							**8**	**19**
		2	**92**	**2**	**7**	**91**	**-**	**61**	**28**	**61**	**9**	**2**							**4**	**5**
		E	**2**	**100**	**0**	**0**	**-**	**25**	**0**	**50**	**0**	**50**							**50**	**0**
75	Three-dimensional autonomous navigation systems for water vessels.	1	**96**	**10**	**25**	**65**	**-**	**55**	**26**	**46**	**24**	**4**							**0**	**9**
		2	**104**	**7**	**17**	**76**	**-**	**54**	**15**	**70**	**15**	**0**							**0**	**1**
		E	**7**	**100**	**0**	**0**	**-**	**71**	**43**	**57**	**0**	**0**							**0**	**0**
76	Wireless communications technology that works over several horizontal kilometers in seawater to enable smooth performance of underwater work.	1	**91**	**13**	**22**	**65**	**-**	**58**	**29**	**46**	**24**	**1**							**6**	**11**
		2	**102**	**10**	**13**	**77**	**-**	**57**	**20**	**69**	**10**	**1**							**2**	**2**
		E	**10**	**100**	**0**	**0**	**-**	**70**	**40**	**60**	**0**	**0**							**10**	**0**

Countries at the leading edge					Regarding technological realization												Time of social application							Regarding social application										
					Necessity of gov't involvement				Effective measures that should be taken by gov't															Necessity of gov't involvement				Effective measures that should be taken by gov't						
Japan	USA	EU	Asia	Other	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Development of R&D infrastructure	Expansion of R&D funding	Internationalization of R&D activities	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other	2006–2010	2011–2015	2016–2025	2026–2035	2036–	Will not be applied	Do not know	High	Moderate	Low	None	Human resources development	Strengthened industry-academic-government and interdisciplinary collaboration	Improvement of environment for business startups	Support through taxation, subsidies, and procurement	Relaxation or elimination of relevant regulations	Tightened or new regulations	Other
(%)					(%)				(%)													(%)		(%)				(%)						
60	34	0	0	6	31	39	26	4	51	55	50	50	13	16	8	4						4	17	25	40	29	6	40	60	36	39	27	17	3
86	14	0	0	0	25	67	8	0	54	62	55	55	5	13	3	1						1	4	25	64	10	1	50	76	32	38	22	12	0
67	33	0	0	0	33	67	0	0	100	33	0	33	33	0	0	0						0	0	100	0	0	0	100	33	0	33	0	0	0
38	47	8	0	7	58	33	7	2	50	57	53	64	24	10	3	0						2	15	48	35	13	4	49	66	37	44	18	11	2
28	69	2	0	1	76	20	3	1	54	58	55	74	14	3	3	0						3	5	73	20	5	2	50	78	26	45	16	5	0
40	60	0	0	0	80	20	0	0	80	20	40	60	40	0	0	0						33	0	83	0	0	17	60	40	0	60	0	0	0
26	54	12	0	8	26	53	18	3	57	42	49	55	13	4	1	1						3	18	21	55	21	3	49	58	40	35	9	11	2
17	79	4	0	0	24	74	2	0	66	40	44	62	4	2	2	0						0	5	23	71	6	0	59	78	24	33	3	5	1
33	67	0	0	0	0	100	0	0	67	33	33	0	0	0	0	0						0	0	33	67	0	0	67	67	0	0	0	0	0
19	69	8	0	4	31	39	27	3	69	29	44	52	23	2	0	2																		
6	87	6	0	1	29	57	12	2	84	18	42	57	16	1	1	0																		
17	83	0	0	0	57	43	0	0	86	14	29	29	0	14	14	0																		
26	63	5	0	6	34	40	23	3	56	44	49	51	18	6	0	1						3	22	32	36	26	6	48	67	31	36	10	1	4
11	87	2	0	0	30	61	7	2	71	43	49	63	3	2	1	0						3	8	28	56	13	3	59	74	21	32	5	2	0
0	100	0	0	0	0	100	0	0	100	0	0	0	0	0	0	0						0	0	100	0	0	0	100	0	0	0	0	0	0
28	69	1	0	2	24	43	25	8	51	52	41	63	11	6	0	2						1	12	24	35	33	8	40	66	22	34	13	1	3
10	90	0	0	0	23	63	14	0	57	48	37	68	4	2	1	1						1	2	24	59	16	1	52	76	16	32	7	4	1
29	71	0	0	0	43	57	0	0	67	33	33	67	17	0	0	0						0	0	57	43	0	0	86	71	0	29	0	0	0
16	81	0	0	3	25	37	36	2	49	44	45	63	11	6	1	3						1	16	24	30	40	6	49	55	22	34	9	1	3
2	98	0	0	0	26	56	18	0	56	52	36	66	4	0	1	3						2	3	28	43	28	1	52	72	17	35	5	4	1
0	100	0	0	0	50	40	10	0	56	44	22	56	0	0	0	11						11	0	60	10	30	0	40	40	20	50	0	0	10