Consideration on Visions of Future Society and Likely Issues to Emerge in the Future (Global)

Handout 2

Inevitable Flow	World Trends	Examples of Likely Issues to Emerge (Business Chances)
Explosive increase in population **(India and Africa)** **Rapid aging of population** **(China, developed countries)** Population in 2050 ( ) shows the level in 2017 Worldwide: 9.8 bn. people (7.6 bn.) Asia and Africa: 7.9 bn. People (5.8 bn.) Elderly population worldwide (60 yrs. old or older): 2.1 bn. People (1 bn.) * Data from the UN Advancement of aging of population in China and developed countries	**■ Eating in the future** ✓ **Food shortage** (food demand: currently 4.5 billion tons → 6.9 billion tons in 2050) ✓ Possible **skyrocketing of prices** (due to abnormal climate, desertification, etc.) ✓ **Unbalanced distribution** (food waste accounts for 30 to 50% = enough to feed 3 billion people; obesity of urban residents → the healthcare spending of the US is projected to increase by $550 billion by 2030) **■ Health and medical care in the future (life science)** ✓ Proper medical care will be **available only to 30% of the world population**. ✓ With the advancement of medical technology, **the average life expectancy will be extended** (the worldwide elderly population is projected to reach 2 billion people in 2050). In many regions, healthcare spending for the elderly will **put pressure on the medical care systems**. ✓ When healthcare spending **as a percentage of GDP exceeds 20%, the medical system can no longer be sustained** (over 17% in the US). Worldwide healthcare spending is projected to reach $20 trillion in 2040. (Estimated by the IMF) ✓ The scale of preventive care based on genetic information, etc. is expected to be $50 billion in 2020. (McKinsey) ✓ **GDP losses caused by chronic diseases such as dementia** will amount to $47 trillion worldwide in 2030. (Estimated by the WHO) ✓ Advancement of aging in many Asian countries by 2050, and **expansion of the market for healthcare services and nursing care services** to supplement public service systems (Analyzed by Mizuho Financial Group)	**■ Foods** ✓ Increase in yields by accelerating breeding, etc. ✓ Expansion of food markets in East Asia, and globally growing awareness of health ✓ Sustainable use and management of fishery resources **■ Health and medical care (life science)** ✓ Streamlining and cost reduction of medical services ✓ Enhancement of preventive care (for lifestyle-related diseases, dementia, etc.) Worldwide healthcare spending in 2040: approx. 2,200 trillion yen * According to The Lancet Worldwide social costs of dementia in 2040 (healthcare spending, nursing care spending, and the burden on the family): approx. 290 trillion yen * Estimated on the basis of materials of Keio University
Rapid urbanization	**■ Future city** ✓ **The world market for infrastructure and maintenance is estimated to be worth 200 trillion yen annually**. ✓ Around 2050, **70% of the world population will be living in urban areas, resulting in a serious shortage of infrastructure** (housing, buildings, water supply and sewerage systems, transportation networks, etc.). ✓ **Aging infrastructure will become negative legacies** (it is necessary to increase the amount of investment by 1.6 times just to maintain the current infrastructure [estimated by McKinsey Global Institute]). ✓ **Diffusion of "smart city" approaches** that adopt computer-controlled intelligent city functions (for electricity, public transportation, etc.) (Dubai and Singapore)	**■ City** ✓ Incorporation of intelligent systems into cities, smart city ✓ Infrastructure development in emerging countries
Escalation of global warming and environmental pollution Temperature rise by 2.6 to 4.8°C at a maximum by 2100 * Data of the IPCC	**■ Future energy** ✓ **Investment of 800 trillion yen in renewable energy** by 2040 (2017 Report by Bloomberg) ✓ **Diffusion of smart grids (IT-utilizing electrical** grids) in combination with renewable energy sources such as solar power **■ Future environment and resources** ✓ **Pollution and scarcity of water resources** (40% of the world population will be under stressful conditions due to a lack of sufficient water in 2050 [the water business market will be worth 110 trillion yen in 2025]) ✓ **Escalation of urban air pollution** (the PM 2.5 problem will be more evident in Delhi, Beijing, etc.; serious impact on the entire world by 2050) ✓ **Plastic ocean** (275 million tons of plastic waste are generated each year, and 4.8 to 12.7 million tons of this volume are flown into the ocean) ✓ For accomplishment of the **"2°C target" of the Paris Agreement**, it is necessary to reduce the volume of greenhouse gas emissions to zero in real terms during the latter half of this century. ✓ **Flood damage and submersion risk due to sea level rise** (Guangzhou, Miami, New York, Mumbai, Nagoya, etc.), and **worsening of damage caused by natural disasters** ✓ **China promotes solar power generation** with an aim at reducing its CO2 emissions to approx. 60% per unit of GDP by 2030. ✓ **Depletion of natural resources** (the remaining antimony resources (for lead-acid batteries) will last 8 years; the remaining indium resources (for solar panels) will last 12 years; and the remaining phosphate rock resources (for fertilizers) will last 75 years) ✓ **Resource exploration in Africa** (the region retains 1/3 of the mineral resources and 10% of the crude oil reserves on earth)	**■ Energy** ✓ Energy storage, diversification of energy sources (hydrogen fuel) The world market for smart grid infrastructure by 2030: approx. 138 trillion yen Analyzed by Financial & Economic Research Center, Nomura Securities **■ Environment and resources** ✓ Efficient use of water resources, water purification ✓ Suppression of air pollution by decarburization, air purification ✓ Marine purification, development of substitute materials for plastic ✓ Exploration of alternative resources, development of new materials The world market for biofuels, bio-plastics, etc. in 2030: approx. 69 trillion yen * Analyzed by the Organisation for Economic Co-operation and Development (OECD) The CCS (CO2 fixation and capture) market: $128 to 221 billion in 2030 * Research conducted by Pike Research
Dramatic progress in scientific technology by utilizing AI, etc. Cutting-edge technologies: AI, robots, blockchain, genome editing, and quantum technology	**■ Future industries and work** ✓ Diffusion of online marketplaces, 3D printing, and the local manufacturing of made-to-order items, resulting in the shifting **of manufacturing to distributed production** ✓ **Substitution of AI and robots for human labor** in relation to simple labor and those types of work that require a high level of knowledge or memory retention ✓ **Streamlining of vehicle dispatch services** such as self-driving cars, car-sharing and Uber (**with an emphasis on** not only mobility but also **usability**) ✓ **Diffusion of dynamic pricing that enables prices to be immediately changed according to demand** through online order placement and receipt, which will help demand and supply perfectly match with each other ✓ **The number of elderly people working after retirement will increase,** while **the unemployment rate of young people** will also increase. In addition, the number of freelancers who do not belong to specific companies will increase. **■ Future information, telecommunication and technology** ✓ By 2025, various sensors will be connected to multiple networks, leading to **100 times more efficient transmission of 10,000 times more data compared with the current data transmission and volume levels**. ✓ Introduction of "cognitive networks" in which **things, equipment, buildings and infrastructure will be mutually connected with each other** to process complex tasks autonomously ✓ On the other hand, increased risk of data hacking and the occurrence of **problems with personal data protection and ownership** ✓ Sophistication of personal authentication systems for prevention of unauthorized activities, following the **diffusion of electronic money transactions and virtual currencies such as Bitcoin** ✓ Advancement of digitalization in educational scenes, leading to **the diffusion of online tuition** in addition to conventional face-to-face tuition **■ Future space business** ✓ As of 2017, space industry business is worth approx. 42 trillion yen in the world. ✓ **Firm establishment of satellite business** with satellites regarded as an infrastructure for communications and monitoring ✓ Advancement of the space station construction plans of the US and China from 2025	**■ Industries and work** ✓ Work sharing ✓ Space business development The world market for industrial robots will be worth approx. 3.3 trillion yen in 2025. * Research conducted by Fuji Keizai Management **■ Information, telecommunication and technology** ✓ Data security enhancement, personal Information protection **■ Space development** ✓ Supremacy with respect to space utilization ✓ Measures against space debris

Prepared by the Cabinet Office by reference to "[Data Book] Future Agenda: Six Challenges for the Next Decade" written by Tim Jones & Caroline Dewing and published by Hayakawa Publishing Corporation, among other materials

Consideration on Visions of Future Society and Likely Issues to Emerge in the Future (Japan)

Japan's Strength (Industrial Sector)	Examples of Likely Issues to Emerge (Business Chances)	Domestic Trends	Inevitable Flow
Development of new varieties Vegetable seeds: nearly 20% of the world share The number of plant genetic resources in possession: 5th in the world **Fermentation (health food)** High-value-added amino acids: over 50% of the world share **Regenerative medicine (iPS cells), brain science, and system biology (fusion of physics and biology)** Diagnostic equipment (e.g., endoscopes): over 30% of the world share	**■ Foods** ✓ Overseas expansion of good-quality agricultural products and healthy diet ✓ Establishment of global logistics systems and commercial distribution systems that are just-in-time and prevent waste losses ✓ Sustainable use and management of fishery resources **■ Health and medical care (life science)** ✓ Streamlining and cost reduction of medical services ✓ Enhancement of preventive care (for lifestyle-related diseases, dementia, etc.) ✓ Establishment of telemedicine technology for remote islands and depopulated areas	**■ Eating in the future** ✓ **Weakening of the domestic production power** due to the aging of population and depopulation (the current food self-sufficiency rate: 39%) ✓ **Decrease and depletion of fishery resources**, and increased risk of spread of animal infectious diseases, etc. ✓ **Growing awareness of health and that of prevention and care with balanced diet**, in connection with the advancement of aging of population ✓ Relative rise of food prices following **the expansion of overseas markets (export)** ✓ **Degradation of ecosystem service functions such as source water replenishment and the erosion control function**, due to the advancing devastation of rural communities, mountains and forest **■ Health and medical care in the future (life science)** ✓ **Increase in social security spending (medical spending and pension)** due to the aging of population (aging rate: 17% in 2015 –> 38% in 2050), **placing a financial burden** (social security spending of 110 trillion yen in 2012 –> 190 trillion yen in 2040, estimated by the Ministry of Health, Labour and Welfare) ✓ The number of persons certified as in need of long-term care is approx. over 5 million people today, and **one in 5 elderly persons will be at risk of dementia in 2025.** ✓ Establishment of preventive care**, regenerative medicine technology**, etc. ✓ Higher **risk of contracting new infectious diseases** (such as West Nile fever and brain fever) due to the globalized movement of people, etc.	**Acceleration of decline/aging of population with a low birth rate** * Data from the Ministry of Internal Affairs and Communications
Infrastructure/Maintenance The world share for construction machinery (2016): Komatsu in the 2nd place (12%), Hitachi Construction Machinery in the 3rd place (6%)	**■ City** ✓ Incorporation of intelligent systems into cities, smart city ✓ Enhancement of maintenance efficiency ✓ Overseas expansion of the infrastructure industry	**■ Future city** ✓ **Aging of infrastructure** (the total cost of maintenance, repair and renovation for the next 40 years will be 547 trillion yen; within the next 20 years, half or more of the currently existing facilities will pass the 50 year mark since their construction) (From the "Mid- and Long-Term Outlook for Maintenance, Repair and Renovation Costs for Infrastructure" published by the CAO) ✓ **It will be difficult to maintain and renovate infrastructure due to financial difficulties** experienced by the national and local governments. ✓ **At least half of the municipalities (896 municipalities) will be at risk of disappearance**, and it will be difficult to maintain social infrastructure. (Estimated by the Japan Policy Council)	**Aging of infrastructure**
Energy-saving, resource recycling Half of the top 10 patent applicants are Japanese companies **Materials** 80% of the world share for carbon fiber **Circulatory social system (air/water treatment)** The world market for environmental/energy catalysts in 2030: 1.4 times greater (approx. 5 trillion yen [estimated by Fuji Keizai Management]) **Disaster prevention technology**	**■ Energy** ✓ Energy storage, diversification of energy sources (hydrogen) **■ Environment and resources** ✓ Development of substitute materials for plastic ✓ Expansion of tide prevention infrastructure in big cities, and cost reduction of infrastructure development ✓ Exploration of alternative resources, and development of new materials	**■ Future energy** ✓ **Relative decline in the competitiveness of the manufacturing industry** due to extrication from oil dependence and use of decarbonized energy ✓ **Establishment of the world's highest-level energy-saving technology and resource recycling systems**, owing to the diffusion of smart grids, etc. **■ Future environment and resources** ✓ Growing public awareness toward **the development of a sustainable society** ✓ **Worsening of damage caused by natural disasters** ✓ **Submersion risk of some coastal cities** due to sea level rise caused by global warming	**Escalation of global warming, and increase of energy/environmental constraints, etc.**
Robot (machine tools) Industrial robots: nearly 60% of the world share **Power semiconductor (energy-saving equipment)** Share in the world market: 20% **Storage battery (automobile)** Panasonic's share in the world market: 20% **Optical/Quantum science** **Space business creation**	**■ Industries and work** ✓ Work sharing ✓ Space business development ✓ Recurrent education in such fields as the data/AI field **■ information, telecommunication and technology** ✓ Data security enhancement, and personal Information protection ✓ Resolution of digital divide in remote islands and depopulated areas **■ Space development** ✓ Supremacy with respect to space utilization ✓ Measures against space debris	**■ Future industries and work** ✓ Advancement of **AI/robotic control in plants** –> Increase in needs for employment of human resources for utilizing data and AI ✓ Global expansion of **diverse problem-solving type industries and services** which are regarded as Japan's strength ✓ **Weakening of the domestic R&D capability** will result in private companies relocating their development and manufacturing bases abroad (**the hollowing-out of industry**). ✓ **The modal revolution** led by the electrification of vehicles, automatic driving, etc. will be advanced, **and new business will be created through collaboration/fusion** with various service business types. ✓ Expansion of **markets for seniors**, such as watching-over service for the elderly living alone ✓ Mandatory retirement ages will be extended and **the number of elderly people working after retirement will increase**, while the **number of unemployed young people and that of freelancers** will also increase. **■ Future information, telecommunication and technology** ✓ Introduction of "**cognitive networks = smart city**," in which things, equipment, buildings and infrastructure are mutually connected with each other ✓ Diffusion of transactions with electronic money, etc., and the **streamlining and diversification of financial services** ✓ **Digital divide** between remote islands/depopulated areas and urban areas **will be an issue**. **■ Future space business** ✓ **Firm establishment of satellite business with satellites regarded** as an infrastructure for communications and monitoring ✓ Advancement of the concept of space photovoltaic power generation, etc.	**Dramatic progress in scientific technology by utilizing AI, etc.**

	2015	2030 (Est.)	2050 (Est.)
Population (No. of People)	125 mil.	116 mil.	97 mil.
Aging rate (> 65 yrs. old) (%)	20	32	39

Example of Overlooking Analysis in Environmental/Energy Research Fields

Trends in international society

- Greater-than-ever concerns about climate change and, more fundamentally, the sustainability of the earth
- Awareness that it is necessary to take on the fields by fully mobilizing regulations, systems, finance, scientific technology, etc., and efforts geared toward SDGs
- In relation to greenhouse gas emissions and long-term prediction scenarios for peak oil, technological advancement scenarios have a strong presence.
- Attention paid to the shift of some corporate investment to ESG investment
- The era ahead is a period in which global trends will be dependent on those who have technologies to resolve issues rather than those with resources.

Trends of scientific technology and R&D in the energy field

- "Electrification," "distribution" and "digitalization" are major R&D directions:
  - Electrification: Expanding the adoption of electricity generated from renewable energy sources (mainly solar power and wind power) (energy shift)
  - Distribution: Construction of energy systems to support a distributed society
  - Digitalization: Collection and advanced utilization of diverse data

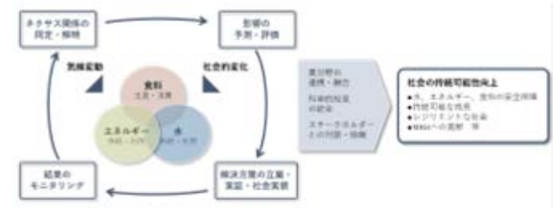
Trends of scientific technology and R&D in the environmental field

- "Integration," "high-precision" and "digitalization" are major R&D directions:
  - Integration: Integrated prediction and evaluation of the impact of human activities and global-scale phenomena
  - High-precision: Spatio-temporal refinement of predictions and evaluations (downscaling)
  - Digitalization: Collection of diverse data, for example, with field sensing technology or through monitoring by the general public; utilization of environment-related big data such as earth observation data; and the sharing of data on a global scale
- Efforts toward global-scale issues: "event attribution" research to study the impact of global warming; circulatory economy (e.g., plastic waste in the ocean); ecosystem and biodiversity (e.g., the IPBES)

Japan	• The energy self-sufficiency rate is 8% (as of FY 2016), which is extremely low compared with other developed countries. • Its GHG emission reduction targets are 26% below the FY 2013 level by FY 2030, and 80% by 2050. • "Plan for Global Warming Countermeasures " (2016), "Basic Hydrogen Strategy " (2017), "Fifth Strategic Energy Plan " (2018), "Fifth Basic Environment Plan " (2018), etc. • "Fifth Science and Technology Basic Plan " (2016), "Integrated Innovation Strategy " (2018), "National Energy and Environment Strategy for Technological Innovation " (2016), "Promotion Strategy for Environmental Research and Environmental Technology Development " (2015), etc.
US	• The shale gas revolution enables the country to be energy-independent. The volume of its CO2 emissions is the world's second largest next to that of China. • Its GHG emission reduction target is 26 to 28% below the 2005 level by 2025. Its policy in relation to ratification of the Paris Agreement has been reversed after the new administration took over. • The NSF, the Department of Energy , the Department of Agriculture , NASA, etc. implement R&D in their respective fields. In relation to the energy field, policy changes in accordance with its policies focusing on national security, domestic job development and economic growth under the current administration are particularly remarkable. • The Department of Energy continues to receive attention since it is reported to be actively making investment in R&D due to concerns about the abolition of its ARPA-E.
EU	• The EU's targets toward 2020 are so-called "Triple 20s" (20% reduction of its GHG emissions, the acquisition of a renewable energy market share of 20%, and 20% improvement in energy consumption efficiency). Toward 2030, its targets are "40-27-27." • The EU positions "circulatory economy" as one of its key economic growth strategies, and its action plan toward 2030, "Circular Economy Package" (2015), lists a significant reduction of plastic waste in the ocean with an aim at contributing to the accomplishment of SDGs.
China	• China aims at reducing its CO2 emissions per unit of GDP by 60 to 65% below the 2005 level by 2030. • China focuses on managing both the environment and economy. With an amendment to its environment protection law passed in 2014, the country shows its strong will to stop environmental pollution. • Although its R&D in the energy field is exhaustive, China particularly puts efforts into the development of resources and energy supply technology.
South Korea	• South Korea has made a downward adjustment to its target level of nuclear power dependency from "41% by 2030" to "29% by 2035." • Its policy is to develop solar power and wind power into its main energy sources. • South Korea aims at reducing its GHG emissions by 37% below the currently estimated level by 2030.

Directions to be focused on in years to come

- International trends: International socio-economic trends deeply associated with scientific technology and R&D in the fields concerned, which include trends relating to measures concerning climate change, SDGs and green finance; trends in the STI policies of the US and the EU in connection with the fields concerned (e.g., energy-related STI policy trends under the current US administration); and the like
- Domestic trends: The realization of Society 5.0, measures corresponding to the Paris Agreement, future energy society, the current situation of R&D communities, etc.
- Science and society: Current discussions concerning deeply socially-connected technologies, etc.
- R&D trends: R&D trends, international comparisons, etc. in the energy field and environmental field

Next-generation energy network, and science of demand	General consumers who produce electricity and are thus so-called "prosumers" are expected to appear in a society in which solar power generation, fuel cells, storage batteries, etc. have been introduced widely and in high volume for use in general households. The implementation of R&D is proposed in relation to how an energy network should be when such energy society arrives and the energy demand of people in such society. Published in March 2017.
Science of electron/ion control to technologically innovate reaction and separation	With an aim at breaking away from use of the conventional energy and materials that rely on fossil resources, the implementation of R&D is proposed in relation to reaction/separation technologies that can be utilized for innovative chemical processes required for energy use and the production of materials. Published in March 2018.
Digital twin	Proposals are made in relation to advanced simulation technologies involving the virtual reproduction of physical products in a cyber-environment to predict future events in the virtual world. Cases of complex phenomena involving friction, wear, fluids, oscillation, heat-transfer, etc. are introduced. Published in March 2018.
Reduction and control of new risks associated with water use	Studies are in progress to identify new risks associated with water use and caused by social changes such as population decrease and the aging of infrastructure and/or by environmental changes such as the frequent occurrence of disasters due to abnormal climate, and to explore R&D-related issues, etc. that need to be overcome in order to reduce and control such risks.
Future green	Studies have been conducted to look into issues, etc. concerning the prediction and evaluation of impact of social changes such as population decrease and environmental changes due to climate change on agricultural lands, woodlands and the surrounding environment, and concerning the development of countermeasure technology. In particular, such studies focus on semi-mountainous areas that account for 40% of the whole agricultural land in Japan. WSs have already been held.
Food-Energy-Water nexus	As a case of transdisciplinary research aiming at simultaneously resolving issues involving multiple fields, research trends with regard to nexus approaches, which attract rising attention on an international basis, are currently studied. 
Technology/System to directly capture low-concentration CO_2 in the atmosphere	Studies are in progress in relation to trends, social implementation scenarios and other relevant matters of technologies and systems to directly capture low-concentration CO_2 in the atmosphere (negative emission technology).

Important themes explored so far

"Phase interface science," "use of medium to low temperature heat," "reaction process," "energy carrier," "hydrogen energy system," "nitrogen circulation," "regional environment and ecosystem prediction model," "vision of future energy society"

Prepared by the Center for Research and Development Strategy (CRDS) of the Japan Science and Technology Agency (JST)