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The 9th Science and Technology Foresight
-Contribution of Science and Technology to Future Society-

Future Scenarios
Opened up by Science and Technology

(Summary)

March 2010

Science and Technology Foresight Center

National Institute of Science and Technology Policy

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Ministry of Education, Culture, Sports, Science and Technology

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Chapter 1: Design of the 9th S&T Foresight

The National Institute of Science and Technology Policy — an organization affiliated with MEXT (Ministry of Education, Culture, Sports, Science and Technology) — conducted a survey titled “The 9th Science and Technology Foresight” under grants-in-aid from the Special Coordination Funds for Promoting Science and Technology (FY2009). The objective of the survey was to clarify the policies to be taken in the fields of science, technology, and innovation in view of coping with future challenges. For this purpose, extensive discussions were held on an out-of-the-box basis while considering the direction to take for the future, whereby the focus is placed on the sciences and technologies that contribute to solving the global and national challenges. The mission-oriented approach (specifically aiming at solving the global and national challenges) and the interdisciplinary approach (out-of-the-box discussion crossing the boundaries of existing disciplines) characterize the methodology employed in this survey.

Considering the current global trends and situation in Japan, the survey narrowed down the course of actions, in terms of scientific and technological challenges, into the following four directions (grand challenges).

- ✧ Central player in the scientific and technological arena
- ✧ Sustainable growth through green innovation.
- ✧ Successful model for healthy- aging society.
- ✧ Secure life.

Subsequently, an interdisciplinary, out-of-the-box discussion was held from the viewpoint of constructing the framework for knowledge integration and paths to be taken, aiming at providing solutions to the grand challenges. In specific terms, the survey employed a combination of the following methods: Delphi survey based on interdisciplinary considerations with the targets in the future society clearly in mind; scenario writing using several methods in view of paths to be taken toward the desired future; region-based discussions for the realization of sustainable regional societies (Figure 1).

The results of the discussions are summarized in the following three reports:

[Delphi survey]

The 9th Delphi Survey（NISTEP REPORT No. 140）
http://www.nistep.go.jp/achiev/ftx/jpn/rep140j/idx140j.html

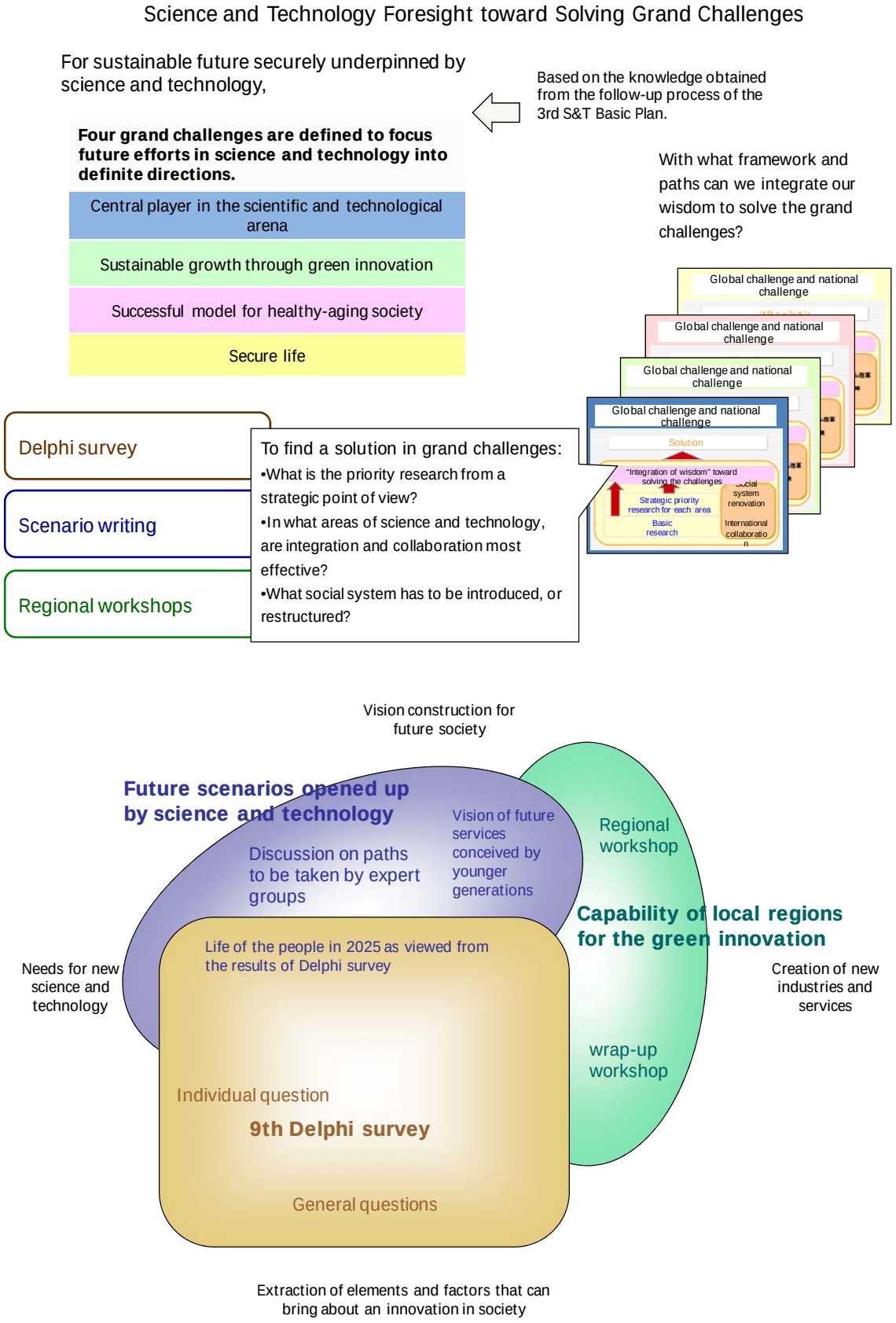
[Scenario writing]

Future Scenarios Opened up by Science and Technology (NISTEP REPORT No. 141)
http://www.nistep.go.jp/achiev/ftx/jpn/rep141j/idx141j.html

[Regional Green Innovation]

Capability of Local Regions for the Green Innovation (NISTEP REPORT No. 142)
http://www.nistep.go.jp/achiev/ftx/jpn/rep142j/idx142j.html

Figure 1: General overview of the survey



Chapter 2: Overview of Scenario Writing

The objective of this investigative research is to shed light on the future toward which the forthcoming science and technology are geared, and also to identify science and technology required in overcoming global and national challenges that lie ahead of us.

The research tried to ascertain the challenges that Japan's science and technology should take, wherein the paths for attaining the objectives and the framework in future society that will come into being as a result of social changes and integration of knowledge were investigated through the following three approaches: scenario writing by group work, future scenarios derived from results of Delphi survey, and discussion by younger generation on future society.

2-1. Scenario writing by group work

（1）Implementation overview

Groups consisting of experts held extensive interdisciplinary discussions about the state of society 15 to 30 years from now, in view of identifying science and technology that will be conducive to the realization of such future. Each scenario was supposed to be centered on drawing up paths to the future, whereby an extensive coverage and description of related elements was requested, including priority research and development, human resources development, social systems to be improved, and international deployment (Figure 2).

The experts, 54 in all, examined 12 scenarios (Table 1) and came up with illustrative ideas for the framework and paths to be implemented toward a solution of global and national challenges, whereby collaborative accomplishment through interdisciplinary effort involving a variety of fields in science and technology, and the improvement of social systems were counted for.

Figure 2: Structure of a scenario

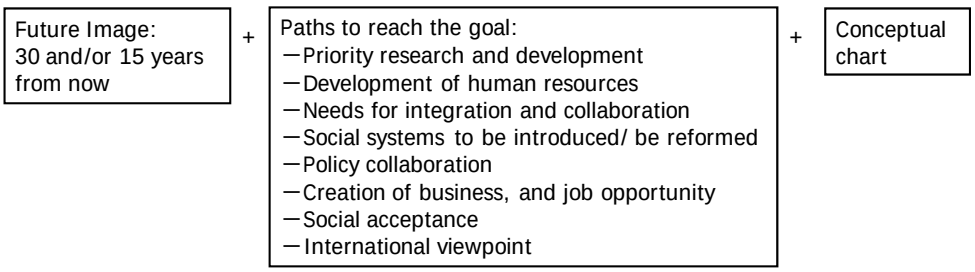


Table 1: Scenario themes

Grand challenges	Scenario theme
Sustainable growth through green innovation.	Realization of a low-carbon society through the active use of the Smart-grid
	Water supply system with global reach
	Green ICT business
	Integration of the agriculture, forestry, and fishery industries into a unified entity
	Measures against environmental changes
Successful model for healthy-aging society	Maintenance and promotion of health in an aging society with fewer children
	World's highest level medical environment underlying the healthy society with longevity
	Health information infrastructure for eliminating disparities
Secure life	Stable supply of food
	Safely securing fossil and mineral resources
	World's highest level life security: realization of a society oriented toward disaster reduction
	Reliable social infrastructure

* "Central player in the scientific and technological arena" is also mentioned as grand challenges. But it is set aside from the scenario writing themes, as it is an objective common to all areas of science and technology.

(2) Future scenarios

Scenario 1: Realization of low-carbon society through the active use of the Smart-grid

Leader: Dr. Hiroshi Asano, Central Research Institute of Electric Power Industry and Tokyo University

Key issues:

- Technical development and international diffusion of the smart grid
- Japan should lead the construction of the low-carbon energy supply/demand system, thereby contributing to the reduction of green house gas (GHG) emissions, promotion of new breeds of industry, job creation, and local activity.

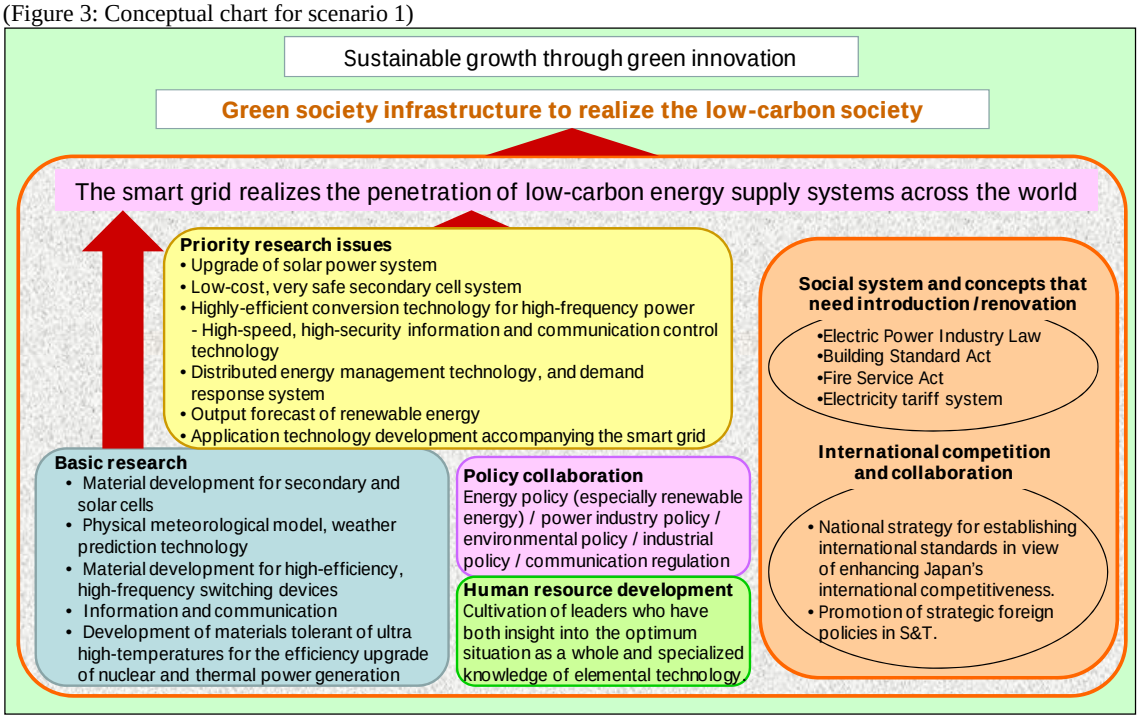
Future image in 2040:

- Due to integrated operation of the demand-side resources and supply-side large-scale power generation and transmission/distribution networks, energy/power supply system with high-efficiency, high-reliability, and high-quality will be realized.
- Expanded market size of power demand-supply chains in developing countries: from the trunk system to the demand system.

Path to realization:

- Development of elemental/communication/control technologies required to streamline the path to full-fledged application of solar and wind power generation.
  - Solar generation system, secondary battery cells, highly-efficient, high-frequency power conversion technology, high-speed and high-capacity information and communication and control technology, distributed energy management system, etc.
- Breakthrough in basic research
  - Secondary battery cell materials, new materials for highly-efficient next generation solar cells, weather forecast technology to facilitate output prediction of renewable energy sources, highly-efficient switching devices, security technology for information and telecommunications.
- Integrated research that includes institutional design, aiming at the provision of a total life solution.
- The securing of human resources that lead to system integration.
- Review of regulations to comply with the changes in the socio-economic environment and advancement and diffusion of technologies: the Electric Power Industry Law, regulations on connecting distributed power systems, the Building Standard Act, the Fire Service Act, and the consumer protection law.
- International collaboration to formulate international standards, and conclusion of strategic alliance.

(Figure 3: Conceptual chart for scenario 1)



Scenario 2: Water supply system with global reach

Leader: Prof. Kaoru Takara, Kyoto University

Key issues:

- Global deployment of water supply system technologies compatible with regional conditions (e.g. weather, climate, and social conditions), contributing to the construction of a society with access to a safe and secure water supply.

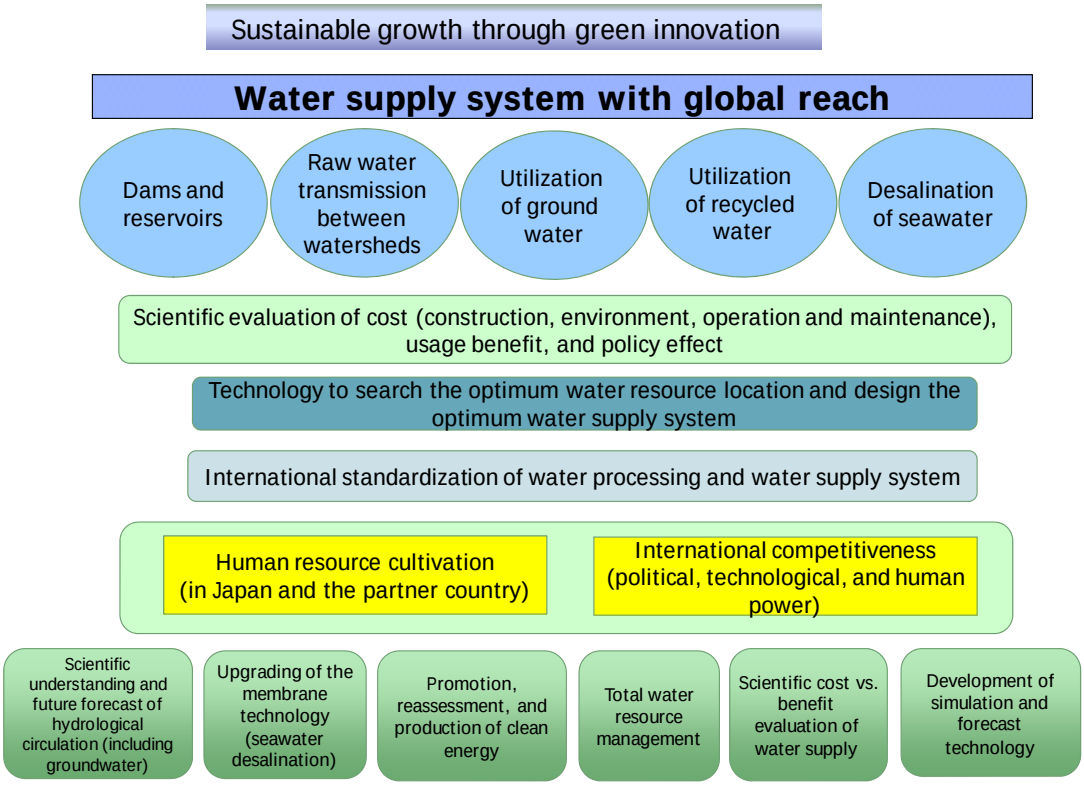
Future image in 2040:

- Low-cost, low environmental load water is supplied, but the scarcity of water continues. The securing of new water resources in inland areas has become an issue, due to reduced sizes of lakes, contamination, and the depletion of surface water and fossil water.
- Japan's water supply system and weather-water forecast system gain global acceptance, and receive large business opportunities from many countries.

Path to realization:

- Realizing a global deployment of water supply systems that are oriented towards a low-carbon society and provide Japan with a wider business opportunity.
  - Scientific understanding of water and groundwater circulation systems in global, continental, and watershed scales as a prerequisite to shed light on the optimum water supply system.
  - Further upgrading of engineering technologies for desalinating seawater.
  - Utilization of solar, wind, and geothermal energies.
  - Total water resource management within a watershed, and in an aggregate of watersheds.
  - Evaluation of costs and benefits of obtaining water.
  - Sophistication of simulation/forecast technology conducive to the development of an enhanced water supply system.
- Collaborations among hydrology, meteorology, civil engineering, energy science, public economics, international law, and policy studies.
- Cultivation of human resources capable of global thinking with a sense of ethics and mission: specialists with general understanding, and generalists with the viewpoint of a specialist.

(Figure 4: Conceptual chart for scenario 2)



Scenario 3: Green ICT business

Leader: Dr. Shinji Nakadai, NEC Corporation

Key issues:

- Realization of the infrastructure that distributes thermal energy evolved in ICT to household demand using the water supply network.

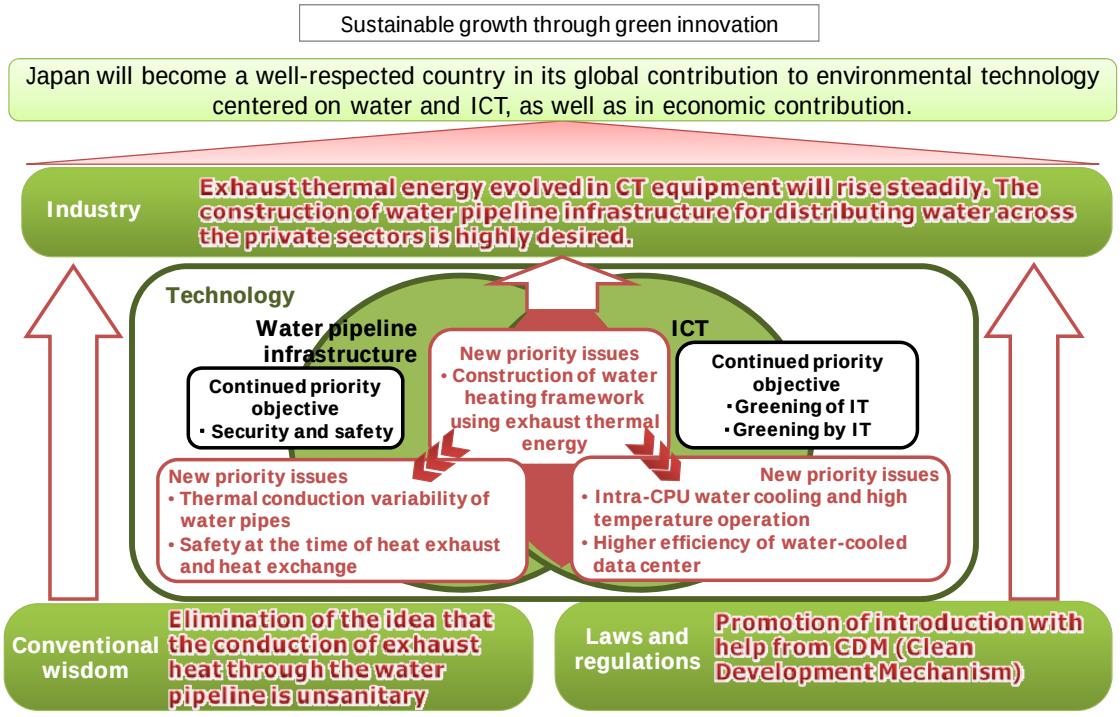
Future image in 2040:

- A water supply system that uses exhaust heat is in operation
- A water treatment facility and a data center are located adjacent to each other, enabling the cooling down of server-cooling water using the low temperature water of the water treatment facility.
- Overseas presence is gained by taking advantage of the operational know-how developed in Japan on water heating (utilization of exhaust heat)

Path to realization

- The thermal energy evolved in ICT can be viewed as a supplementary heat source useable in the private sector. The energy consumption in the ICT domain is recaptured in conjunction with the water infrastructure, leading to a symbiotic utilization of ICT and water networks.
- Priority objectives
  - Optimum arrangement of geothermal sources and IT exhaust heat sources in a water supply network
  - Provision of variable thermal conductivity to water channels
  - Stable heat exchange requires a complete exclusion of foreign objects from the water channels.
  - Development of water-cooling technology inside a CPU chip.
  - Efficiency upgrade in the water-cooling system of the data center.
  - Search for untapped exhaust heat sources other than the data center.
- Collaborations among hitherto unrelated areas for the construction of a general framework, under which a set of individual research projects is organized.
- Institutional reform: relaxation of responsibility boundaries in water business, and promotion of introduction through the green development mechanism.
- Harmonization among government policies
- Understanding of water quality needed by citizens, and awareness on the side of the water business as a “cool energy provider”

(Figure 5: Conceptual chart for scenario 3)



Scenario 4: Integration of the agriculture, forestry, and fishery industries into a unified entity

Leader: Prof. Kei-ichiro Maeda, Nagoya University

Key issues:

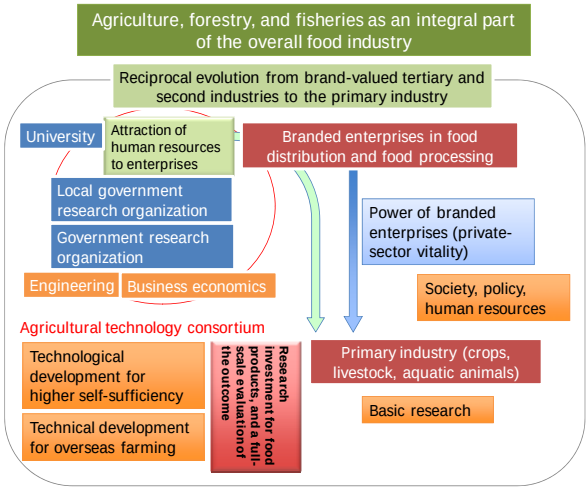
- Agriculture, forestry, and fishery industries as integral elements of total industry.
- Reciprocal evolution from brand-valued third and second industries to the primary industry

Future image in 2040:

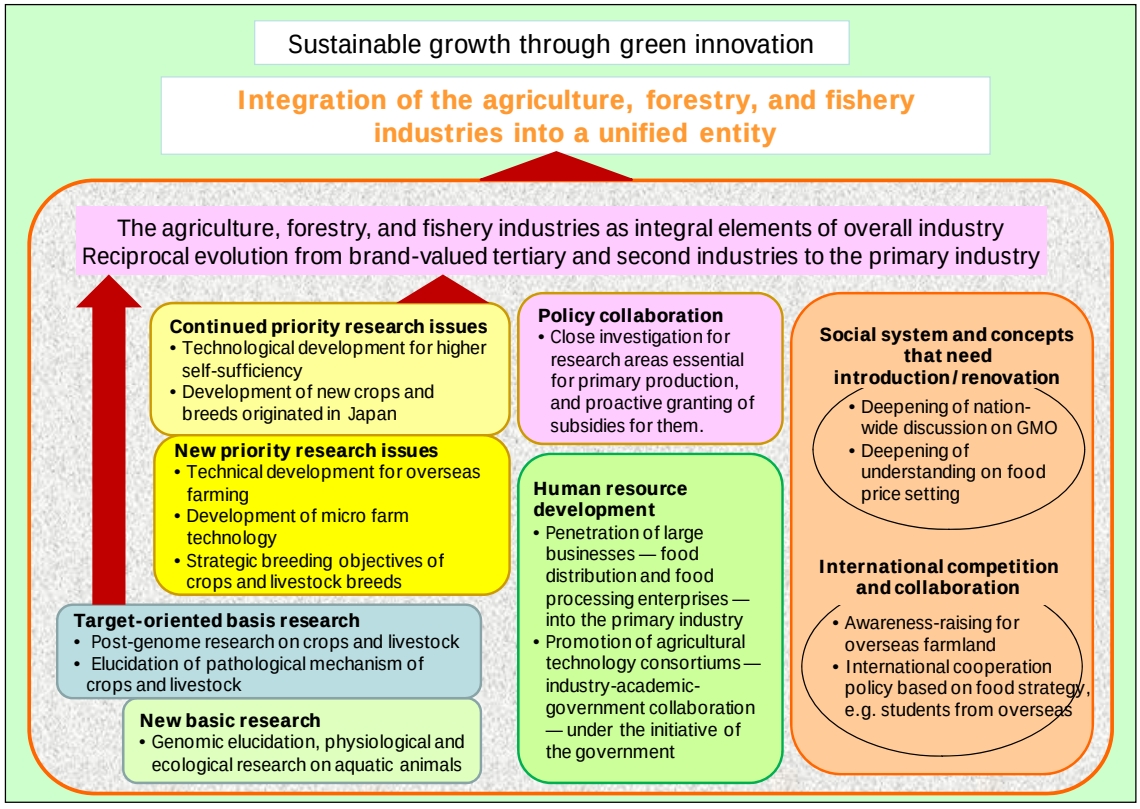
- "6th industrialization": backward evolution from the third industry to the second, and then to the primary industry. The primary industry as a total entity embracing the secondary and third industries. Production of brand-valued crops
- Collaborative technical development by private sector enterprises (second and third industries) and the government, aiming at global deployment (fostering of multinational enterprises that engage in primary industry). Agricultural production overseas under the control of Japanese companies (i.e. farmland ownership outside Japan).

Path to realization:

- Establishment of a technology consortium centered on private sector enterprises, and involving the government and universities.
- Close investigation for research areas essential for primary production, and proactive granting of subsidies for them.



(Figure 6: Conceptual chart for scenario 4)



Scenario 5: Measures against environmental changes

Leader: Prof. Satoshi Takizawa, Tokyo University

Key issues:

- Enhanced adaptability to environmental changes — caused by climate change and socio-economical activities — that supports social innovation for safe and secure life.

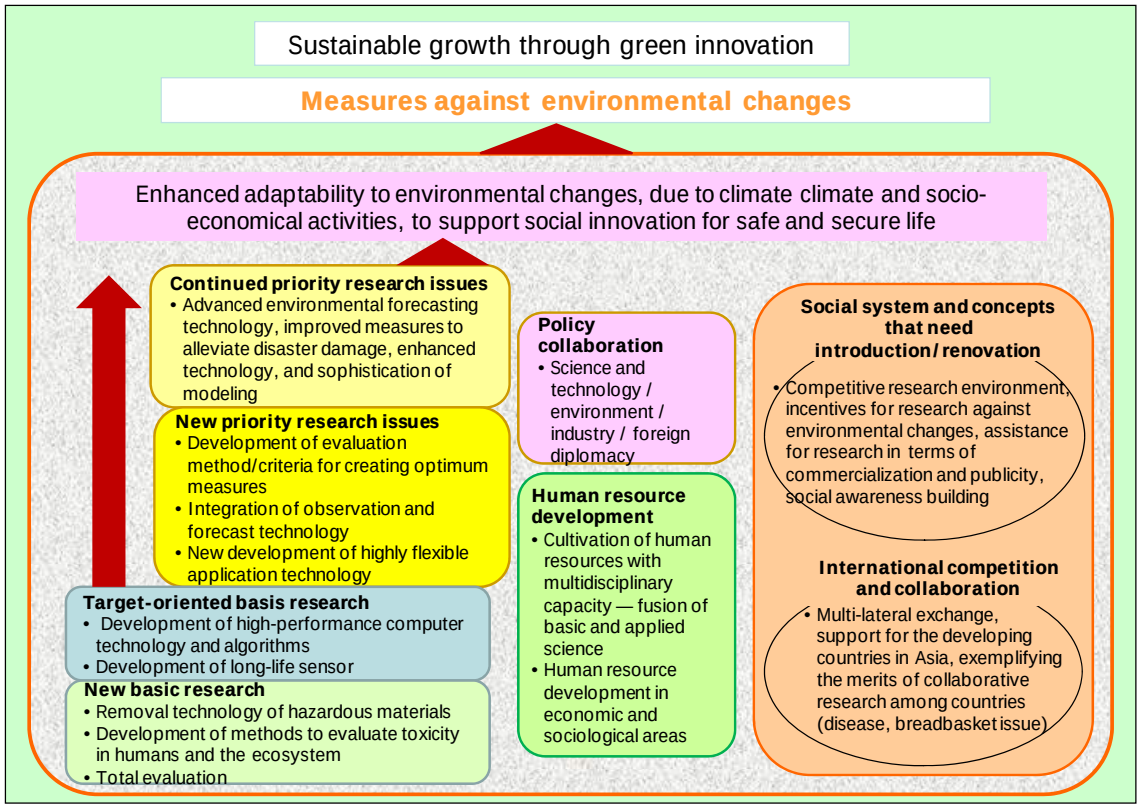
Future image in 2040:

- Significant contribution to solving the urban environmental problems that evolve in line with explosive urbanization in developing countries. Development of life-oriented technologies based on natural energy. Transfer of these technologies to Africa, where rampant regional conflicts are triggered by burgeoning environmental refugees, and thereby contributing to solving regional issues.
- In Japan, a drastic review of urban structure to alleviate the heat-island effect. Reduction of CO_2 emissions through the introduction of electric vehicles and other methods into the public transport system. Production of unconventional crops in high-latitude and high-altitude regions.
- Development of advanced disaster forecasting system, which will function as the core of the system operation to distribute real-time disaster forecast information to the countries of the Asia-Pacific regions.

Path to realization:

- Construction of advanced environmental forecast technologies that relate to all aspects of human life — water resources, eco-system, agriculture, forestry and fishing industry, coastal protection, disaster prevention, and health — and thereby provide a way to prevent environmental degradation in the future.
- International cooperation from a global perspective is an integral part of science and technology for effectively addressing the changing environment. Bilateral and multilateral exchange and mutual support of technology enable coordinated research in several countries, and result in effective sharing of the technology.
- Cross-cutting efforts involving economics and sociology from the viewpoints of synthesis, integration, and combination.

(Figure 7: Conceptual chart for scenario 5)



Scenario 6: Maintenance and promotion of health in an aging society with fewer children

Leader: Dr. Norihiro Kato, Research Institute National Center for Global Health and Medicine

Key issues:

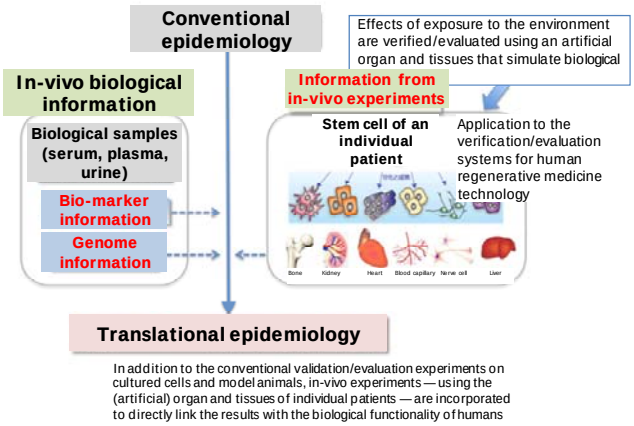
- "Tailor-made" management of mental and physical health with special emphasis on preventive medicine, based on the life-long clinical record.

Future image in 2040:

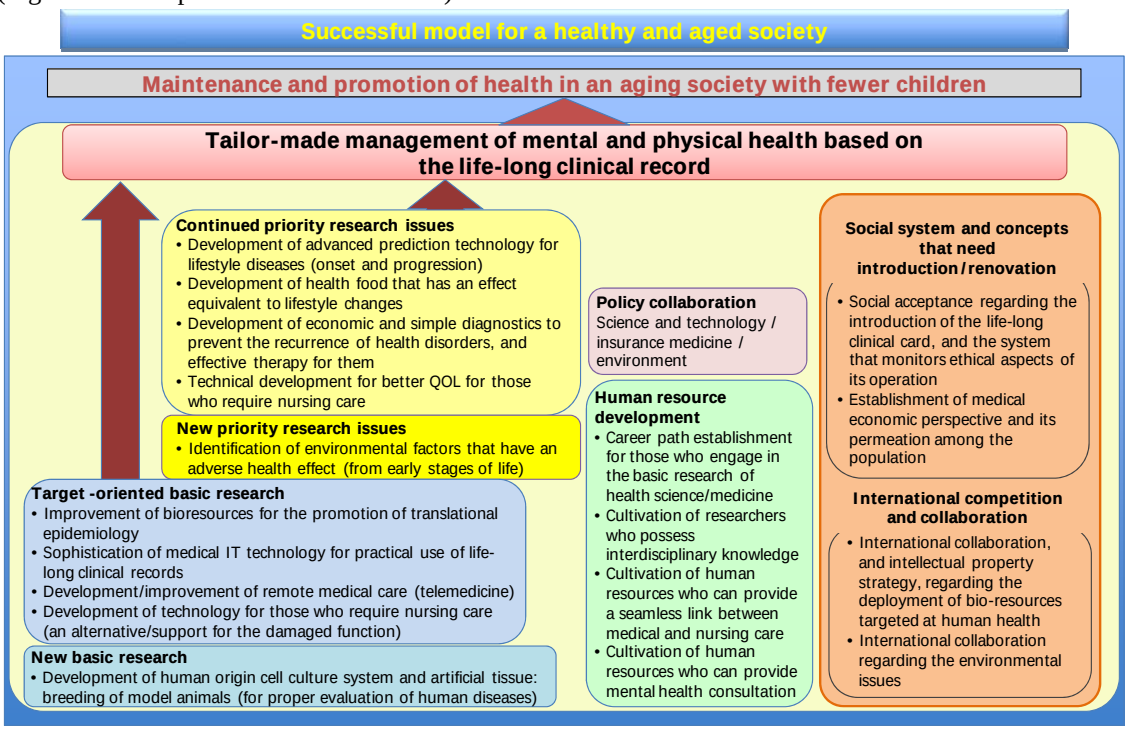
- Proactive promotion of dietary education to prevent the three major diseases, enabling meticulous dietary life management based on the genetic make-up of each individual.
- Tailor-made health management, prognosis, and preventive medicine based on life-long electronic clinical records, which also include information on the interaction between the environment and genetic make-up of the individual.

Path to realization

- Development and promotion of translational epidemiology.
- Development of health food, prevention of disease aggravation, and identification of environmental factors affecting the occurrence of a disease.
- Enhanced collaboration between medical and nursing care, and better QOL of those who require nursing care (e.g. provision of alternative physical functions), as well as mental health and enhanced awareness of achieving health through self-reliance efforts.
- Collaboration among such disciplines as physics, chemistry, architectonics, urban engineering, humanities, and behavior science.
- Deliberation from a medical-economics viewpoint and formulation of ethical guidelines, in order to put the life-long clinical record into practice



(Figure 8: Conceptual chart for scenario 6)



Scenario 7: World's highest level medical environment underlying a healthy society with longevity

Leader: Prof. Koichi Kawabuchi, Tokyo Medical and Dental University

Key issues:

- Secure healthcare setting embedded in ordinary life, and an international competition arena for breakthrough medicine and medical devices. Cross-fertilization of these two.

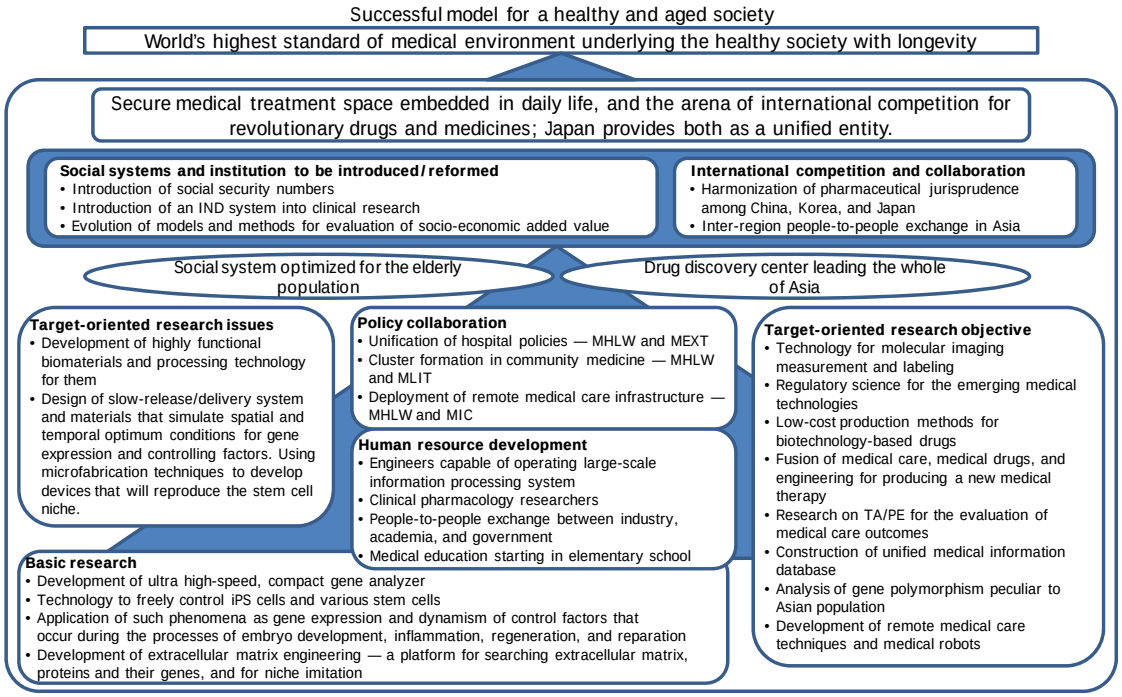
Future image in 2040:

- A health care resource giant that allows citizens to enjoy the world's top-level medical services, and to manage life-long health resources using a single card.
- The largest center of medical product researchers in Asia, and the largest exporter of advanced medical care products in Asia.
- The country where citizens can receive tailored medical care based on their lifestyle and philosophy, with minimum economic burden.

Path to realization

- Priority research and development
  - Technology development conducive to early exploratory clinical trials on humans
  - Computerized treatment information and construction of a variety of databases
  - Medical devices based on the principle of in-vivo regenerative medicine, eliminating the need for cell introduction from outside.
  - Development of an ultra high-speed gene analyzer that provides personal gene information for tailored medicine.
  - Evolution of extra-cellular matrix engineering.
  - Regenerative medicine research for the regeneration of organ functions utilizing human stem cells (e.g. iPs), etc.
- Collaboration with information and communication technology and urban renovation planning. Advanced management linking research development with clinical applications.
- Review and renovation of medical and pharmaceutical regulations: introduction of IND that allows explorative human clinical trials at an early stage, and review of health insurance plans.
- Establishment of a "special medical zone" and other measures to boost the industrialization of medicine for the creation of new business and job opportunities.
- Creation of a social system coping with the rapidly aging population. Japan, Korea, and China should play a central role in this system, which will be capable of global deployment.

(Figure 9: Conceptual chart for scenario 7)



Scenario 8: Health information infrastructure for eliminating disparities

Leader: Prof. Hiroshi Oyama, Tokyo University

Key issues:

- Expansion of domestic demand and the realization of a healthy nation through the improvement of health information infrastructure.

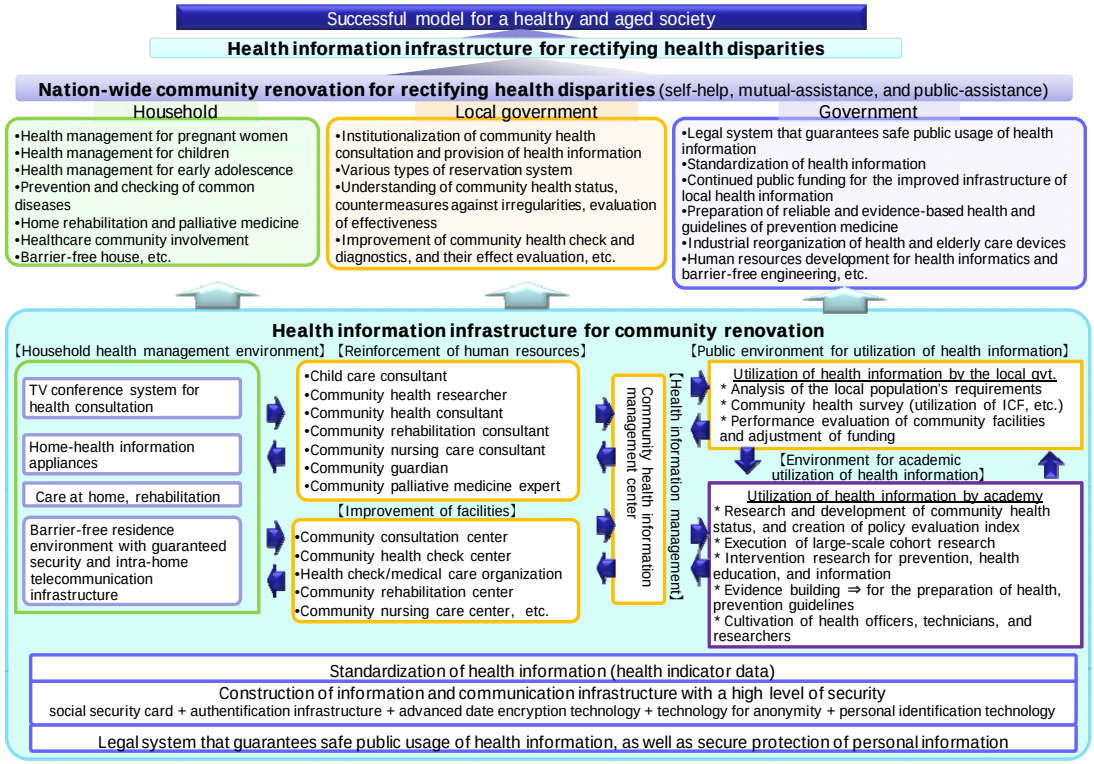
Future image in 2040:

- A complete set of constituent elements for the mutual life assistance social model is in place, including the local nursing care point system and citizen guardian system.
- Local government health facilities for strengthening electronic health checkup, disease surveillance and monitoring real-time emergency health hazards are in operation. The protected health information accumulated at the center is used for disease prevention, health care, health policy and health assurance purposes.
- The electronic clinical guidelines for national health and preventive medicine come into effect, and they function as the infrastructure to eliminate disparities in health management.
- The timing and content of the next health check up and immunization are personalized owing to the development of a person-to-person adaptive health prediction algorithm based on clinical guidelines.
- A personal health information management unit and/or intelligent health monitoring bed are in place in household as needed (leased from the local government).

Path to realization:

- Increase of public investment in healthcare IT: the scale expansion has the effect of inducing human resources into this field.
- Institutional renovation in the public sector systems including: the introduction of a guarantee promotion system of health information; a review of the medical equipment screening system; a review of the community healthcare system.
- Implementation of the following measures to eliminate disparities in national health care: 1) an accurate collection and analysis of anonymous personal health information, 2) improved environment for the full use of reliable health information, 3) deployment of self-help, mutual-assistance, and a public-assistance system in each region.

(Figure 10: Conceptual chart of scenario 8)



Scenario 9: Stable supply of food

Leader: Prof. Akira Yamauchi, Nagoya University

Key issues:

- Stable supply of food to the Japanese population.
- Development of innovative technology to boost food production in farmland in Japan and abroad.

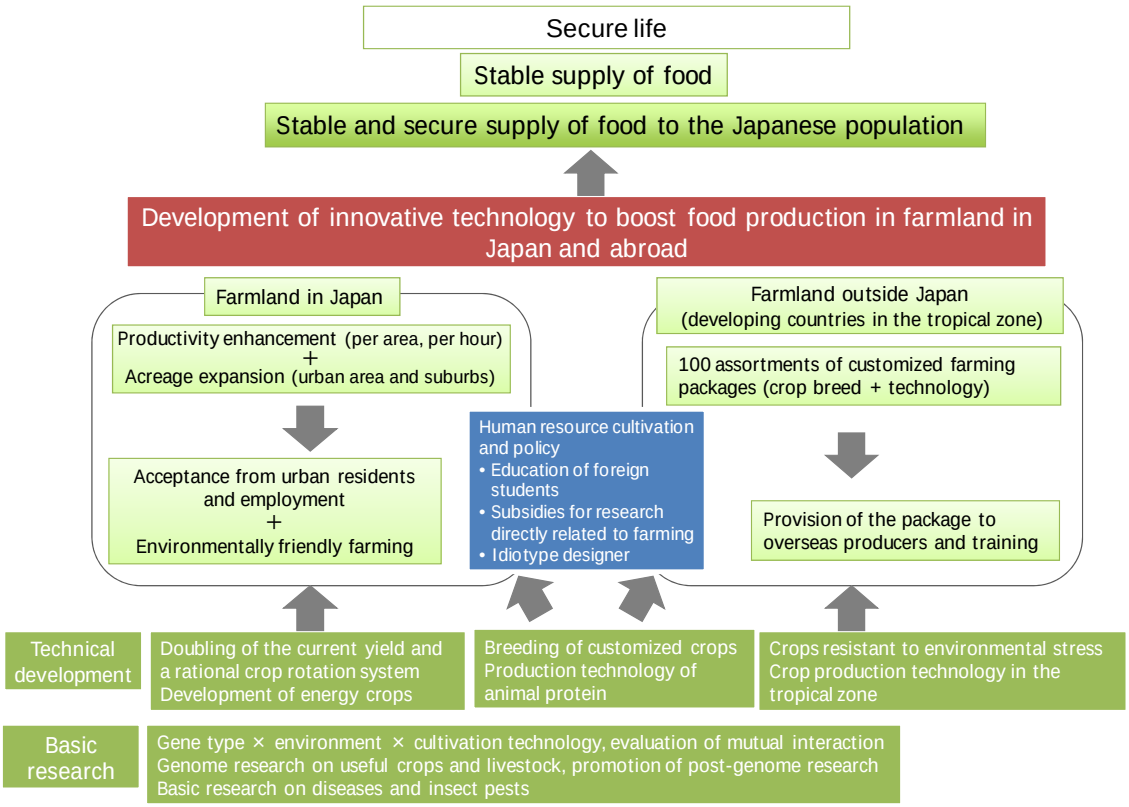
Future image in 2040:

- Establishment of the system that guarantees a stable supply of food: enhanced yield and increase of cultivated acreage at home, the securing of farmland overseas, and the implementation of Japanese technology to boost productivity.
  - Enhancement of unit yield and technology level
  - Conversion of idle land into farmland: vast area of land becomes redundant as a result of the changes in industrial structure and due to decreasing population.
  - Agricultural production overseas under the guidance of Japanese technology.

Path to realization:

- Technical development
  - Creation of new crops customized with consideration given to biological, environmental, and social factors.
  - Improved production technology of crops and livestock
  - Establishment of crop production and control technology specifically applied in overseas farmland.
- Human resource cultivation
  - Ability to propose the optimum combination of breed and cultivation techniques, whereby the genetic heredity of crops/animals and their interaction with environmental factors must be considered, as well as socio-economical factors.
  - Ability to tackle farming on site, and carry out research for boosting agricultural production abroad.

(Figure 11: Conceptual diagram for scenario 9)



Scenario 10 <Safely securing fossil and mineral resources>

Leader: Dr. Kazunori Taniguchi, Idemitsu Kosan Co., Ltd.

Key issues:

- Development of world leading technologies, and fostering of industry for actual application of them, in such areas as the securing of resources in quantity, replenishment by recycling, higher usage efficiency, and reduction of environmental load.

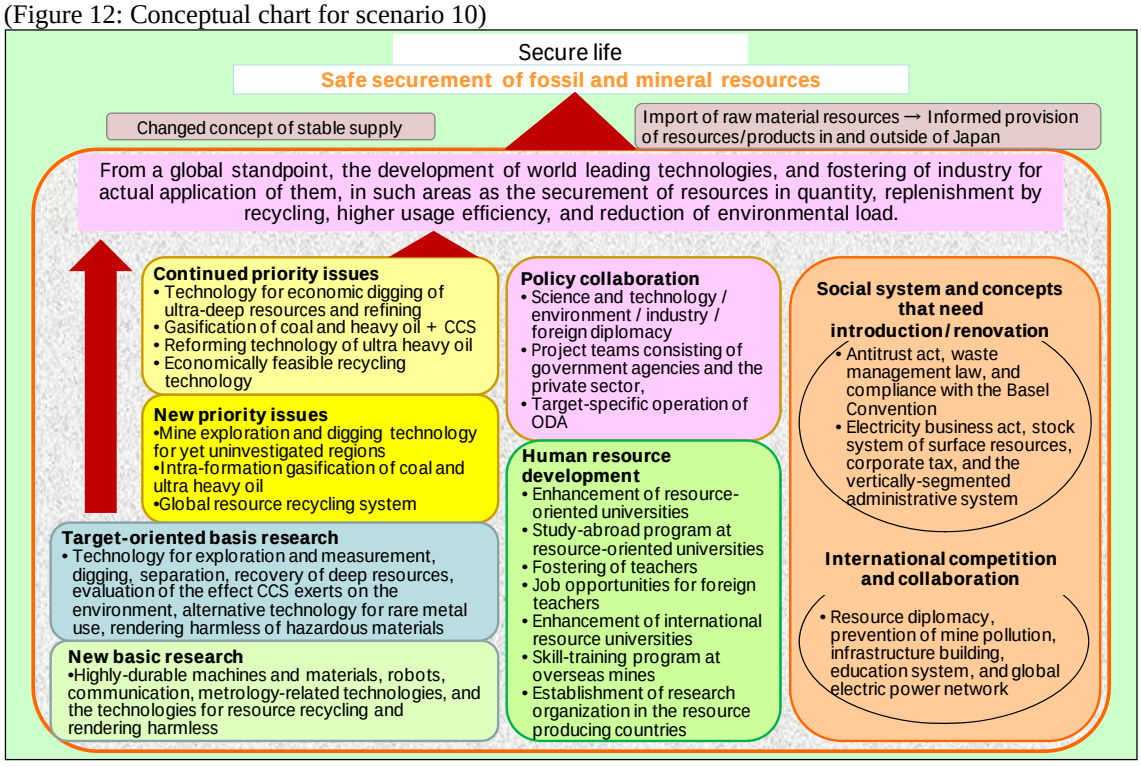
Future image in 2040:

- The minimum required resources are available. But the trend toward higher pricing continues, and the risks in terms of geopolitical situations and the inflow of speculative funds persist.
- Fund procurement consortiums consisting of enterprises with global competitiveness have huge power.
- Construction of interdependent, multi-strata relationships with resource producing countries, e.g. establishing full-scale production facilities on site — from raw materials to the final product — in cooperation with resource-producing countries.

Path to realization:

- The essential theme is to maintain the balance of supply and demand in view of the rapid economic growth in developing countries, and to address properly the increasing restrictions on the environment. Japan should lead the world through the development of science and technology that provide solutions in terms of commercialization, engineering, and industrial production.
- Technology development for untapped, unconventional resources, such as ultra-deep and seabed resources, cyclic use of metal resources, and upgrading the utilization efficiency of fossil resources.
- Suppression of CO_2 emissions in production and utilization processes. Elimination of hazardous materials or rendering them harmless.
- Resource exploitation in uninvestigated regions, and method of development for obtaining resources using techniques other than digging. Unconventional approaches that change our mind-set will become important, e.g. a resource recycling system crossing national borders.
- The need for the integrated production approach, from upstream to downstream, located in resource-producing countries. Therefore, the cultivation of human resources capable of overseas assignment is urgently needed.
- National policy based overseas investment in the areas relating to mines and refining, and ODA funding for resource development purposes.

(Figure 12: Conceptual chart for scenario 10)



Scenario 11: World's highest level life security: realization of a society oriented toward disaster reduction

Leader: Prof. Hirokazu Tatano. Kyoto University

Key issues:

- Promotion of visualization of urban security, and introduction of community safety diagnostics and concrete measures.

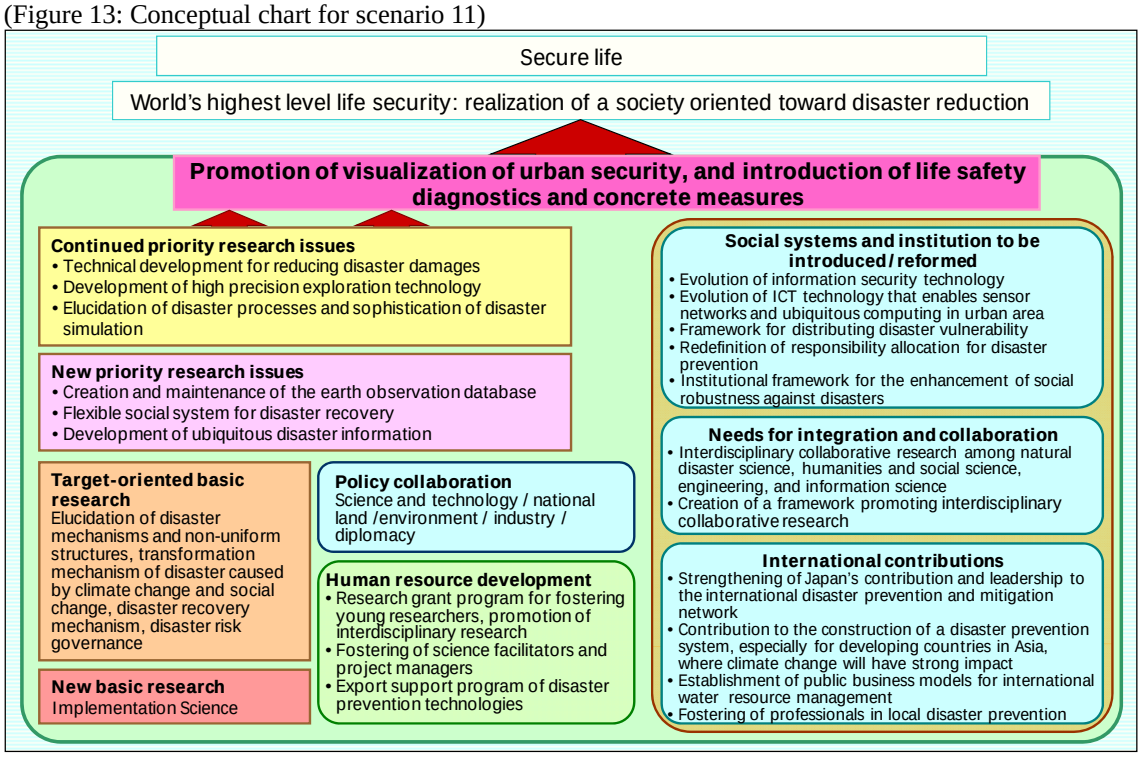
Future image in 2040:

- Sensor networks are ubiquitously deployed across the urban environment. The sensor nodes directly provide citizens with useful information regarding ordinary infrastructure management and human actions to be taken when a disaster takes place.
- Although the frequency of extreme climatic phenomena increases, citizens act appropriately under the guidance of advanced forecast technology.
- Implementation of a real-time disaster-stricken information and communication system enables quick first response at the time of disaster.

Path to realization:

- Technological development for reducing damage:
  - Sophistication of simulation technology (large structure, disaster phenomena, precipitation)
  - Development of high-precision probing technology (situation inside a structure, crustal architecture, ground)
  - Flood control within a river basin and provision of information, regulations and guidance on land utilization.
- Technology research and development useful to enhance the recovery of the social system (i.e. a flexible social system considering disaster recovery)
- Disaster prevention information and communication through the ubiquitously deployed information network (ubiquitous disaster prevention information system).
- Creation and maintenance of earth observation database (unified control and interoperability of various observation data in such areas as earth crust, geology, soil, terrestrial objects, and hydrology)
- Object specific (solution oriented) basic research, in which a discovery contributes to the realization of disaster reduction society.

(Figure 13: Conceptual chart for scenario 11)



Scenario 12: Reliable social infrastructure

Leader: Prof. Yasuyuki Iida, Komazawa University

Key issues:

- Construction of a safe and secure society through an organic collaboration of law enforcement, community, and media.

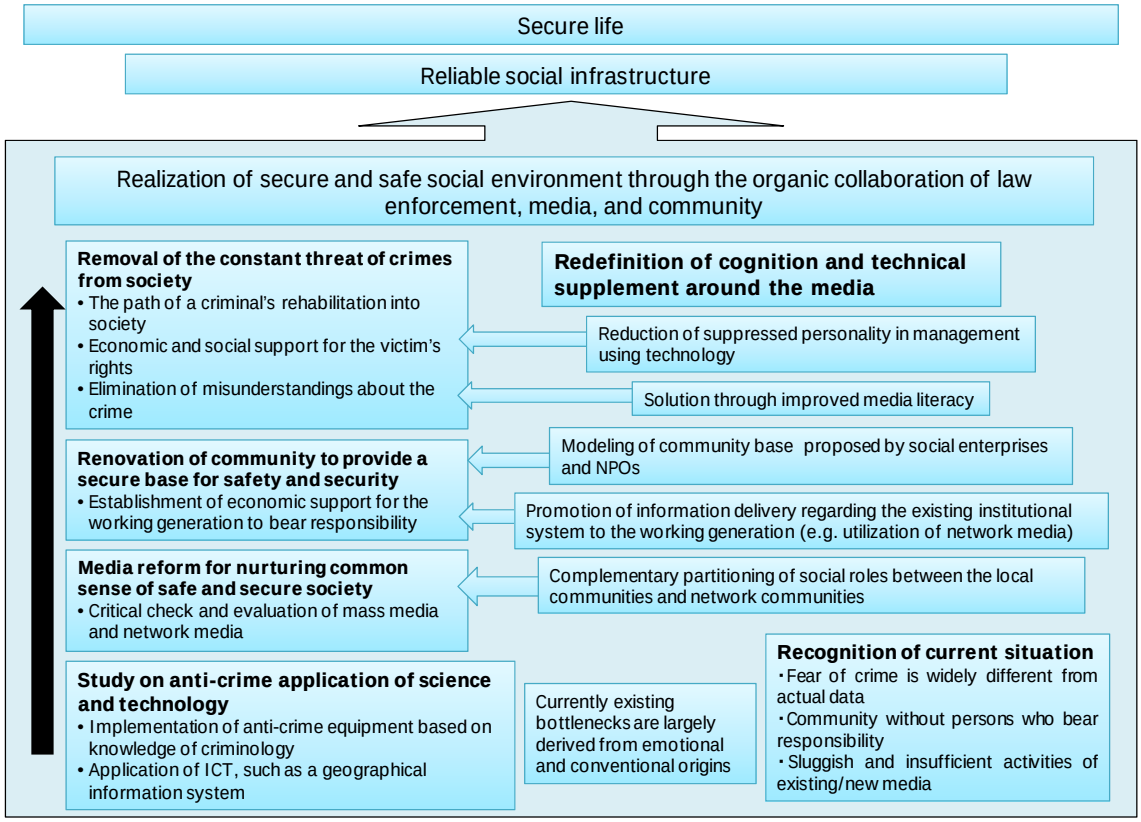
Future image in 2040:

- The three elements (law enforcement, community, and media) play complementary roles, and the citizens have a real feeling of safety and security.

Path to realization:

- Removal of the constant threat of crime from society.
- Renovation of community to provide the base underpinning safety and security.
- Media reform for nurturing common sense regarding crime.
- Study anti-crime application of science and technology

(Figure 14: Conceptual chart for scenario 12)



2-2. Future scenario based on the results of the Delphi survey

Based on the results of the Delphi survey (see NISTEP REPORT No.140), contributions from science and technology to the society as of 2025 were coordinated, from the viewpoint of citizens' daily life, into the three images of society described below. Attempts were made to draw up the images as objectively and as neutrally as possible based on the forecasted maturity of technologies and their diffusion: citizens are likely to enjoy healthy daily life and take environmentally-friendly infrastructures for granted.

* For descriptions of all the scenarios, see Appendix.
* The applicable Delphi topic is shown in each illustration. The number in front of the topic statement indicates ID (Panel-topic number), and the trailing number in parentheses indicates the forecasted year of social realization.

A society in which various diagnostic technologies and systems are incorporated in daily life and health maintenance by individuals has started to prevail
A society where individuals can use various types of energy selectively based on their comprehensive evaluation of value and can feel that they proactively contribute to global warming prevention and environmental preservation
A society in the early stage of coping with the various disasters caused by environmental changes

(1) A society in which various diagnostic technologies and systems are incorporated in daily life and health maintenance by individuals has started to prevail

Primary subject:

- Availability of gene information and medical monitor greatly enhances the level of health promotion and preventive medicine. Excellent public health education enables all citizens to self-manage the way of life for maintenance of health. Even upon falling ill, they are still able to avoid going into decline and hence, albeit with certain compromises, lead a healthy life.
- Expectations are high for the potentials of novel therapies, as the availability of a group of new medical methods, e.g. regenerative medicine, is coming into sight (in terms of technical feasibility).

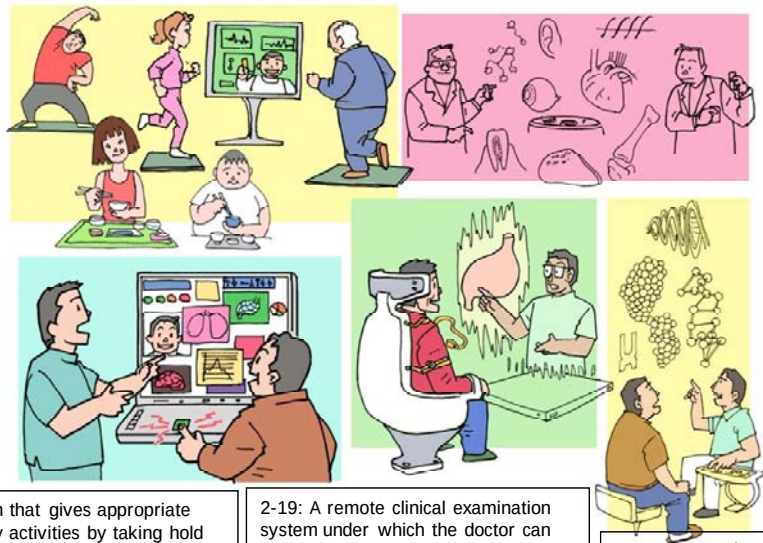
Subordinate subject:

- Pressing problems, such as regional differences in medical care and emergency medical services, have already reached a partial solution.
- An appropriate assessment system for medical practices, including the standardization of medical care and the overhaul of the medical fee scheme, has been established, contributing to the equalization of medical care, and the alleviation of medical manpower shortage and overwork.
- Public trust in doctors and medical facilities has been enhanced owing to the improvements in medical education

Figure 15: Scenes in daily life (a society in which various diagnostic technologies and systems are incorporated in daily life and health maintenance by individuals has started to prevail)

1-16: Ubiquitous computing technology supporting health control to maintain and to improve one's health in daily life using computer software (2018)

3-33: Artificial organs which include human cells or tissues derived from iPS cells (2033)
3-34: Technology for regenerative medicine using iPS cells (2032)
3-35: Therapeutic technology using functional cells induced from stem cells, including iPS cells, without risks of carcinogenesis (2030)
4-10: Technology for the regeneration of muscles and organs using stem cells (2031)



2-05: A system that gives appropriate advice for daily activities by taking hold of information on the lifestyle, health conditions and working situation of each individual, in a continuous and comprehensive manner (2022)

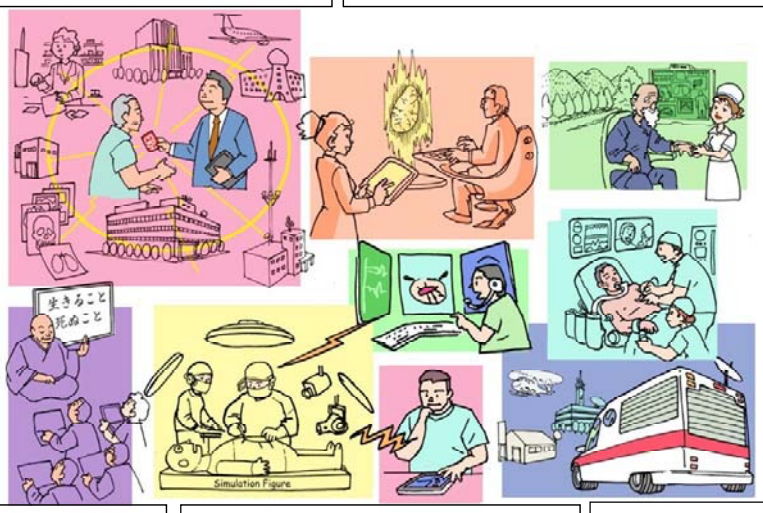
2-19: A remote clinical examination system under which the doctor can use a stethoscope and palpate the patient or smell the patient's breath from a distance, as if they were face to face (2029)

4-51: Diagnostic methods for the risks of acquiring diseases through genome data (2023)

4-80: Integrative medicine in which a lifelong regional electronic health record is introduced and community-based care is possible (2023)

11-17: In Japan, the medical records containing motion video will be converted into electronic form and entrusted to patients, and the medical information, including the results of examination, will be shared among all medical institutions. Based on this environment, a health care agent business will be formed between patients and medical institutions (2024)

12-20: Diffusion of logistics services that deliver medicine and food for medical treatment, without requiring a hospital visit, to support the lives of elderly persons and patients of lifestyle diseases living in inconveniently located areas, such as mountainous regions, by establishing a remote consultation system and health care system using IT technologies (2020)



4-83: Medical ethics education for healthcare professionals (2017)

4-84: Medical safety education for healthcare professionals in which simulation technology is introduced (2018)

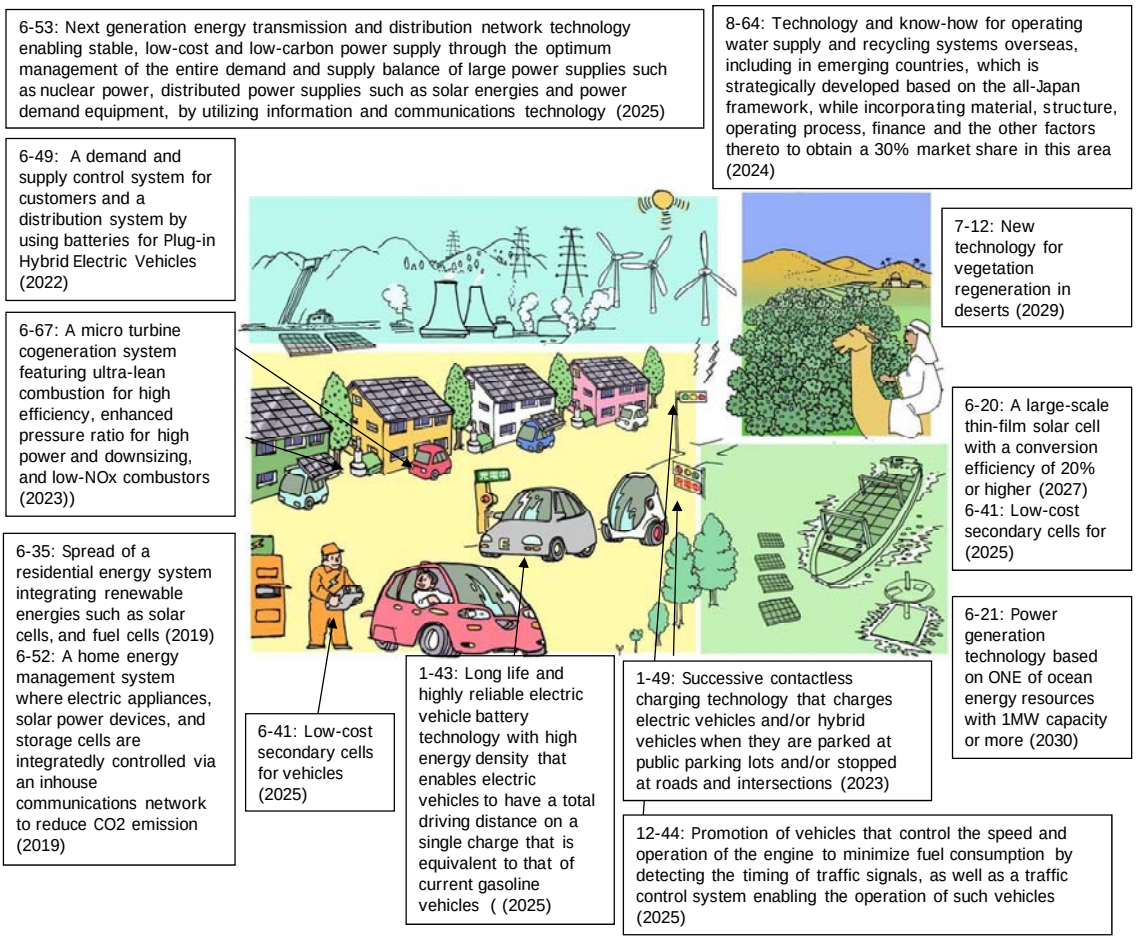
4-66: Regional medical care system that can take prompt actions and correct regional disparities in regard to emergency medical service (2021)

(2) A society where individuals can use various types of energy selectively based on their comprehensive evaluation of value and can feel that they proactively contribute to global warming prevention and environmental preservation

Primary subject:

- A greater number of houses are capable of utilizing non-fossil energy.
- Untapped energy sources, such as garbage and rainwater, are going to be efficiently utilized by each household and local community.
- Electric vehicles have come into wide use with the help of improved performance and infrastructure.
- The collective management of essential utilities (i.e. electricity, gas, and water) allows citizens to make selective use of the energy sources according to personal preference, or based on the overall ecological considerations. In terms of electricity, for example, users are free to choose non-fossil power that is remotely generated using natural energies. The benefit points, obtained from the activities with environmental consideration, can be used for further ecological society by donating them for the forest conservation or by using them as discount tickets for electric vehicle rental, etc.

Figure 16: Scenes in daily life (a society where individuals proactively contribute to global warming prevention and environmental preservation)

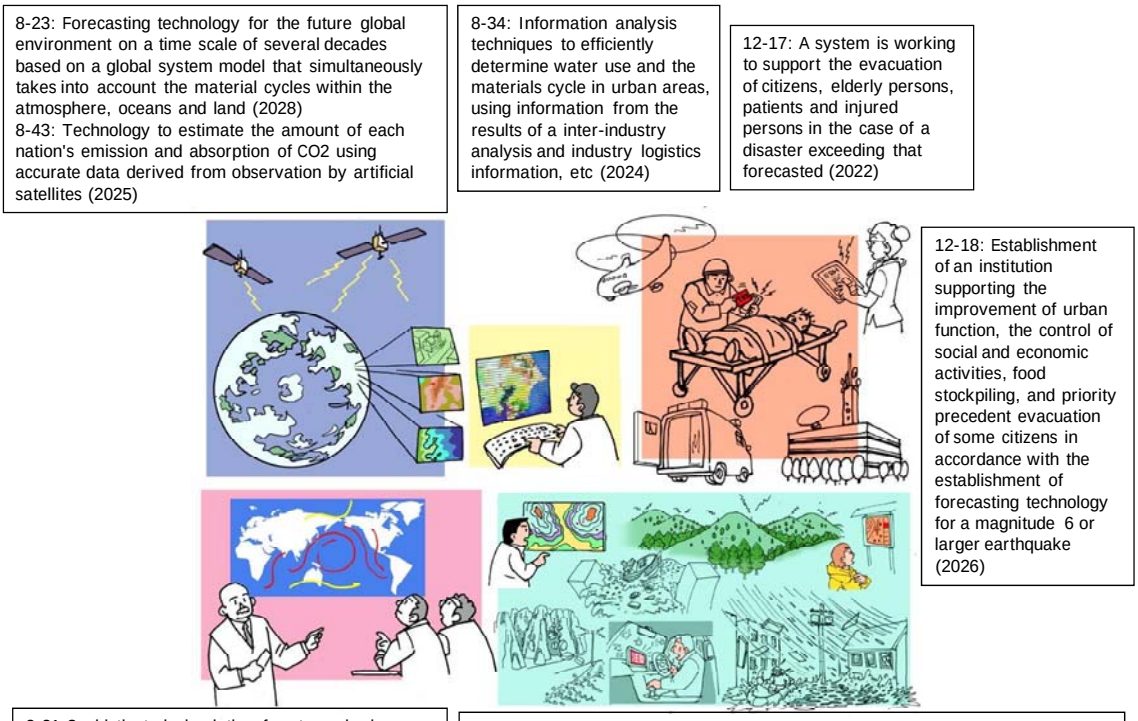


(3) A society where people have begun to cope with various disasters caused by the environmental change

Primary subject:

- Upgrading of global observation networks enables us to obtain manifold environmental data on a global scale. The data are used in various forecasts and simulations, resulting in much better accuracy.
- Global environmental information is accessible to the public on a real-time basis and is used for environmental education and for raising people's awareness of environmental issues.
- Such global information, however, has not produced substantial effect on local societies. For instance, it is not effectively used in a disaster-prevention system
- Local environmental data also become available as necessary. Local forecast and simulation of sudden incidences, such as outbreak of infectious diseases, concentrated heavy rains, flash floods, and so on, comes into practical use to a certain degree, which enables the local government to take quick action against such sudden incidences.

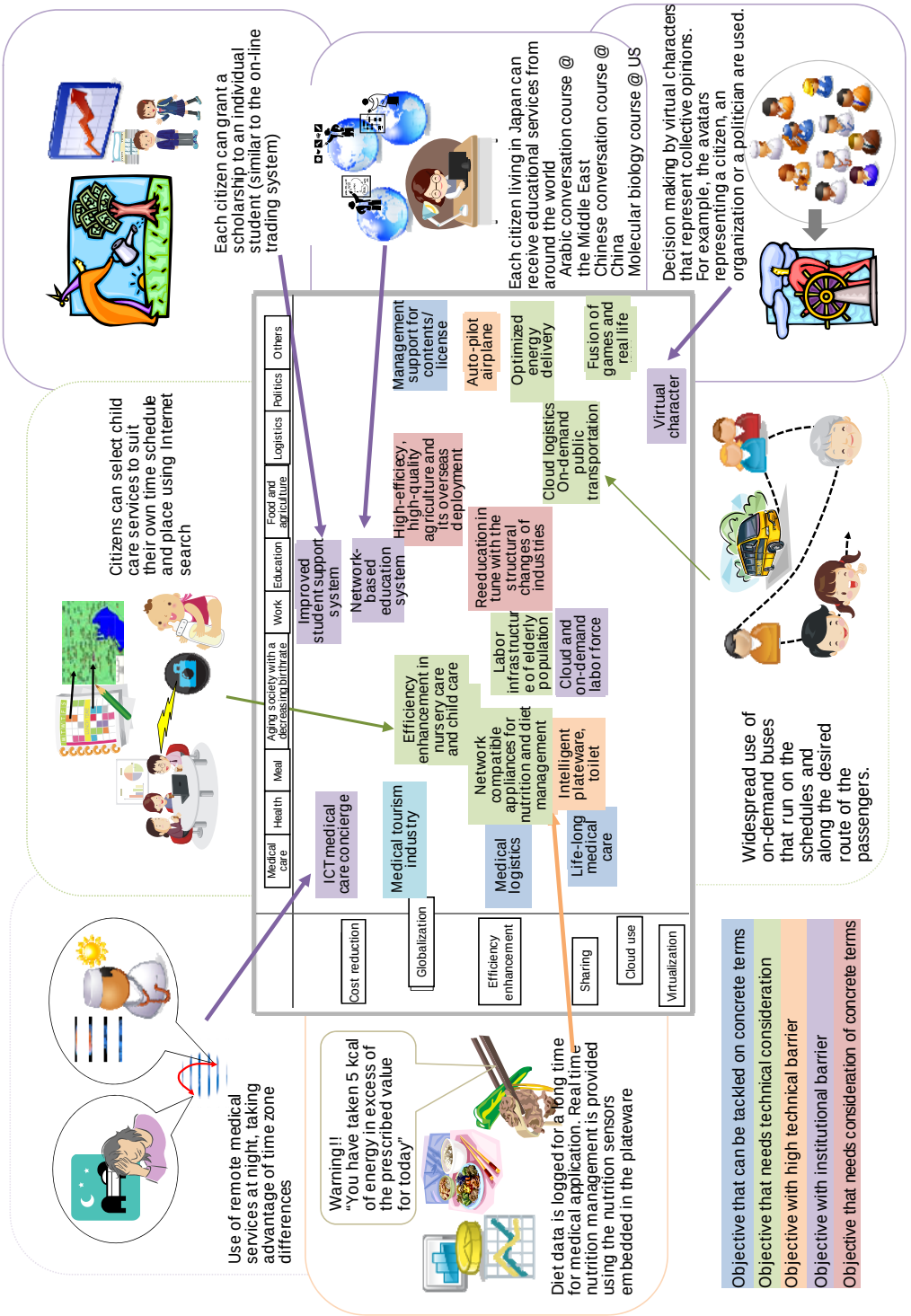
Figure 17: Scenes in dairy life (a society where people have begun to cope with various disasters)



2-3. Future society as discussed by younger generation

To complement the argument in 2-1 and 2-2, a discussion was held by a group consisting solely of members of younger generation (aged from 20 to 30). The discussion was focused on the service case studies of ICT applications, i.e. the potential contribution of ICT to such areas as medical care, nursing care, education, labor, and environment.

Figure 18: Future innovation envisaged by younger generations



Appendix: Scenes in future daily life

* The numbers shown in the parentheses indicate the Delphi topic ID (i.e. panel-topic number). The corresponding topics are listed in NISTEP REPORT No. 140.

A society in which various diagnostic technologies and systems are incorporated in daily life and health maintenance by individuals has started to prevail

Eiko Morimoto was watching a morning news show, when she suddenly got a severe headache and screwed up her face. Her husband, Koichi, looked at her anxiously. Since Eiko's stroke several years ago, which left her right arm and leg crippled, she has always been careful about her health so as to avoid another stroke, and has received home care support for daily life. Koichi suggested that Eiko should have an examination just to be safe, and accompanied her to a hospital in the city.

"The results of your examination show no abnormalities," said Dr. Honda, the physician who examined Eiko, with a smile on his face. "The temperature has been unstable over the last few days, so you may feel a little sick, but I don't see any concerning symptoms." Honda's remark eased Eiko's anxiety about a relapse. Dr. Honda himself felt relieved too, seeing Eiko leave the examination room with Koichi. He turned off the high-definition tablet terminal displaying electronic medical records and left the room. This was the last outpatient examination of the day for him. Dr. Honda decided to read the latest electronic medical journal before going home.

It has been several years since Dr. Honda obtained his medical license, finished his clinical training, and started working for this hospital. At first, he had his hands full examining patients' diseases, but recently he has been feeling that he has become calm enough to face patients. Medical students acquire skills to communicate with patients at university, but it is rather difficult to put such skills into practice. Experience needs to be accumulated. Dr. Honda learned from talking with his senior doctors that the education he received while he was a student and then an intern was quite different from that for those senior doctors. Communication methods for doctors to use when talking to patients or their families were not included in the curriculum for medical courses in those days. Dr. Honda still remembers an experience during his university days when he was deeply impressed by the preaching of a famous Buddhist monk that he listened to as a part of his medical ethics education(4-83). Through sincerely considering what life and death mean, he thought that he could foster morals as a doctor who will always face the border between life and death.

The era of "Medical Breakdown" referred to by senior doctors is an old story for Dr. Honda. When the shortage of obstetricians, pediatricians, ER doctors and doctors engaged in regional healthcare was a problem, doctors were forced to bear a heavy burden, pressed by extremely hard daily work. Senior doctors say that it was difficult to find a balance between compensation, work load, and accomplishment as a specialist.
However, at present, medical service fees have been revised so as to better reflect the reality of the medical front and doctors' medical practices are now evaluated properly. The medical service fee system has been established whereby the State guarantees compensation for safe and secure medical treatment (4-70).

Furthermore, the original Japan Medical Standard system was established (4-71) and medical treatment is now often expressed with the term "medical social system that enables the optimum management of quality and resources" (4-72). In fact, imbalances, such as the concentration of doctors in urban hospitals, have been corrected gradually, and the equalization of healthcare has been progressing. Co-medical manpower has been strengthened and hard work at the medical front is being reduced.

Medical safety education, using experience-based medical treatment simulation technology, has been enhanced (4-84) and citizens' sense of trust in doctors and medical institutions has been growing. Doctors, less busy than before, now have more time to talk with each patient. Dr. Honda himself reaffirms that good communication strengthens ties between doctors and patients. Eiko, who he examined a little while ago, and her husband Koichi, who always accompanies her, both looked nervous at first. They usually go to their personal doctors in their neighborhood and seldom visit the city hospital where Dr. Honda

works. They said that they felt awkward at first and could not talk frankly to doctors in such a large hospital.

As a result of the advancement in regional healthcare systemization technology, the home-care and hospital care that Eiko receives are connected through a seamless and close alliance (4-78). In order to create a system to "treat patients comprehensively in the region," the medical information network is indispensable. Such network functions in a truly effective manner when each household makes its utmost efforts and supplementary public and private nursing care services are optimized. In terms of technology, the lifelong regional Electronic Health Record system was introduced and accelerated the move towards integrated healthcare focusing on patients (4-80).

The dissemination of electronic medical records prompted the shift to personal medical history management by patients themselves, and examination results and medication information can be shared among all medical institutions upon obtaining consent from patients. Based on such information, a new trend in the form of the "health management agent" business started between patients and medical institutions (11-17). Information on the treatment Eiko received from her personal doctor has also been transferred smoothly to Dr. Honda at the city hospital, and he could confirm her medical history and health conditions immediately, which means he could provide proper treatment. The computerization of medical information also enables doctors to inspect examination result details visually, using moving images. This is also a merit in making a diagnosis. On the other hand, patients' personal doctors can also obtain and share information on treatment at large hospitals. The other day, Koichi said to Dr. Honda, "Patients are no longer as motivated as before to go all the way to large hospitals. We can receive healthcare of the same quality even in our neighborhood."

The direction of Japan's healthcare has changed dramatically in the last twenty years. Rather than passive healthcare that starts after patients become sick, preventive medicine with careful preparation has come to be emphasized. This trend has spread wide, not only among aged people, but also among younger generations. Firstly, this change is largely owing to "ubiquitous computing technology" that supports the enhancement and maintenance of health in daily life with software, such as through calorie counting and exercise intensity calculation (1-16). Thanks to the coming of the ubiquitous age, patients can access necessary medical information at their convenience. Citizens feel more familiar with healthcare and their interest has grown significantly.

As health data is recorded automatically on a daily basis by various health check equipment with interlocking functions, individuals can keep up-to-date with the general conditions of their own life, health, and work. Eiko also obtains various pieces of information so that she can maintain healthy blood vessels in her brain, while Dr. Honda can give her appropriate advice on her daily life (2-05). Furthermore, in order to reduce Eiko's risk of contracting a lifestyle disease in general, Dr. Honda provided medical guidance based on her biomarker examination results (4-50) and judged the risks of contracting diseases through genomic information (4-51). Family medicine education on lifestyle diseases and aging has widely spread (4-81) and the possibility of Eiko contracting a serious disease unexpectedly in the future is quite low.

However, not all diseases can be predicted. Some more time is required to create a system to accurately predict the risk of cancer or other intractable diseases by using biochips (3-18) or conducting early diagnosis and health management based on omics information and past health check data (4-46). Eiko is also instructed by Dr. Honda to carefully check her health conditions every day just in case.

Regarding the emergency medical system, a regional healthcare system that enables prompt and proper response has been established and regional disparities have been alleviated (4-66). The growth of technology for designing medical societies and medical cities (4-59) has been rapid and prominent. Nevertheless, there are still areas, such as mountainous regions, where transportation systems and other daily-life infrastructure are not sufficient. Koichi's father, who is old and bedridden, is in one of such underpopulated areas, but his care worker says that they feel no particular inconvenience as a remote healthcare system utilizing information technology and a distribution system to deliver necessary medicine and dietary supplements have been developed (12-20). However, depopulation cannot be stopped and healthcare in such areas surely faces the problem of high costs.

It is expected that the remote healthcare system will be further enhanced in the future and doctors will be able to see patients in remote areas, who cannot come to hospitals, in a manner as if they are directly facing each other. An innovative

remote system that enables the doctor to feel like he/she is placing a stethoscope on the patient and smelling the patients' breath (2-19) was developed and is soon to be commercialized, but no matter how advanced the technology is, the connection between doctors and patients should not be ignored, and doctors' communication skills may become more important. Various pathological mechanisms are also being clarified in the field of mental health (3-25). Response to childhood school refusal and learning disabilities (4-28) and early diagnosis of mental diseases (4-26) have been developed, but the most important matter is the connection between doctors and patients.

After leaving the examination room, Dr. Honda dropped in at his office in the hospital. He used the PC there to inspect the latest research reports on regenerative medicine published in an electronic medical journal. Much is expected of regenerative medicine as a means to not only cure diseases but also to recover bodily functions damaged in accidents. One of Dr. Honda's colleagues serves concurrently as a professor and a clinician, and actively continues research under an international research consortium.

Full-scale regenerative medicine will soon be realized. The ethical guidelines for clinical application of regenerative medicine (4-69) have already been shared among healthcare workers. The director of the hospital, who hired Dr. Honda, said that reconstituent blood vessel prostheses using degradable scaffolding materials such as polylactate (9-38), biocompatible materials with almost the same functions as human bones (9-39), and other new technologies will soon be adopted in the medical front. Dr. Honda himself is engaged in test research in clinical practices so as to ascertain the applicability, as general medical treatment, of the technology to cure diseases by inducing stem cells, including iPS cells, to functional cells while avoiding the risks of canceration (3-35).

In the process of developing regenerative medicine, it is essential to harmonize bioethics and research activities. Discussions among a wide variety of members of the general public (4-74) have been underway and efforts have been made to build consensus among people concerning regenerative medicine. Dr. Honda has actively participated in local meetings and workshops, as well as academic meetings, with the aim of translating the opinions of the medical front. He is very passionate about the medicine of the new era.

A society where individuals can use various types of energy selectively based on their comprehensive evaluation of value and can feel that they proactively contribute to global warming prevention and environmental preservation

It is no longer surprising to Eiji that his mail box is full of job offers again this morning. Natural energy advisors, like Eiji, have been very popular since the government increased the subsidies (8-11) for the energy independent housing or zero emission housing (6-69) five years ago. Japan utilized the emissions trading system (8-11) effectively, and managed to achieve the goal of reducing greenhouse gas emissions by 25% in 2020. However, unlike the industry sector, the consumer sector failed to meet the target. Therefore, the government offered new subsidies for eco-housing, aiming for further reduction of emissions.

Thanks to the rapid advancement of communication networks, the number of teleworkers, who live in the suburbs, had already been increasing (2-23, 2-24, 11-26). The government strategies increased the advantages of living in rural villages further, and accelerated the nationwide redevelopment of those rural areas. The zero emission housing in rural area can drastically reduce the consumption of fossil energy with the use of biomass, solar power, and other natural energies together with the home energy management system (6-52). Along with the popularization of such houses (6-35), people can now buy them at an affordable price. Highly-efficient and large-area thin-film photovoltaic cells (6-20, 9-26) have also been developed and have started to be used in some houses, and will become wide-spread in the near future. It is quite natural that Eiji is inundated with job offers, because he is a qualified professional that can design and diagnose zero emission

houses to be covered by the government subsidies.

Eiji moved to his current residence anticipating a boom in migration to rural areas. As he expected, the village he moved to has developed into a town. He now feels comfortable working at his home office, and his only complaint is that he is too busy with work. In this town, many people have long been engaged in dairy farming, pig farming, and suburban agriculture, and methane gas generated from agricultural waste (6-56) is now provided to each household through pipes. It will not be long before zero emission areas are realized nationwide by effectively utilizing waste from local agriculture and forest industries in this manner (3-56, 6-61). Because larger plots of land are available in suburban area, people can live in a large comfortable house designed to enjoy pleasant ventilation and natural lighting as much as possible (6-69). Thus being able to realize a comfortable teleworking office without commuting is also one of the merits of natural energy home located in a rural area. The groundwater with a stable temperature all year round is pumped up from three deep wells in Eiji's town, and started to be delivered and circulated to each household(6-54,7-03). Owing to the facilities, many residents now need no more than a fan even during the summer and winter, and they can make significant savings in electricity charges.

Eiji and his wife Naomi go to the common vegetable garden rented in the neighboring village once a week to grow vegetables for their own use. The village is almost "a marginal hamlet" due to aging and depopulation. Many abandoned farmlands and farmhouses are rented free of charge to urban residents for the purpose of maintaining the environment and the village activity (12-26), but not many people are interested in such offer. Eiji and Naomi rent the vegetable garden free of charge and in return participate in volunteer activities of tree trimming in the village forests twice a year. Sometimes they invite their friend Yuichi, who lives in an urban area, to join the volunteer work. The maintenance of forests depends on such volunteers at present (12-32), but people have become aware of the functions of forest (8-15), and the introduction of "the public forest finance" to support rural areas by the whole nation (12-8) is being discussed.

Micro-grid technology to optimize power supply (1-27) and other infrastructure have also been developed in this village. But villagers living in traditional Japanese houses do not consume much energy and are not necessarily in need of such infrastructure. Nevertheless, small hydraulic generators have been constructed here and there to generate electricity necessary for villagers. This village, located on the forest slope at the bottom of the mountain, has many mountain streams and is rich in water resources. The village sells surplus electricity through the smart grid networks (6-53), which financially supports the village. Furthermore, the traditional Japanese water mills have been reconstructed for power generation and for tourist attraction as well. High quality charcoal is also made in a traditional way, and shipped for the restaurant industry. A rich natural environment can be a tourism resource, but the village lacks young people who can turn it to their advantage and is barely able to survive.

In the meantime, some other rural areas have found new opportunities by enlarging the scale of agriculture and attracting young people. Even if biomass energy is used, organically- cultivated rice and vegetables require a lot of manpower and are rather expensive compared with foreign products (6-61, 3-56, 12-59).
However, nation's growing preference for good health and safety has led to the development of the systems of direct sales and traceability, resulting in such rural areas being supported (8-40). Now, those organically-grown products are even exported to foreign countries as safe foodstuff. As full-scale organic cultivation has been expanded, farmers have tried to reduce the use of agricultural chemicals as much as possible (8-14). The agriculture has transformed itself in Japan so that it may respond adequately to the nation's preference for health and safety, and to the environmental load-reducing.

High-value-added agriculture (8-40) provided a new income source for farm households and also changed their lifestyles. In particular, the expansion of "commuting agriculture" (8-13) and "urban-rural dual life (or weekend agriculture)" in the suburbs bring a new lifestyle to the agriculture as a whole. All-out and full-time farmers need to live close to farmland for the farm management, but "casual farmers" can enjoy such methods of commuting or dual life by small operation with efficient land use. Due to the policy and financial support for the energy saving in daily life and for aging society, "multi-habitation" has been made available even for the general public (8-26). It is no longer unusual to have two living places in rural and urban areas. This trend has been progressed by the people who are retired or quitting their office jobs. The shortening of work hours and the expansion of work sharing have also worked to promote such trend.

Eiji’s friend Yuichi lives in an apartment near central Tokyo because of his work. He is working for a company which deals with a wide-range of environmental technologies, such as water clarification facilities, solar panels, and wind power generators. The job requires him to go on overseas business trips frequently. His company, which used to be a large petrochemical company, was forced to change its business due to the soaring prices of oil and the international convention on the total volume control of oil use. The company was reorganized as an environmental company in its present form several years ago. They discussed the possibility of changing into a chemical company using biomass materials instead of crude oil (3-51), but abandoned the idea because of the difficulty in getting the necessary volumes of homogeneous raw materials. The large-scale plantation farming of energy crops and the biomass resource development (6-59) have been progressed in such countries as Brazil and India. The mid-sized biomass chemical plants are often built adjacent to such large-scale farmlands. In those chemical plants, synthetic fuels are also produced and have become important export items.

Yuichi just came back from Australia after a one-week trip for the replacement of the photovoltaic plant facility (9-26, 7-48) in a desert and for the preparatory work on a new hydrogen production plant (6-27, 6-34). Remote inspection using the high-speed online network is available, but the weather, wind direction, and other subtle issues can be better understood by directly visiting the sites. Yuichi’s company has a photovoltaic plant there and has been conducting power trading (7-48) using ships equipped with high-performance storage batteries (1-43). Now, the company intends to start a new hydrogen business (6-28, 6-29, 9-35) using the opportunity of replacing the photovoltaic plant facility with newly- developed ultrahigh- performance photovoltaic cells (1-44). As the use of fossil fuels is now restricted under an international convention, such new styles of energy business have much potential. When submarine superconducting cable networks (6-40, 9-21) are connected in the future, energy trade will be conducted more efficiently. Yuichi’s company, in conjunction with several other Japanese companies, bid for another big project—the construction of a large-scale international photovoltaic power plant in the Sahara Desert in Africa. But their bid was unsuccessful, probably due to their high bidding price. The successful bidder was a foreign company that was going to use cheaper solar panels with lower quality.

Yuichi’s company developed low-cost water purification technology (8-63, 8-67), which has been selling well. Their products have been adopted broadly in Asian countries, and penetrate now into African and South American markets. Nevertheless, it will take some more time until all people on the earth can have access to safe water because some of countries have collapsed due to the internal fighting or economic trouble. Yuichi's company adopts a policy to incorporate the construction of facilities, the transfer of operation know-how, and the effective funding in the businesses (8-64), and has succeeded in gaining market shares in developing countries because the policy was accepted. However, the competition against other companies has become severer recently. Another innovative product of the company is a large-scale desalination plant. The company constructed the desalination plant on the Atlantic coast in the Sahara Desert and is now developing a large farmland there. This farm project has become possible partly due to advances in the breed improvement of cultivated crops(7-12). Daily farm work will be conducted by local residents, but works that require highly-advanced judgment are to be done by humanoid agricultural robots that can be operated remotely from Japan. Yuichi’s coworkers are dispatched to the site for the trial operation of those robots. The company is planning to make a contract with a US information company that gives the crop market forecast and the long- term weather prediction, and to plant rice, wheat, beans and other crops based on such information. They are to sell most of the harvest through markets, but a part of the harvest will be sold locally for a contribution to the local area (8-49). Yuichi’s company intends to contribute to the world by total improvement of food, water, environment, and lives in this way.

High-performance storage batteries, like those that Yuichi’s company uses for power trading, are also equipped in electric vehicles, enabling them to run 500 km or more on a single charge (1-43). Yuichi owns a vehicle of this type. He usually charges his vehicle with nighttime discount power but can use a wireless charging system (1-49) while waiting at traffic lights or while parking, if necessary. As this type of vehicle is rather expensive, many people still drive conventional hybrid vehicles. However, thanks to the popularization of a transportation system that automatically adjusts engine operations according to traffic conditions (12-44), mileage has been improved further. For example, vehicle speed can be adjusted so that the vehicle will not encounter any red

traffic lights on its way to its destination. Recently, a new car-sharing service (8-18) started and those who cannot afford to own electric vehicles can also use such vehicles easily.

Yuichi and his family's rental apartment located near the central Tokyo needs to be equipped with a solar power units and rainwater reuse system (6-54) by the regional agreements. If residents join the regional agreements, they benefit by receiving free hot water delivered from a waste incineration plant (8-16). Toxic materials emitted from waste incineration are completely eliminated and the plants only emit water vapor and a little carbon dioxide. Therefore, not a few communities are willing to attract a new waste incineration plant, expecting the benefit of receiving a hot water. Because the apartment where Yuichi and his family live is rather new, it is a intelligent building (1-41) where communications, room temperatures, lighting, electricity, drinking water, hot water, and drainage water are controlled comprehensively. As highly-efficient lighting using LED and organic EL has become wide spread (6-63, 6-68, 9-50), not many fluorescent lamps are used now. Old houses and apartment buildings were the bottleneck to achieving the target for reductions of greenhouse gas emissions, but a new subsidy system will promote reconstruction and renovation of those houses and buildings, so the target will soon be reached.

A society where people have begun to cope with various disasters caused by the environmental change

Mr. Suzuki transferred to the fire and disaster management division of the city government this spring. This division is the key section of the local administration concerning disaster prevention. Last year, massive earthquakes struck South America and then midwestern China. A great volcanic eruption in Iceland also caused flight cancellations throughout Europe. Natural disasters have thus become much more frequent and large-scaled all over the world. Three years ago, the city area where Mr. Suzuki lives was hit by a strong typhoon, which produced 40 casualties through rainstorms, landslides, and collapsing houses. In the southern part of the city, which is a low-lying area, many houses were flooded up to the floors. Under these circumstances, the local administration is required to take more prompt and proper actions. Technology and tools for such purposes have become more advanced day by day and administrative officers in local governments need to keep up with the latest knowledge. The roles of Mr. Suzuki and other administrative officers are becoming more and more important for protecting the lives of residents.

Since two years ago, full-scale disaster drills have been conducted twice a year in Japan, under a government initiative, with specific themes set each time (12-21). The Japanese government has also called for world attention to the effectiveness of disaster drills. The themes of today's disaster drills are tsunamis for coastal areas all over Japan including the coastal suburban city Mr. Suzuki lives, and large-scale seismic fires for inland areas. In the tsunami scenario, the epicenter is assumed to be Chili, and the disaster drills were also conducted in Chili, Indonesia, and Thailand, in tandem with Japan. Due to the recent sea level rise, these countries frequently suffer extensive damage from floods and tidal waves, and the governments have come to recognize the importance of disaster drills. Detailed tsunami predictions across the Pacific Ocean based on the simulation results with supercomputer are provided each and every second through communication satellites and broadcasting satellites to all over Japan and also to foreign countries if necessary (12-35). This wireless communication system, which started to operate last year, is also checked during disaster drills and further improvements are sought.

The emergency headquarter was set up by Mr. Suzuki and coworkers immediately after the announcement of the tsunami prediction. The headquarters issued an evacuation order to residents in the southern part of the city, and evacuated them to several junior high schools and elementary schools located on hills. Hazard maps are prepared in advance, but residents can not realize the serious risk unless they actually participate in these drills. The micro-grid networks

(1-27) that are usually used to optimize energy supply to each household can be used to check on the damage in the region and to predict the expansion of damage immediately (12-16) by their emergency mode. Mr. Suzuki switched the micro-grid networks from the normal mode to the emergency mode, and carefully checked that it would work well. He also tested whether he could remotely turn off the gas and electricity in each house, and whether movable storm surge barriers and monitoring systems would rightly operate.

The fire and disaster management division once discussed raising storm surge barriers on the southern coast of the city, but the division adopted the movable barrier of concrete panels depending on the disaster risk assessment taking aesthetic landscape and land use into consideration (12-3). The new barriers were constructed last year and can extend upward only for emergency. The new barriers are also automatically controlled by the micro-grid networks, but periodic checkups are required every six months. Water levels in rivers, landslides, and other hazardous locations can also be monitored automatically at all times. When a river rises to a dangerous level or any sign of a landslide is detected, a warning is sent to the disaster control center and the information is announced to residents in the dangerous areas (12-13) at the same time. The current water levels and forecasts, including those for upper streams, are available on the internet and are updated on a real time basis (12-01), which enables the authority to issue proper warnings and evacuation orders. Additional information, such as the population of fish in watershed areas and the growth of riverside plants, is publicized in real time and has contributed to ecological preservation.

Household fire alarms that are required to be installed in all houses are now connected to local fire stations through the micro-grid networks and can directly report fire outbreaks. They have decreased fire casualties significantly. In particular, the sensor system, which sequentially reports whether there are any people inside a house by way of Twitter, has drastically changed fire fighting methods. This system is also expected to be effective when rescuing people trapped in collapsed houses due to an earthquake or other incidents. Mobile phones have the function of automatic emergency call that properly tells owner's location and condition to the fire station, the rescue center, or the disaster control center. Thanks to such function of mobile phones, fishing crew members drifting on the sea were all rescued immediately after a fishing boat capsized in an accident three month ago. Rescue robots that recognize survivors by detecting far infrared radiation or carbon dioxide released from human bodies (2-51) started to be used and some municipalities, though not many at present, put such robots in place. Robots of this type were sent to the mountainous area in midwestern China when the large earthquake hit the area. The robots worked exceptionally well, while rescue workers got mountain sickness one after another.

The fire and disaster management division took the initiative to develop mutual support systems among residents (11-40) and fostered leaders of residents in each community. However, such systems do not work perfectly on an emergency basis due to the aging of residents. Close collaboration is now required with the aged and disabled people welfare division of the city government so as to ascertain current conditions of aged households and other matters. This is why Mr. Suzuki transferred from the welfare division to the current disaster management division. During today's drills, a new scenario, i.e. several aged residents are left isolated in a house that is about to be submerged, was added suddenly and the best rescue operation was discussed. Some suggested the idea of using a boat, but it seemed to be dangerous due to an expected tsunami. Therefore, they decided to request the Self-Defense Forces to mobilize a rescue helicopter. Although the Self-Defense Forces had already received more than 20 rescue requests from all over Japan, they accepted the request. In this way, the emergency drills are conducted in collaboration with such authorities as the Self-Defense Forces, the Fire and Disaster Management Agency, the Japan Coast Guard, and the National Police Agency (12-17). The drills play a significant role in helping the government establish its policies against multiple disasters that may occur simultaneously.

Dr. Nakano works as a medical doctor at a hospital in a local city that is located in the inland area of Honshu. His theme of today's disaster drills was to ascertain the capacity of the hospital to accept people injured by the synchronized large-scale fires due to a huge earthquake.
Although broadband seismic networks and observation methods have become advanced, it is still difficult to accurately predict when and where earthquakes will occur (5-8). Therefore, the drills were conducted without any preparation. Ten minutes after the earthquake occurrence, ambulance cars carrying injured people started to arrive at the hospital. Dr. Nakano first called the city headquarters to ask about the scale of casualties. And then together with hospital staff, he made a

first aid room by separating the waiting room in half. Of course there are real patients who happened to be at the hospital to receive medical care. Those who were able to participate in the drills did so, and some of them moved to evacuation shelter. Doctors judge the conditions of each person's injury based on their explanations and provide proper treatment.

In an emergency, electronic medical charts are disclosed to all hospitals and clinics. Therefore, even when an injured person is unconscious, if only his/her medical chart number is identified, doctors can know his/her blood type and medical history. One patient, who was unconscious due to head banging, had his medical chart number and therefore could receive a prompt blood transfusion. After accepting 40 casualties into the hospital, Dr. Nakano refused the acceptance of further casualties and asked the emergency headquarter to transport the injured to other hospitals. That night, doctors discussed what type of medicine and how much medicine they should store in preparation for disasters or infectious diseases (12-15) and how to divide their responsibility among nearby hospitals. Such information is shared among nearby hospitals and local governments.

Thanks to these large-scale disaster drills, we can understand what countermeasures against natural disaster are truly necessary. Last year, when disaster drills were conducted supposing that an earthquake hit many large cites including the Tokyo metropolitan area and blocked the transportation network all day long, nearly 100,000 people had trouble returning home from work. No effective countermeasures have yet been taken for this issue. Problems were that enough shelters could not be secured and that the restoration information of railways was not effectively transmitted (12-49). In the past, a great volcanic eruption in Iceland caused a disturbance of air transportation in the whole area of Europe and affected Japan in many ways. We learned that it is important to secure the practical alternatives in emergency as well as to promptly restore transportation and distribution networks, but any real action to address this issue is not taken yet (12-18).

Recently, unusual weathers have often been seen, such as cool summers, warm winters, heat waves, big chill, dry weather, and heavy snowfall. In addition to affecting crop harvests, such unusual weathers have also started to damage people’s health. In order to cope with the extreme weather events, over 100 countries and international organizations are developing “the Global Earth Observation System” that can comprehensively observe the earth. Our system of global whether monitoring with sensors on satellites and ground-based observation (5-02, 5-03, 5-07) is scheduled to be made highly accurate in two years, which will help to understand the origin of the extreme weather events and to contribute accurate prediction of them. Furthermore, the land-and-sea seamless database is constructed from the past 100 year observation and the data are now analyzed (5-25). The results will soon be compiled. Various types of simulation technology (2-30) and forecasting technology have been developed and are almost ready to be put into practice. It is not possible to predict at present whether global warming will further progress or whether large-scale volcanic eruptions all over the world will gradually cool the earth, but many people feel that such a prediction will become possible in the near future.

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as of March 2010

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