Science and Technology Trends — Quarterly Review

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Science & Technology Trends

# Quarterly Review

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# Executive Summary

Life Sciences

## 1 Trends in Molecular target therapy for Lung Cancer

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Molecular target therapy is receiving much interest as an effective way to treat refractory cancers such as lung cancer. Lung cancer is the most fatal cancer in Japan and developed Western countries, accounts for approximately 20% of cancer-related deaths, and has a low 5-year relative survival rate of approximately 30%. Molecular target therapy is designed to improve symptoms by suppressing the function of specific molecules involved in the development and/or progression of the disease, and is categorized as chemotherapy due to the use of chemical agents.

In Japan, three drugs have received sales approval to be used in molecular target therapy for lung cancer, and are used for unresectable progressive/recurrent non-small-cell lung cancer. New molecular target drugs for lung cancer are also being developed, including ones based on the *EML4-ALK* fusion gene, a milestone discovery made by Dr. Hiroyuki Mano of the University of Tokyo/Jichi Medical University. In addition, Dr. Mano and colleagues developed a molecular diagnostic method enabling early lung cancer detection based on *EML4-ALK* fusion gene screening, contributing to the construction of nation-wide diagnostic network.

Concerns for molecular target therapy for lung cancer include the risk of new side effects that never occurred with traditional cytotoxic anticancer agents and the development of drug resistance by cancer cells. Therefore, a thorough investigation of these mechanism and its risks is necessary, and the development of preventative measures for new side effects and drug resistance is an urgent future task, along with the search for new target molecules for lung cancer diagnosis, treatment, and drug development. At the same time, the current medical system needs to be revised, including the guideline on molecular target therapy for lung cancer. In particular, diagnoses based on the *EML4-ALK* fusion gene should be covered by insurance in order to make it more accessible to clinical practice.

(Original Japanese version: published in July 2010)

Information and Communication Technologies

## 2 Smart Grid as New Big Opportunity of Information and Communication Technology

p.23

The next generation power supply system, holding the promise of gaining higher reliability, lower cost, and reduction of load on the environment by utilizing Information and Communication Technologies (ICT), is often referred to as the Smart Grid. The smart grid may have a greater significance if viewed as an arena for the next stage of developments in ICT industries, providing a new social and economic infrastructure.

In line with the global trend toward low-carbon society, the effort to save energy has become a ubiquitous need in all areas of our activities including our personal lives, business operations, and local societies. The trend has also been giving support globally to accelerate research and development toward commercial realization of the smart grid. It may be relevant to point out here that, in conjunction with the smart grid, a much scaled-up version of a communication network – many-fold greater in scale than the current Internet – is expected to emerge, having a huge impact on the technological and industrial aspects of our society in the future.

In the United States, leading companies in the ICT sector have grouped to enter into technology development and businesses around the smart grid, and the economy in the United States seems to be regarding the areas surrounding it as the next important market for ICT industries. Strategic effort has been increasing with the government working together with the private sector to back up the new moves in the economic quarters: the federal government is proactively implementing measures including capital investment ($45 billion USD in total), promotion of standardization, and legislative preparations. Many entrepreneurial ventures have also been stepping up their activities.

In Japan, on the other hand, although there have been discussions toward realization of a smart community, research and development investment has been focused mainly on renewable energy (e.g. solar power) and storage. The effort toward research, development and commercialization of ICT around the smart grid has not been sufficiently activated. The intrinsic value of a technology can be upgraded only if it is properly defined and developed with the perspective of the grand design, and the vehicle to realize the design in the real world is ICT. In the future, renewable energy technology will evolve in Japan and the technological components may have international competitiveness, but they are likely to be exported as a “part” to be incorporated into upper systems.

We have to see the smart grid in a fresh light: by the arrival of new types of networks, the world of “the Internet of Things” will be expanded beyond the one composed of home electrical appliances and electric vehicles. An all-new concept of “informatization” lies here in that, by bringing the digital infrastructure into close contact with the real world, much improved availability of information, analysis of them, and actions thereupon will finally “push the society and economy in motion,” wherein ICT is expected to find a new evolutionary stage.

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Environmental Sciences

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## Trends and Problems in Research of Permanent Magnets for Motors — Addressing Scarcity Problem of Rare Earth Elements —

p.40

Enhancing the strength of magnets makes it possible to develop smaller and lighter motors with higher torque, leading to the advancement of energy savings in a range of consumer products such as home electric appliances. As a result, reductions in the power consumption of motors, which accounts for approximately 52% of total domestic power consumption, and in the carbon emissions of next-generation vehicles are expected, as well as enhanced performance of motors for wind-power generation. In fact, the strength of magnets is an important element for promoting green innovation.

In 1983, a neodymium magnet was invented in Japan, and is the strongest in the world, even now. Neodymium magnets for motors are important materials for next-generation vehicles and energy-saving home electric appliances, which are necessary to create a low-carbon society. The urgent issue facing neodymium magnets, for which demand has increased dramatically, is resource risk. In particular, the resource problem of dysprosium (Dy) is serious. Dysprosium is used in magnets for the motors of next-generation vehicles, in which the motors are exposed to a high-temperature environment.

Since 1917, when an artificial permanent magnet was first produced, more than 10 kinds of magnets have been invented. The research and development of magnets is a long-term challenge, requiring 20 to 30 years to produce a revolutionary discovery or invention. Historically speaking, the inventions of new permanent magnets have been brought about by bold interdisciplinary ideas, passion and chance, and Japanese researchers and Japanese technology have played an important role in such inventions. Most of the revolutionary discoveries and inventions have been put to practical use and are expected to have a major impact on green innovation. Therefore, the provision of public funds for basic and generic research, like the three national R&D projects now being carried out, should be continued and increased. Specifically, a new guiding principle for material development should be obtained by combining structure and mechanism analyses that utilize advanced measuring technology with theoretical analysis that utilizes computing science, in order to promote the discovery of new chemical compounds and organize magnetic alloys. It is desirable to promote these teamwork-type planned research projects in parallel with proposal-based research, based on the free thinking of individual researchers, by encouraging researchers in other fields to participate.

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Social Infrastructure

# 4 Development of an Earthquake Early Warning System and Its Benefits

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The Earthquake Early Warning, launched by the Japan Meteorological Agency in October 2007, has been favorably received as a case example in which results of seismic studies have been directly put to beneficial use in peoples' lives. The Earthquake Early Warning (EEW) is a system which, using a nationwide seismic observation network, aims to infer the seismic intensity to be expected at various locations based on earthquake information instantly analyzed at the observation point nearest to the source, and to transmit an alert to those locations before large ground motion arrives there. During the two and a half years from the launch until March 2010, a total of 14 EEWs were issued via television, etc. Although there were some malfunctions caused by erroneous transmissions and seismic intensity prediction errors, the performance of the EEW system more or less fell within the anticipated scope. However, since the time allowance generated by an EEW is just about sufficient from a workable standpoint, how the EEWs' realistic effects can be optimized remains as a future challenge.

The EEWs are divided into Advance Notices and Alerts, depending on the level of the predicted seismic intensity. With the former being intended for expert users in various specific fields, and the latter for general users, the two types of EEWs are used in completely different patterns. Meanwhile, the EEW involves regressiveness whereby the time allowance becomes shorter as the seismic intensity becomes larger. In the case of inland earthquakes, for which the source is nearer to the EEW recipients than that of subduction-zone earthquakes, the EEW generally does not reach the recipients in time for ground motion with a seismic intensity of 6 lower or greater. The figure below, which shows the circumstances at the time of an actual M7.2 earthquake, reveals that the EEW did not reach the recipients in time for strong ground motion within the inner-most circle. In the case of a subduction-zone earthquake, on the other hand, the EEW could generate a time allowance of 10 seconds or more. In particular, the EEW is expected to demonstrate a substantial disaster mitigation effect for the next Tonankai-Nankai Earthquakes for which a seafloor seismic observation network is being developed.

In this manner, the characteristics and the effects of the EEW differ considerably depending on the situation of the users and on the conditions of earthquake occurrence. Since the EEW has only been operated for two and a half years, it has not yet encountered an event where it could fully demonstrate its intended function. Through accumulation of experience, users in their respective standings need to learn the most effective use of the EEW, while understanding its characteristics and limits.

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**Science & Technology Policy**

## 5 Have Past Foresight exercises been able to correctly indicate future directions?

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The National Institute of Science and Technology Policy (NISTEP) conducted the ninth Foresight to probe the direction of the development in science and technology over the coming 30 years. Included in this exercise is a review of the outcomes of the Delphi surveys (a repeated questionnaire for experts, regarding technological development) that were conducted more than twenty years ago (the $1^{st}$ to $5^{th}$ survey), as to how many of topics have been realized. The Delphi survey has been a part of every one of the NISTEP's foresight exercises since the first one conducted in 1971.

The review indicates that, on the whole, around 70 percent of the past topics have been realized. Field-by-field examination suggests that fields related to environment, safety, health care and medicine have relatively high realization ratios. On the other hand, fields related to transport and energy show low ratios of realization. The general tendency is that groups of topics that were predicted to be realized at earlier dates scored a high realization ratio, and groups of those with lower degree of importance generally show low realization ratios.

Generally, technical difficulties are cited most frequently as the reason for no realization of a topic. As viewed on a field-by-field basis, technical difficulties have been cited as the main obstacle to realization in many of the topics related to medical and health care. On the other hand, many of the fields related to resources and energy, fields related to infrastructure (transport, construction, and civil engineering), and those related to frontiers (space and marine) cited cost and budgetary issues as well as technical difficulties. The advent of alternative technology is also cited as a reason in fields related to information or electronics, and especially in fields related to communication.

Because of the ratio of realization — around 70 percent — the Delphi survey has a certain level of reliability. On the other hand, it may also be proper to ask ourselves if we, living in the present day, have excellent insights that will be highly appreciated by experts in the future.

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**Science & Technology Policy**

## 6 Main Points of White Paper on Science and Technology 2010

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On June 15, 2010, the "White Paper on Science and Technology 2010 (annual report on the promotion of science and technology in fiscal 2009)" was decided at a Cabinet meeting and was reported to the Diet. The White Paper is a law-based document consisting of two parts. Part 1 focuses on a specific theme every year and Part 2 summarizes the science and technology measures implemented by ministries and agencies in the preceding fiscal year.

Part 1 of the White Paper on Science and Technology 2010 deals with "A new frontier to be extended by value-creating human resources ~ How science and technology should be for Japan to make a new start." "Value-creating human resources" refers to diverse human resources essential for the creation of new values and includes not only researchers and engineers but also persons engaged in the management of universities, research institutes, private corporations and administrative organizations, etc., persons related to intellectual property, persons working in industry-academic-government collaboration, and science and mathematics teachers.

In order to create new value by generating innovation in Japan, it is necessary for diverse human resources to further enhance creativity and productivity. In order to maintain and enhance international competitiveness and the quality of people's life, it is essential to promote science and technology conducive to solving the issues involved in creating a low-carbon society, such as global warming, enhance basic scientific capability, and foster and secure not only researchers and engineers but also "value-creating human resources" engaged in diverse S&T activities. It is also important to enhance the relationship between people/society and science/technology, including the creation of occasions to generate innovation through industry-academic-government collaboration and the promotion of the transparency of and people's participation in policy process.

In recent years, science and technology have increased their role in ensuring national economic growth and affluent national life. In the future, science and technology policy in the world will become science, technology and innovation policy.

Science and Technology White Paper
http://www.mext.go.jp/b_manue/hakusho/html/hpaa.201001/1294965.hlm

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