Development and Evolution of Energy and Environmental Technology

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Abstract

NTT Energy and Environment System Laboratories has taken up the challenge of developing various technologies and products using information and communications technology for protecting the global environment and achieving a sustainable society based on the Kyoto Protocol and the NTT Group Global Environmental Charter. Furthermore, in order to answer growing concerns about the low-birth-rate and aging society as well as other social issues related to living environments, we have been extending the scope to the safety and security of society and human beings. In addition, we are promoting business developments using these technologies for the 21st century, the "Century of the Environment". This article describes research and development and other activities conducted in NTT Energy and Environment System Laboratories and introduces their key technologies and prospects.

1. NTT's basic stance on protection of the global environment

We firmly recognize the importance of protecting the global environment. To fulfill our corporate social responsibility for environment protection, NTT established the NTT Group Global Environmental Charter in 1991 and a system for implementing it. When NTT was reorganized in 1999, we further enacted the NTT Group Ecology Program 21, which consists of three major initiatives: the Global Environmental Charter, promotion of environmental activities in local communities, and research and development of environmental technology. To execute this program, the NTT Group Global Environment Protection Promotion Committee was founded. It coordinates various environmental programs in cooperation with the environmental sections in NTT group companies. Two specific entities—the Environmental Management and Provisioning Project and NTT Energy and Environment System Laboratories—were set up in the Information Sharing Laboratory Group of the NTT holding company to address environmental problems. Their activities range from research and development of core technology to technical support for NTT group companies (**Fig. 1**).

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2. Our objectives

NTT Energy and Environment System Laboratories is working toward a safe, secure, and earth-friendly society that provides comfortable living environments to individuals and uses sustainable social systems that minimize the environmental impact on the Earth (**Fig. 2**). The research projects are strategically and flexibly organized not only to contribute to these objectives but also to create evolutionary technologies. The research themes related to telecommunications and living environments are illustrated in **Fig. 3**. The key technologies for these themes are introduced in the following sections (**Fig. 4**).

2.1 High-efficiency energy supply

As telecommunication systems come to be based on IP (Internet protocol) and optical broadband networks, a sharp increase in electrical power consumption by communication systems and the use of high-current power supplies for them are becoming serious problems. These problems will have to be solved in the next-generation network (NGN). We have drafted and established safety guidelines for power supplies to communication equipment and devices that ensure

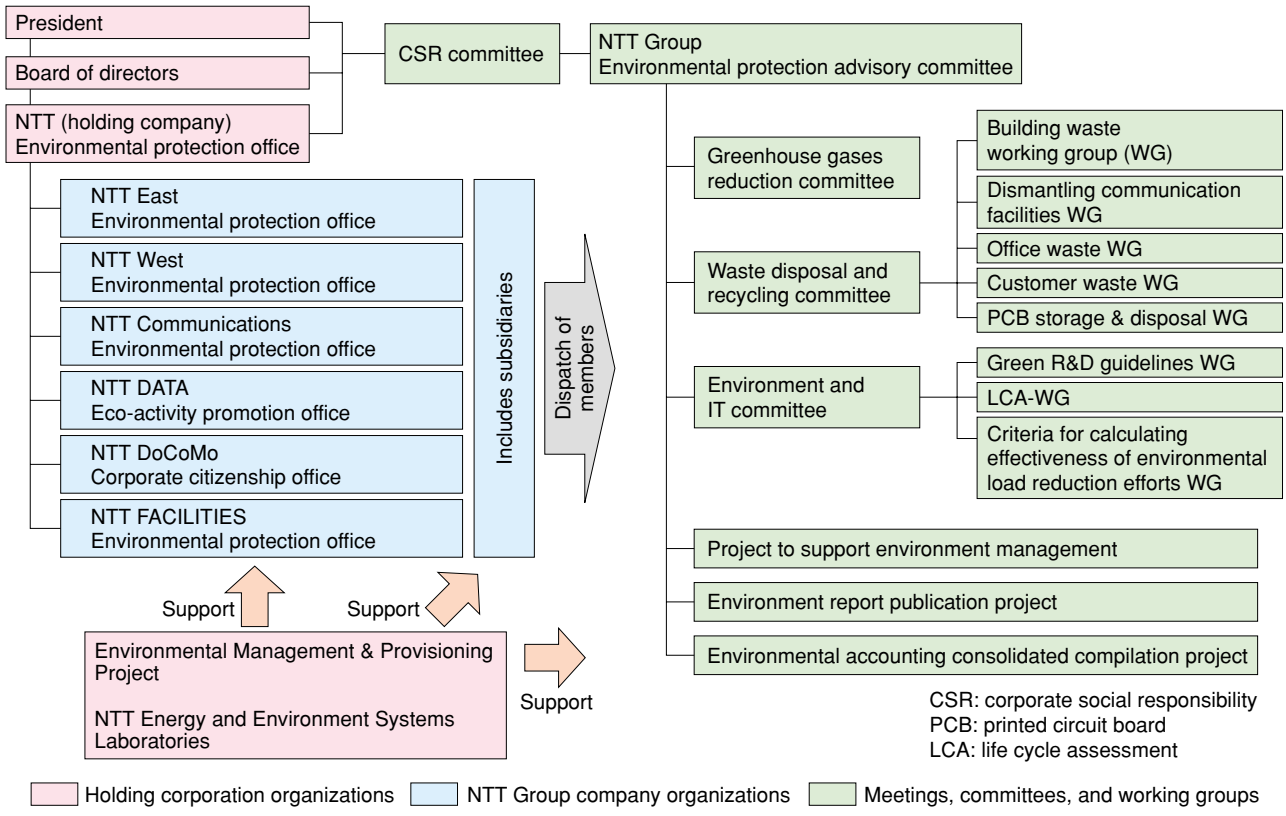

Fig. 1. NTT Group organization for promoting environmental protection.

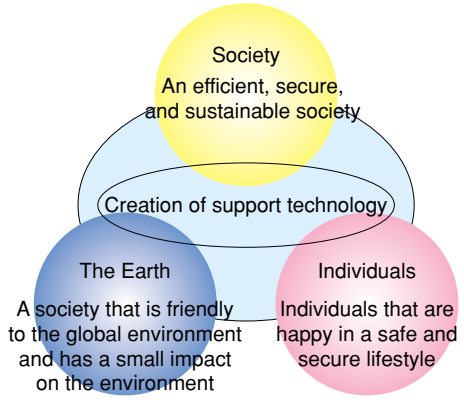

Fig. 2. Objectives of NTT Energy and Environment Systems Laboratories.

the reliability of telecommunication systems as an important part of the social infrastructure. The guidelines outline incremental improvements to support the NGN, in which safety against high DC supplies and problems with hybrid DC/AC power supplies must be considered.

The increase in energy consumption is the main factor contributing to global warming and the depletion of fossil fuels. Conversion to clean energy sources is a fundamental solution to it. We have been conducting research on fuel cells under the theme of power generation. Energy system control is another key technology that significantly improves energy efficiency. One important element of this is the prediction of energy demands and power generation capability, where the stored energy amount and conversion efficiency are considered. Only by properly considering and manipulating all these factors, all of which have different characteristics from those of the conventional power grids, can we maximize the overall energy efficiency. We have been intensively working on this technology too, and some of our developments have been utilized in a project, where NEDO (New Energy Development Organization) was the organizer and NTT Facilities, Inc. was the main contractor, to create an integrated local power supply system using clean energy sources. This project was demonstrated at Expo 2005 in Aichi Prefecture. The various clean energy sources, including the fuel cells and solar cells, were controlled using this technology and they successfully supplied stable power to the Nagakute Japan Hall and the NEDO Pavilion with high efficiency. We will continue to develop this technology until we get an energy network system that

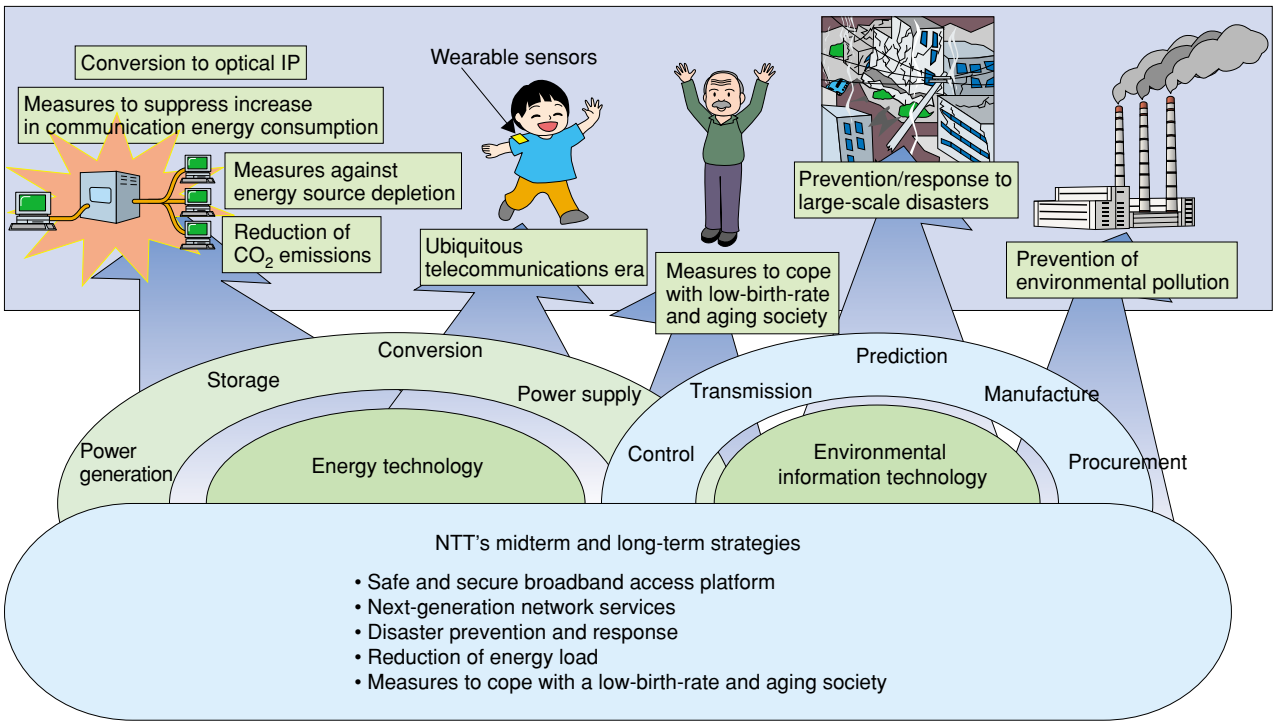

Fig. 3. Research topics that are the focus of efforts by NTT Energy and Environment System Laboratories.

controls the whole energy supply operation in a particular area by coordinating local energy needs and power generation with maximum efficiency.

2.2 Ubiquitous information and communication society

In the coming ubiquitous information and communication society, monitoring systems for personal health and living environments will be in strong demand. We are developing wearable sensors that are essential parts of such systems. To drive various ubiquitous devices, we are also developing small and lightweight energy sources as well as wireless power transmission. We have devised a wearable ozone detector, since ozone is a cause of photochemical pollution and may be hazardous to humans. Utilizing the chemical reaction between a dye and ozone, it can detect ultralow levels of ozone in the atmosphere.

As an energy supply for ubiquitous devices, we have developed a portable solar power card device that can provide electrical power to various electronic devices for both telecommunication applications and general purposes. In this device, the very low voltage generated from a single solar cell is raised so that it can charge batteries that in turn provide power. We are also developing micro fuel cells, which use hydrogen gas as a fuel, and testing their use in cellular phones. We have demonstrated that it is possible to achieve a talking time several times longer than that with conventional high-power batteries, thus confirming good expectations for use as a future ubiquitous energy source that can meet the requirements of high-power mobile devices.

Wireless communication networks are also essential for the information society. We have been working on electromagnetic compatibility (EMC) technology related to telecommunication equipment, power supplies, and wireless systems for many years. We will continue to use the resulting technologies to assess the emissions from and immunity of various telecommunication devices and equipment and to prepare countermeasures against diverse EMC problems.

We recognize the importance of environmental assessment technology, which is essential to many of NTT's environmental activities. We have been collecting various data for conducting environmental analyses and developing assessment methods, which are utilized in the evaluation of environmental impacts resulting from procured products/facilities and telecommunication services.

2.3 Safe and secure society

Due to recent large-scale natural disasters, disaster

prevention is a hot issue. The reengineering of related information systems and facilities has been carefully considered. Especially in local governments, many of which have been reorganized and unified, the whole system needs to be reviewed and reconstructed. In this area, sensing and monitoring systems coupled with environmental and microclimate simulation can play a significant role in predicting potential problems so that steps can be taken in advance to minimize loss of life and damage to property. Another important point is to ensure the availability of networks in the event of a major disaster. We have developed a multi-hop wireless communication system that can be easily set up at remote sites that are outside the service area of cellular phones. Such a system requires a large-capacity high-performance battery.

We have developed an atmospheric simulator that considers the effects of weather, topography, artificial heat, and buildings. It can evaluate local environmental problems like the street canyon phenomenon, in which the local concentration of atmospheric pollutants is affected by artificial changes to the local topography caused by buildings. Further improvements of this simulator will enable more detailed environmental assessment. We are also considering realtime methods of transmitting environmental information so as to ensure the safety and security of people in the locality.

We have constructed a disaster information announcement system that provides quick and reliable transmission over mobile phone networks even in emergency situations like natural disasters. It uses data mining techniques to select only useful information, which is processed and transformed into easy-to-understand advice that urges listeners to take appropriate action.

With respect to power storage, we have built a power backup system that uses nickel metal hydride (NiMH) batteries. The NiMH battery, which is much smaller and lighter than the conventional lead battery, can fit into a limited space and provide more energy for a longer period of time than the lead battery. It will enable us to eliminate the use of lead, which is toxic and is being phased out of general products. The backup system, which was originally designed for

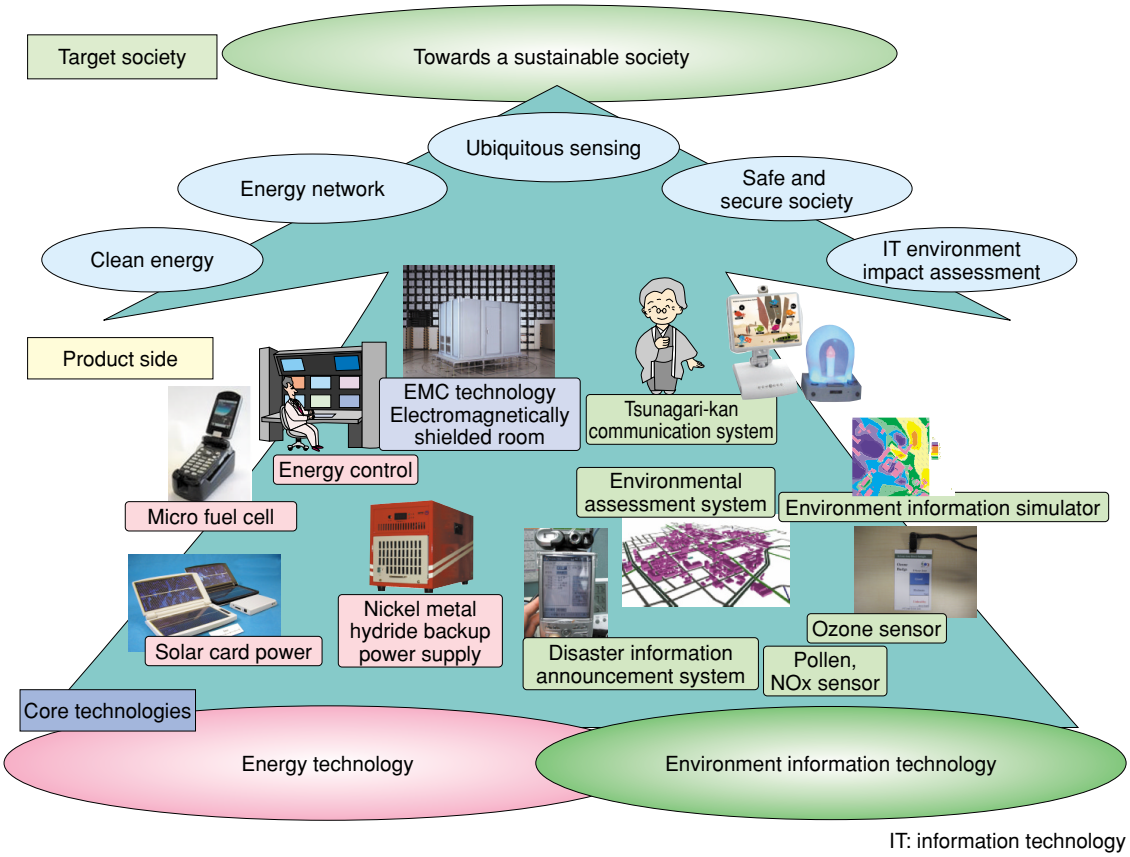

Fig. 4. Promotion of R&D to contribute to the earth, individuals, and society.

telecommunication equipment, can power various equipment and devices during a power outage. We have also fabricated a power storage system using this technology to power the movable boom of an aerial bucket truck. Whereas the hydraulic boom of a conventional aerial bucket truck is powered by the truck's diesel engine, this new one is driven by electric motors, so it is very quiet and does not generate any exhaust fumes while it is being operated. This should lead to a reduction in complaints from local residents about aerial installation work in populated areas.

Furthermore, considering the needs of the aging society, NTT has developed the *tsunagari-kan* communication system to enable elderly people to keep in touch with their children living in distant places. The human interface of this system is very user friendly, especially for the elderly who feel safe and comfortable being kept in the thoughts of their family through these sophisticated but unobtrusive network communication tools. The effectiveness of this system has been demonstrated in a field test.

3. Future development

We will continue to work on environmental information systems to improve the global environment and ensure safe and secure lives for people. In particular, we will focus on the development of local environment monitoring and weather forecasting technology that uses information collected from monitoring systems and the way in which the forecasting data is distributed. Furthermore, we will try to utilize such information for coordinating and controlling a wide range of social infrastructures. In the energy area, we promote the development of clean energy and integrated energy control systems to increase the overall efficiency of NGNs and hence reduce carbon dioxide emissions. Furthermore, we will try to combine environmental and energy technologies, for example, by developing micro energy sources for ubiquitous environmental sensors. The quantitative evaluation of the effects of ICT on reducing environmental impacts is another important development that we are working on. With all these combined, we believe that we can significantly contribute to all the critical components: the Earth, individuals, and society.

Hiroki Tanaka
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He received the B.E. degree in electrical engineering from Niigata University, Niigata in 1976. He joined the Musashino Electrical Communication Laboratories of Nippon Telegraph and Telephone Public Corporation (now NTT) in 1976 and engaged in the development of digital switching systems and switching software. From 1983 to 1987, he worked on the provisioning of the digital data switching system (DDX) and facsimile transmission systems at the engineering office of NTT headquarters. From 1987 to 1998, he was a member of NTT Network Systems Development Center, where he was involved in ISDN system development and various switching system improvements. From 1998 to 2000, he was engaged in the development of the Intelligent Network system and its service software systems in NTT Network Service Systems Laboratories, as a project manager and as an executive research manager. From 2000 to 2003, he was the project manager responsible for the HIKARI Service Promotion Project to create a wide range of services and business appropriate for the full-scale broadband and ubiquitous era that will result from optical access. Currently, he is working to achieve a safe and comfortable society based on two key approaches: environmental IT and R&D into clean energy technologies.