Energy and Environmental Technologies Toward a Sustainable Society

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Abstract

The Feature Articles in this issue focus on NTT's efforts to introduce environmentally friendly and energy-efficient technology in line with objectives to establish effective business continuity planning and, ultimately, to achieve a sustainable society. The Great East Japan Earthquake in March 2011 was a forceful reminder of the importance of both of these areas. This article presents an overview of NTT's energy management technologies that are bringing us closer to a sustainable society and reviews green infrastructure technologies that help conserve natural resources.

1. Introduction

As environmental degradation due to global warming, depletion of natural resources, and loss of biodiversity (**Fig. 1**) becomes more severe, the task of solving global environmental problems is one that companies must address as part of their corporate social responsibility.

Providing information and communications technology (ICT) services to the public requires a huge amount of electric power for routers, servers, and other network equipment, as well as for air-conditioning and power-supply systems. Moreover, the ongoing deployment of optical fiber lines, the surging use of smartphones, and the sharp increases in Internet traffic to deliver large-volume and video content has further driven up power use and caused CO_2 emissions to rise as a result.

To help bring about an environmentally friendly sustainable society*, NTT Energy and Environment Systems Laboratories conducts research and development (R&D) in areas related to the NTT Group's core business activities in order to reduce CO_2 emissions that are the main cause of global warming and conserve resources as a way of contributing to a sustainable society.

* Sustainable society: A society that meets the needs of the present without compromising the ability of future generations to meet their own needs.

2. Migration to a sustainable society

NTT Energy and Environment Systems Laboratories has committed itself to creating new technologies that will reduce the CO_2 emissions and waste generated by the NTT Group's activities to zero by the year 2050, and as illustrated in **Fig. 2**, is pursuing R&D in two broad classes of technologies to help achieve this ambitious vision: *energy management technologies* that reduce CO_2 emissions and *green infrastructure technologies* that conserve natural resources.

In the aftermath of the devastating Great East Japan

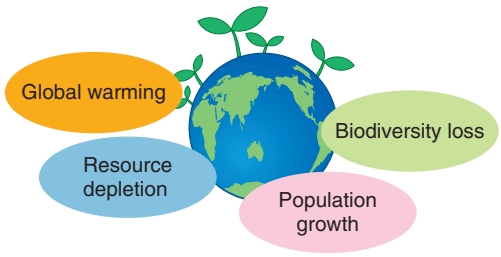

Fig. 1. Global environmental issues.

Earthquake in 2011, we learned that certain technologies are critically important: namely, energy-saving technologies that reduce energy consumption and technologies that enable a stable energy supply to ensure that ICT services—which are a critical social infrastructure—remain up and running 24 hours a day, 365 days a year through normal times as well as during disastrous events.

A schematic of a robust sustainable infrastructure that supports ICT services is shown in **Fig. 3**. The rest of this article takes a closer look at the energy management technologies and green infrastructure technologies needed to achieve a sustainable society.

2.1 Energy management technologies

An energy management system scheme that leverages and controls energy-saving, energy-storing, and energy-creating technologies to ensure that ICT services are kept up and running and available 24 hours a day, 365 days a year is under development.

2.1.1 Energy-saving technologies

The power consumed by telecom buildings and datacenters continues to increase, and it has been reported that by 2016 these facilities will require some 1.3 times the power they used in 2011 [1]. Clearly, this calls for aggressive efforts to reduce energy consumed by ICT equipment itself as well as to streamline the energy supply, air conditioning, and other functions. Some of the energy-saving technologies now being developed by the NTT Group include new energy-smart ICT equipment and ways to improve the energy efficiency of communications networks [2], as well as direct current (DC) power supply technology that supports DC power feeding in telecom buildings and datacenters [3].

We can also anticipate substantial temperature and power load fluctuations in ICT equipment now that virtual servers and networks have become so commonplace. To coordinate and harmonize the power supplies for ICT equipment with the air conditioning used to cool exhaust from that equipment, we must be able to track CPU (central processing unit) utilization, traffic loads, and other process load fluctuations and to control the amount of power consumed. A datacenter energy management system (DEMS) that will minimize these problems by coordinating and implementing optimum control between air conditioners and ICT equipment is currently under development [4].

2.1.2 Energy-storage technologies

ICT services must remain up and running not only during normal times, but also in the event of a disaster. Indeed, ICT services are even more critical when a disaster strikes. The NTT Group maintains robust backup power sources to ensure that ICT services are not interrupted by power outages. R&D work continues to focus on cost-effective high-energy-density storage batteries for telecommunications that provide

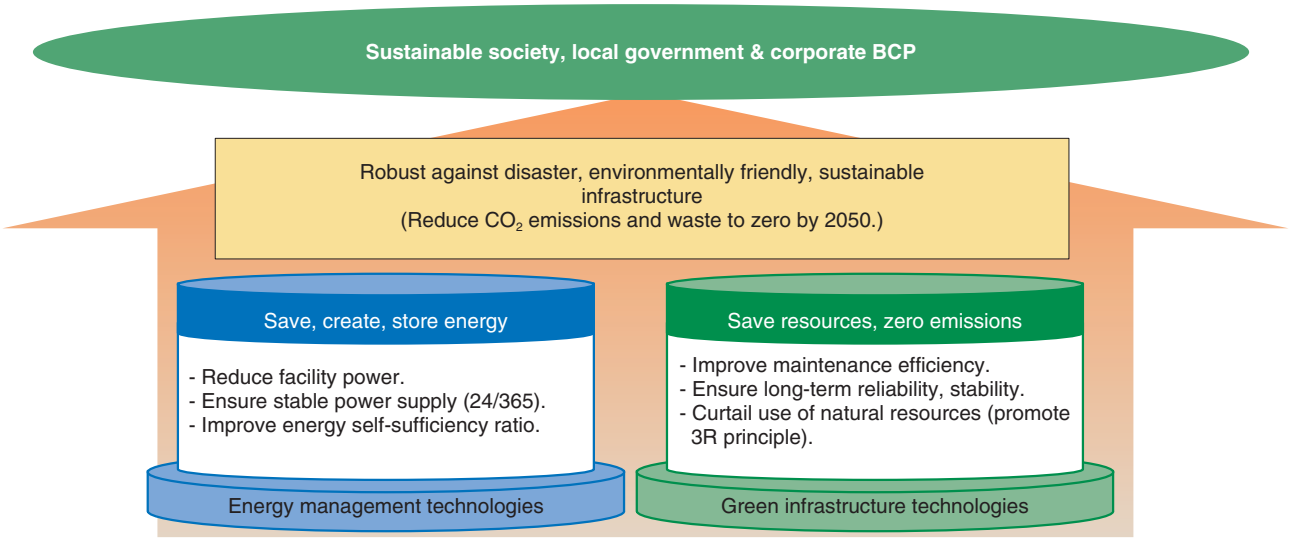

Fig. 2. R&D policy of NTT Energy and Environment Systems Laboratories.

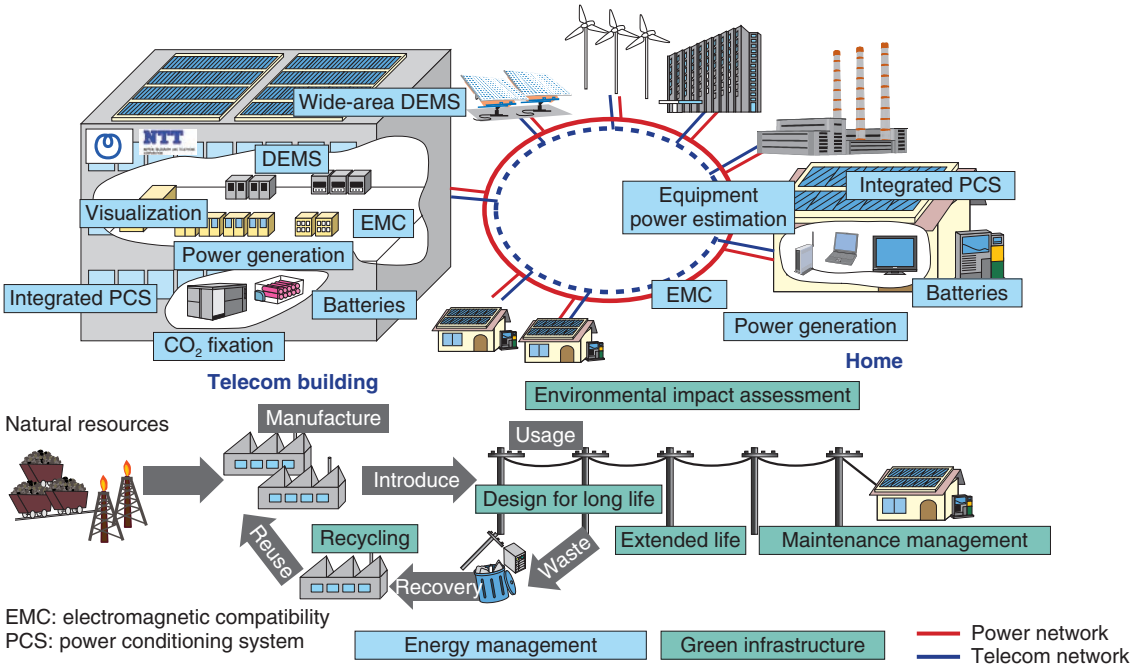

Fig. 3. Schematic of sustainable infrastructure.

the compactness and long battery life required of backup power systems.

2.1.3 Energy-creating technologies

The importance of creating low-carbon clean energy and not simply relying on commercial power became apparent in the aftermath of the Great East Japan Earthquake of March 2011. One such energy-creating technology under development at NTT Energy and Environment Systems Laboratories is the high-efficiency solid oxide fuel cell [5].

In addition, the recent implementation of a renewable energy buyback program in Japan in July 2012 is expected to accelerate the adoption of solar, wind, and other sources of renewable energy. However, the electricity-creating capacity of solar and wind power varies tremendously depending on climate and weather conditions. For the telecom sector to effectively exploit renewables, we must be able to accurately estimate and optimally control electricity generated from renewables on the supply side and energy consumed by telecom buildings and datacenters on the demand side. NTT Energy and Environment Systems Laboratories is working on an integrated PCS (power conditioning system). It provides stable centralized control that ensures a highly reliable power supply required for critical telecom loads.

A projection of energy management advances for telecom facilities that illustrates how these technologies will continue to evolve is shown in **Fig. 4**. Currently, we are seeing rapid expansion of the visualization capabilities that enable us to observe electrical power, temperature, and other pertinent data for entire buildings and for individual pieces of equipment. NTT Energy and Environment Systems Laboratories is also developing a way to visualize energy demand situations and to implement demand-side optimum control using DEMSs, DC power supply, and other tools, while seeking to improve energy efficiency. Finally, through a combination of storage batteries and solar power generation, we are working on a two-way (supply and demand) optimum energy control scheme covering a wide area that implements a robust sustainable infrastructure 24 hours a day, 365 days a year.

2.2 Green infrastructure technologies

As Japan's flagship provider of ICT services, the NTT Group owns a vast amount of equipment and resources including ICT equipment, telephone poles, and communication cabling. All of this equipment is eventually taken out of service when it reaches the end of its useful life or when equipment is overhauled to accommodate new systems. The NTT Group discards close to 800,000 tons of waste every year but

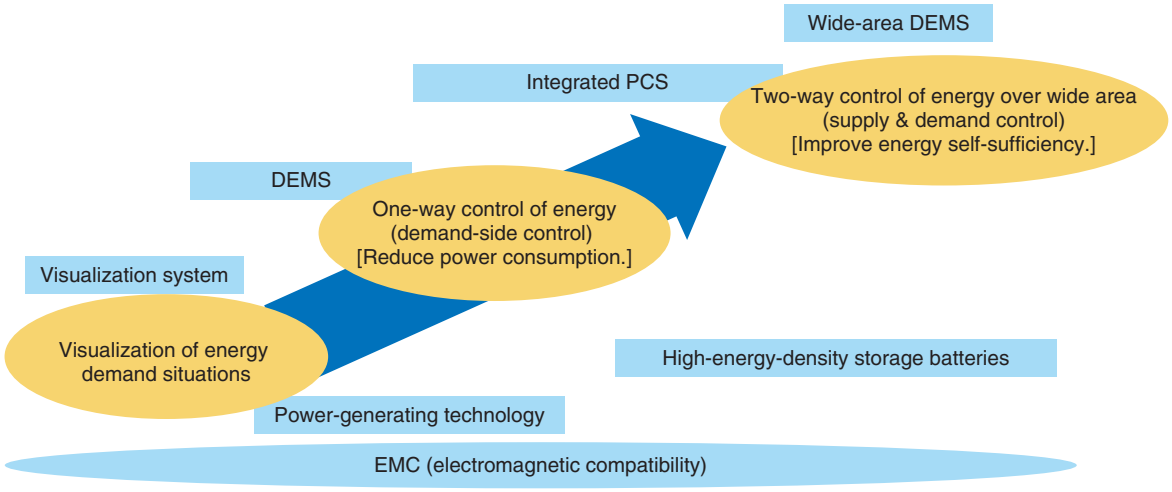

Fig. 4. Projected upgrade of energy management.

is now pursuing an ambitious program to slash company-generated waste to zero emission by reusing and recycling obsolete equipment and other materials. NTT Energy and Environment Systems Laboratories has stepped up resource-saving R&D initiatives by focusing on: (1) life-prolonging technologies that extend the useful service life of resources for as long as possible and (2) recycling technologies that promote reuse of value added materials. Specific initiatives include analyzing the breakdown mechanisms of materials, introducing technologies to extend the life of materials, developing diagnostic tools for visualizing the vulnerability to salt damage and other risks [6], designing equipment for long life and durability that minimizes the amount of resources going into telecom equipment from the time it is manufactured until it reaches the end of its useful life and is taken out of service, and finally, using recycling-friendly technologies to facilitate disassembly of equipment and easy salvage of rare metals and other useful components.

3. ICT utilization to reduce environmental impact on society

We are doing everything possible to reduce the amount of energy needed to deliver ICT services, but ICT utilization by its very nature provides a number of other energy-saving benefits. For example, by streamlining industrial activities and by reducing the need to physically travel (e.g., through videoconferencing) and transport goods, an enormous amount of energy is saved, and the associated CO_2 emissions are eliminated. To objectively quantify and assess the impact of these various factors, we created an ICT Service Environmental Impact Assessment model that we have proposed as an international standard [7]. Used in conjunction with a *Solution Eco Label* system [8], this model is helping to support and promote the NTT Group's environmental initiatives and policies.

4. Conclusion

This article offered a broad overview of NTT Energy and Environment Systems Laboratories' R&D objectives and initiatives. We recognize the importance of business continuity planning and a sustainable society, so we have redoubled our commitment to these objectives in line with our corporate responsibility to society. We are also committed to the development and deployment of a robust sustainable telecom infrastructure that remains up and running through good times and disasters alike 24 hours a day, 365 days a year.

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He received the B.E., M.S., and Ph.D. degrees in applied physics from Osaka University in 1982, 1984, and 1997, respectively. In 1984, he joined the Musashino Electrical Communication Laboratories of Nippon Telegraph and Telephone Public Corporation (now NTT), where he was engaged in R&D of micro-optical integrated devices. He served as Branch Manager of the Aomori branch office in 2009 and moved to NTT Energy and Environment Systems Laboratories in 2012. He has mainly been studying the technology for integrated MEMS (microelectromechanical systems) and environmental technology. He is a senior member of IEEE and a member of the Japan Society of Applied Physics.