Green Energy for Telecommunications

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***Abstract* - 8.2 terawatt hours of electrical energy is consumed per year by NTT group companies. This huge amount of energy is used, for example, for fixed telecommunications, mobile communications, and data centers. As network equipment has become more IP-based, the energy consumption required has steadily increased. We have implemented various energy-saving measures to prevent global warming. We introduce the actions we are taking on the strategy of "Green integration." "Green integration" is not limited to telecommunications, and it is a set of solutions that contributes to the environment in terms of energy and structure.**

I. INTRODUCTION

Global warming is a serious problem for the world, and the Intergovernmental Panel on Climate Change (IPCC) has reported that greenhouse gas emissions must be halved no later than by the middle of this century. In addition, global warming was the most important topic in the G8 summit in 2007.

Companies worldwide regard sustainable management as an important part of CSR. Thus, decreasing energy and environmental impact are necessary not only for the economy but also the earth.

This paper describes what NTT facilities is doing, mainly for telecommunications, to decrease its environmental impact.

II. ENERGY TREND OF TELECOMMUNICATIONS

A. Energy trends in Japan

The electrical energy that telecommunications consume is increasing as advances in information technology (IT) are being made. The trends of estimated energy consumption in Japan are shown in Fig. 1 [1]. The energy needed for mainframes is decreasing, but the energy needed for personal computers and routers that make IP networks is increasing.

The amount of electric power in fiscal year 2004 needed for telecommunications in Japan was 42 terawatt hours (TWh) [1], which was about 1% [2] of the total energy consumption in Japan—and was about 4% of the total power generated (970 TWh)[3].

Trends regarding NTT group's electricity consumption and revenue are shown in Fig. 2. NTT group's electricity accounts for about 1% of Japanese electric consumption. Active effort enabled us to reduce our electric consumption by 20% compared with the level in 1986. However, after 1990, electricity consumption increased because of the use of digital equipment in addition to analog equipment and the growth of a new communications services: mobile communication, datacenter, etc. In 2005, both revenue and electricity consumption were double 1986 levels. Energy consumption is mostly proportional to the NTT's business revenue.

Telecommunication is supposed to reduce the need for transportation and the movement of people, so total energy consumption should decrease in spite of the increased energy consumption needed for telecommunications.

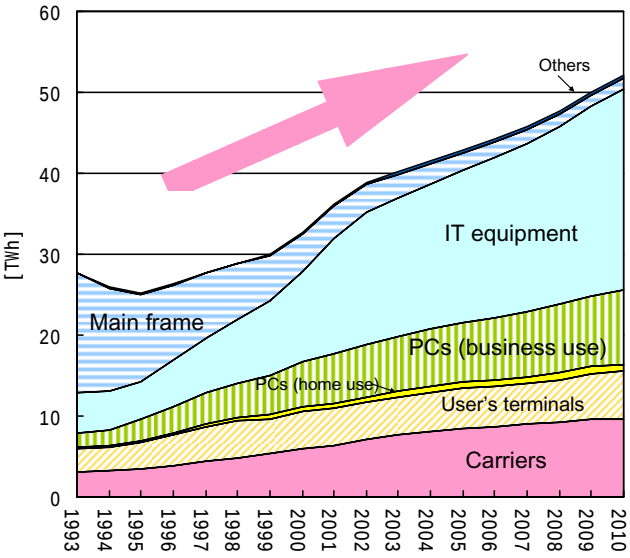


Fig. 1: Trends regarding energy for information and communication technology in Japan.

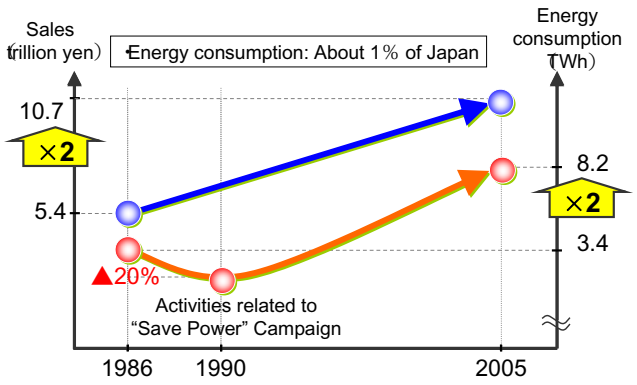


Fig. 2: NTT group's demand for electricity.

B. Activities of the NTT group to save energy

The NTT group has worked hard on energy conservation, prompting us to introduce new sources of energy in the telecommunication field as part of the "Save Power" campaign from 1987. A total of 282 solar power systems generating a total power of 4,745 kW and 18 wind power generators producing a total power of 781 kW were introduced.

We continuously worked on additional energy conservation activities following the Save Power campaign. Furthermore, we concentrated hard on improvements during the Total Power Revolution activities that started in 1998. The activities included developing network equipment to decrease power consumption. As a result, in 2005, we reduced power consumption by 0.17 TWh (about 2% overall) below the forecasted power consumption level without the activities. [4]

III. NEW CONCEPT OF "GREEN INTEGRATION" FOR NEXT GENERATION FACILITIES

The past activities that the NTT group has been involved in are ones chiefly concerning the conservation of energy for the sake of improving the economy. As stated before, we need to take global environmental protection seriously in the future to ensure company liability.

NTT Facilities, which has taken responsibility for energy system design, architectural design, and building and energy management, proposed the new concept of "Green integration." This concept involves global environment protection and is based on NTT Group's past experience and the results we have obtained.

"Green integration" is not limited to telecommunications. It is a set of solutions for contributing to environmental protection regarding energy system design, architectural design, and building and energy management. The solutions offered by "Green integration" and the areas they cover are summarized in Fig. 3. These solutions cover the three broad areas of sustainable management, reducing environmental impact, and environmental risk management. Figure 4 shows the list of items in the main menu, including concrete solutions and equipment. Figure 4 shows some of our solutions, though we have many others.

An example of an important solution first applied to telecommunications is shown in the following chapter. The case applied next is outside the field of telecommunications.

A. Implementation for telecommunications

Continuous, uninterrupted service and high reliability are needed for telecommunication infrastructure and services. Because it operates day and night, this infrastructure requires a substantial amount of electric power, but there is still a strong need to reduce the amount of power consumption.

We are now in a transitional period wherein IP networks composed of routers and other equipment are being installed, though switches have been used in telecommunications

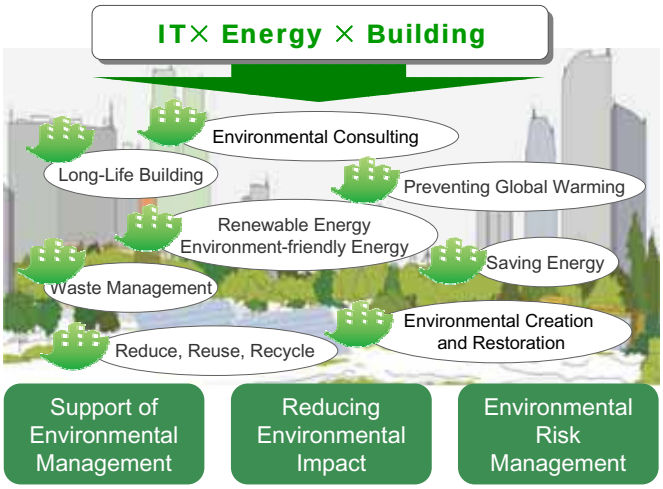


Fig. 3: Areas of "Green integration."

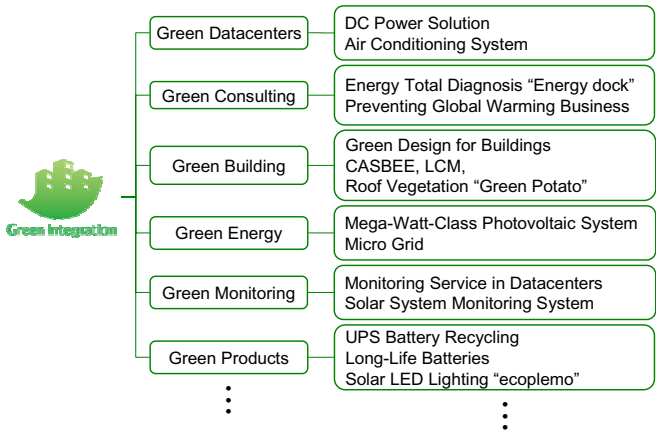


Fig. 4: Major solutions of "Green integration".

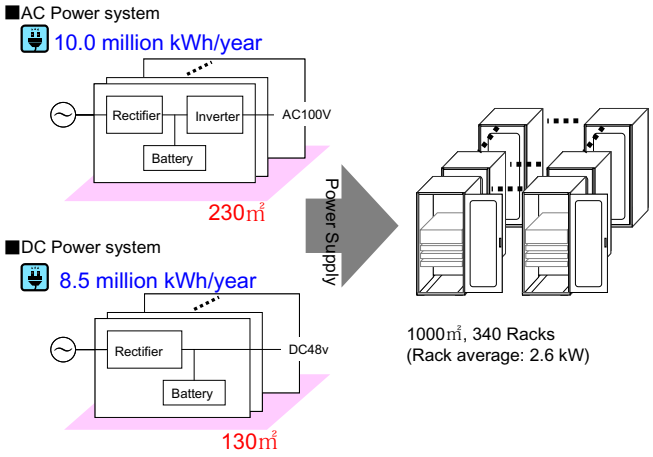


Fig. 5: Comparison between AC and DC for power supply.

equipment in the past. A building where a device on the IP network is installed is called a data center. NTT Facilities has plans for Green data centers, which will be constructed and operated in an environmentally friendly policy, and we will offer construction of the facilities based on the "Green integration" concept.

1) DC-Power: Devices for which switches and transmission devices, etc., are used in telecommunications require that power be fed by DC. However, servers, routers, and other devices that are part of the IP network are mainly fed power by AC [5]. The reason for AC being used is that the power supply is generally inside the building.

We need AC when there is no equipment with DC input. However, to improve reliability and decrease electric power loss, we must feed power using DC in NTT's data centers, where we have a lot of servers.

The difference in the composition of AC power and DC power is depicted simply in Fig. 5. The efficiency and reliability of AC power decrease, requiring there be an extra converter compared with the use of DC power, which requires inverters that compose UPS. The reliability increased by a factor of ten for the DC power compared to the AC power in a trial calculation example for the condition shown in Fig. 5. Power consumption decreased by 15%.

Evidence was obtained from an experiment conducted in California regarding the use of direct current to promote DC power [6]. Moreover, all systems in NTT facilities with monitoring and management of power and cooling systems were made with DC power [7]. A photograph of our system is shown in Fig. 6. The system has large-scale operation equipment that consists of about 30 racks. The manufacturer of the IT equipment used DC power when this system was created. The system has about 1 kA current of DC 48 V.

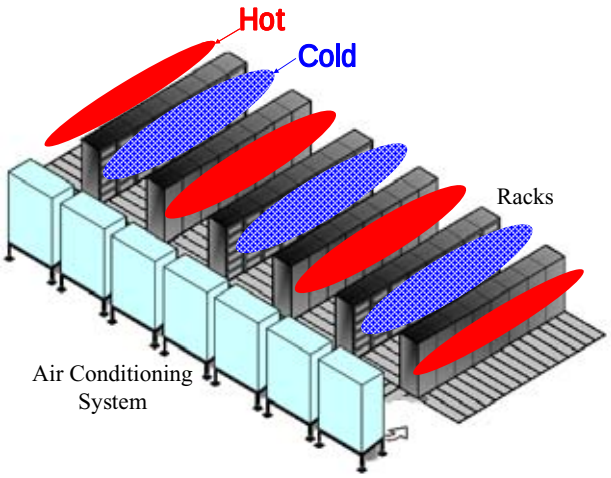
Other efforts have been made to implement environmentally friendly DC power systems at some universities and in government offices, such as the Tokyo metropolitan government.

2) Air conditioning for data centers: IT equipment for the IP network tend to have higher density and to generate more heat every year, and localizing the heat increases the calorific value of the entire telecommunication system.

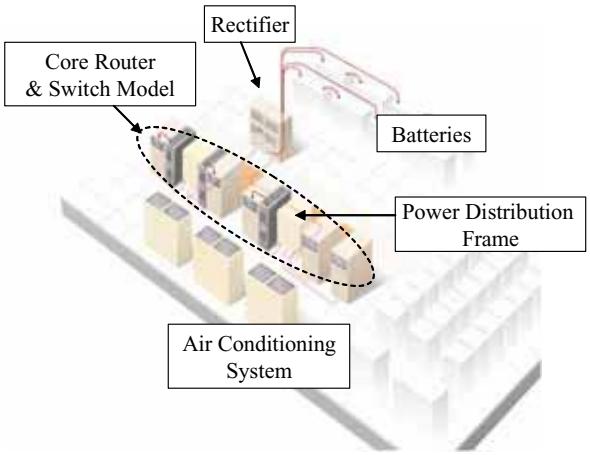
The data center needs high quality air conditioning to ensure that the characteristics of the device remain at their peak. NTT Facilities has developed a FMACS air-conditioning system, by taking into account the indoor air current, that can effectively cool such equipment, and the system eliminates high temperature areas and reduces the amount of energy consumed for air conditioning (the energy consumption is about half of that of the previous system)[8].

A next-generation network (NGN) using the IP network is being developed for the novel infrastructure. In cooperation with NTT, NTT Facilities is developing power systems and air conditioning facilities for the NGN. The racks affect power consumption and the generation of heat, and the arrangement

Fig. 6 : DC powered monitoring and management system: MaRIA.



(a) Room cooling test.



(b) Power supply test.

Fig. 7: Experiment of powering and air conditioning for NGN.

ensures practical use of the NGN, which is shown in Fig. 7. We are conducting experiments on power flow and air conditioning.

3) Monitoring measurements: Monitoring technology is used to determine in real time the rise in heat based on the amount of use of the network device. The current, power, and temperature of each rack are measured, and data is collected on the server through the Internet. The structure is shown in Fig. 8. Fig. 9 shows an example of measurement results.

The data is displayed, and web base management is possible. It is possible to measure the data using various sensors and to analyze it in a combination. In the data center of a real estate company, clients frequently add network equipment. Reliability must be high. Therefore, the amount of daily energy use must be determined, and the system must be made stable enough to avoid system crashes caused by power supply shortages and other problems. The monitoring technology greatly assists the company serving data center. Moreover, the technology plays an important role in clarifying the amount of CO_2 emissions because it determines the amount of the energy used by datacenter company and by each piece of equipment. This promotes the conservation of energy.

B. *Other implementations*

The electric power technology we have used in telecommunications can also be used in other fields.

The technology can determine the optimal solution for reliability, cost, and the environment (an image of this relationship is shown in Fig. 10.). We herein introduce businesses and experiments that use the technology.

1) Micro grid: A micro grid was constructed to study an actual proof. The grid combines various distributed power such as fuel cells, solar cells, and NaS batteries. The outline of the test system is shown in Fig. 11. The energy control system operates the distributed generators to control the influence on the commercial electric power lines wherein the micro grid is connected. This control system also optimizes the generation scheduling in terms reducing cost and environmental impact.

During an experimental study conducted at Expo 2005 in Aichi, Japan [9], we suppressed the change in the received electric power from the commercial lines by controlling the distributed generators, and we also did a test operation isolated from the commercial lines. This study was a project that the New Energy and Industrial Technology Development Organization (NEDO) commissioned us to undertake.

2) Solar system of megawatts class: Solar power systems are a pressing need, and the Japanese government is working on measures to prevent global warming as part of a national strategy.

We are participating in a "Regional sharing megawatt solar model project" commissioned by the Ministry of the Environment. Work on this project has been conducted since

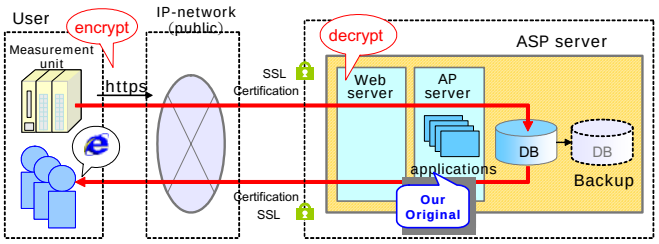


Fig. 8: Construction of monitoring service.

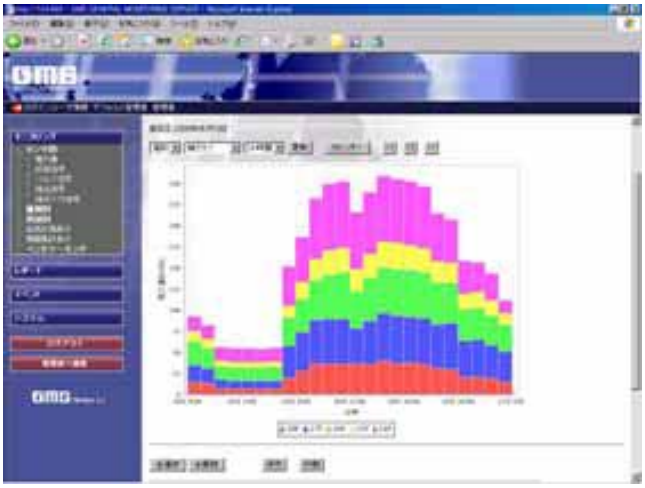


Fig. 9: Measured data.

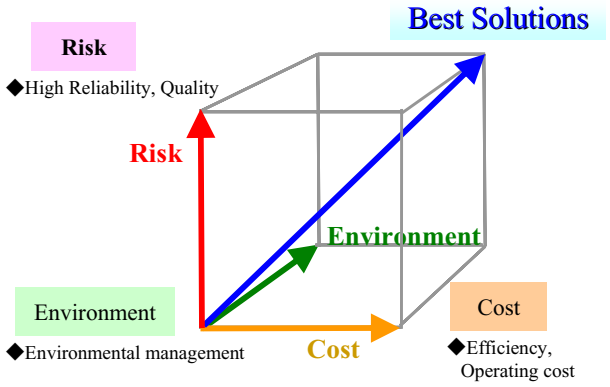


Fig. 10: Best solution regarding risk, cost, and environment.

2006 in two locations as part of a model to show the possibility of using a mega-watt solar generator for regional sharing as a means to prevent global warming.

We are also participating in another project that NEDO commissioned us to undertake. The purpose is to ensure grid stabilization with large-scale PV power generation systems. A drawing of the equipment in the plan is shown in Fig. 12. An

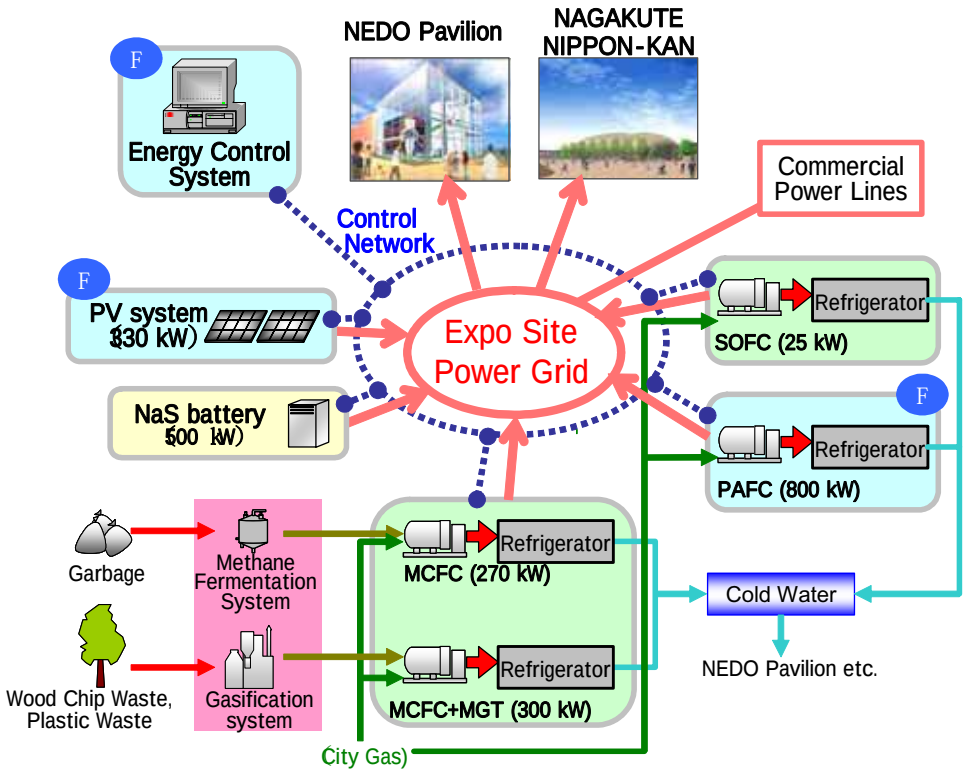


Fig. 11: Experiment involving a micro grid (Expo2005 Aichi, Japan).

approximately 2 MW solar power system with advanced solar cells will be constructed in Yamanashi Prefecture. We will develop the operation, economics, and simulation techniques for this system, along with an environmental evaluation, to promote the use of large-scale solar power systems.

3) Monitoring photovoltaic system using web technology: The system obtained information on the power generation situation and the state of operation of the solar power system using the Web in real time.

Previous solar power measurement systems were troublesome, such as hard disk crashes and OS freezing. We have developed a new monitoring system using Web technology for solar power. The system incorporates our experience from providing highly reliable technology and maintenance for various telecom systems.

This system uses memory instead of a hard disk, thereby avoiding hard disk crashing, and we used Linux as the OS because it does not freeze often. We implemented an email function that notifies engineers of trouble, and Web technology enables data to be read seamlessly. The system has been used in the mega-solar project that our company is engaged in, and the power generation has been monitored with a high degree of accuracy and reliability.

IV. CONCLUSION

NTT's trial calculation indicates that we can reduce the amount of energy consumption across Japan by as much as

Fig. 12: Mega-watt photovoltaic system.

3.9% in 2010 based on the effect of using IT, which is shown in Fig. 13 [2]. The net energy reduction would be 2.8% because the consumption of energy based on the use of IT equipment would be 1.1%. However, this presumed reduction in CO_2 differs markedly from the current increase in CO_2. In addition, the Internet is an infrastructure used in all fields, and it contributes to energy reductions in the overall industry because it promotes optimal operation of equipment.

Telecommunication equipment has shifted to IP networks. However, telecommunication energy systems should be made with due consideration towards the global environment. “Green integration” of energy systems will conduct universally in the future, though telecommunications equipment might shift from IP networks into another form entirely.

We will apply cultivated technology that is highly reliable and effective in the telecommunications to the fields of energy and environment. We will contribute to enterprise management and global environment protection based on the concept of "Green integration." Our business map for expansion is shown in Fig. 14.

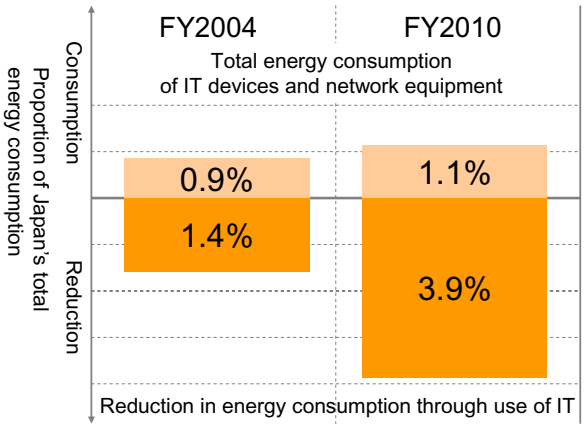


Fig. 13: Energy saved and consumed through use of IT.

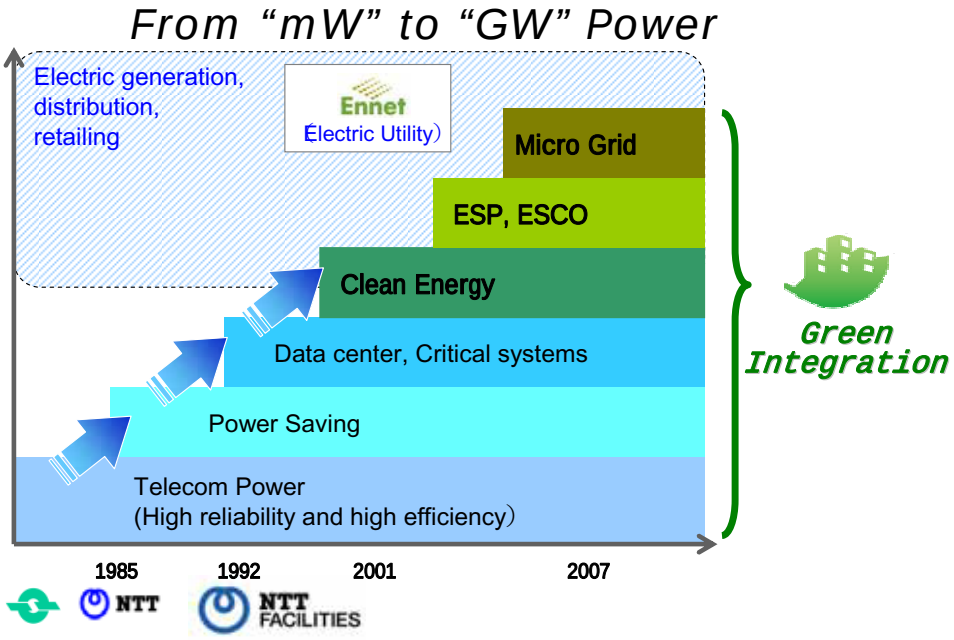


Fig. 14: Expansion of our enterprises.

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