JICA THEMATIC GUIDELINES
ON
RENEWABLE ENERGY

February 2006

Sub-Task Force on Energy Supply/Renewable Energy (JICA)
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FOREWORD

JICA Thematic Guidelines on Renewable Energy were prepared by JICA to show the direction and points to consider in cooperation carried out by JICA, after reviewing the major conditions, assistance trends in development assistance, approaches and methods related to renewable energy. Through these guidelines, JICA will share basic information and knowledge on renewable energy with related parties, as well as use them as a reference for planning and drafting JICA projects as well as for screening and implementation of such projects.

JICA also hopes that the general public will be able to understand our basic concept of renewable energy by providing these thematic guidelines through our websites, such as the JICA Knowledge Site.

Renewable energy refers to natural energy that cannot be exhausted however much they are used, such as solar power, hydro power and wind power; and secondary energy obtained by converting these natural energies. Compared with finite resources, such as petroleum and coal, renewable energy has attracted public attention in recent years as a form of energy with a low environmental impact. JICA has also been working actively on the use of renewable energy from the point of view of rural electrification.

First, in Chapter 1, the issues pertaining to the development of renewable energy are described. The fundamental challenges are reviewed from the aspects of human security, poverty reduction and redressing disparities, sustainable growth, gender, and environmental issues. The characteristics of each energy source are then discussed and the trends in assistance provided both by Japan and internationally are summarized.
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Chapter 2 discusses the purposes of developing renewable energy, the issues to be tackled, and the various approaches of JICA to cope with these issues.

Chapter 3 describes the aspects of the approaches for cooperation mentioned in Chapter 2 on which JICA should focus and the cross-cutting issues that must be considered based on past experiences in development cooperation.

These guidelines focus on the use of solar power, hydro power, wind power, biomass energy, and geothermal heat to produce electric power, which is the most common form of utilization and for which JICA has provided extensive assistance. Therefore, the utilization of these sources of energy for uses other than the generation of electric power, such as their use for heat or fuel is not included.

It is said that renewable energy is a very important consideration in response to various problems in sustainable economic growth, poverty reduction, or the improvement of people's livelihood. We therefore hope these guidelines will be of some help in the field of renewable energy development.

Finally, we would like to express our sincere thanks to the people, both within and outside JICA, who cooperated in preparing these guidelines, and to the members of the staff of the taskforce for editing them.
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Viewing the Development Objectives Chart

The following development objectives chart contains each development issue in these guidelines. This chart was prepared as a tool to understand the overall picture of each development issue and to examine the policies, direction and items for cooperation.

<Development Objectives Chart (Abstract)>

Development Objectives	Mid-term Objectives	Sub-targets of Mid-term Objectives	Examples of the means of achieving the sub-targets	JICA's main activities
1. Achievement of rural electrification and promotion of regional development through the effective utilization of renewable energy	1.1 Establishment of rural electrification plans using renewable energy for regional development	1.1 (a) Clarification of the political positioning of the introduction of renewable energy for regional development	○ Support for and review of the establishment of energy policies	Dispatch of experts, such as policy advisors, or conducting certain development study, such as surveys for rural electrification plans using renewable energy, including the implementation of various types of training.
			○ Support for and review of the establishment of electric power development policies	
			Support for the establishment of renewable energy policies	

* The symbols ○, △, and the absence of a symbol in the "Examples of the means of achieving the sub-targets" indicate the status of JICA's activities.

○: These items are firmly entrenched as the targets of JICA's cooperation programs.

△: These items are factors in JICA's cooperation programs.

No symbol: These items have hardly any role in JICA's cooperation programs.

The "Development Objectives," "Mid-term Objectives," and "Sub-targets of Mid-term Objectives" in the above chart provide a breakdown of each development issue.

The Development Objectives Chart encompasses the extent of the whole process from the development objectives to examples of the means of achieving sub-targets, and shows them in a form that includes the activities in JICA programs. Therefore, the Development Objectives Chart will help you have a clear image for examining cooperation programs.

Development Objectives Chart

	Development Objectives	Mid-term Objectives	Sub-targets of Mid-term Objectives	Examples of the means of achieving the sub-targets	JICA's main activities
Objectives chart on renewable energy	1. Achievement of rural electrification and promotion of regional development through the effective utilization of renewable energy	1.1 Establishment of rural electrification plans using renewable energy for regional development	1.1 (a) Clarification of the political positioning of the introduction of renewable energy for regional development	○ Support for and review of the establishment of energy policies ○ Support for and review of the establishment of electric power development policies Support for the establishment of renewable energy policies	Dispatch of experts, such as policy advisors, or conducting certain development study, such as surveys for rural electrification plans using renewable energy, including the implementation of various types of training.
			1.1 (b) Clarification of the feasibility and adequacy of the introduction of renewable energy for regional development	△ Determination of the potential of particular decentralized power sources △ Electric power demand forecasting based on rural community surveys in non-electrified villages △ Survey of people's willingness to pay in non-electrified villages △ Determination of the criteria for selecting methods and locations △ Validation of the project using economic and financial analyses, including an examination of electricity prices and financial plans △ Survey of environmental and social considerations through EIA and SEA	Assistance as a part of development study or technical cooperation projects, such as for rural electrification plans using renewable energy, and the implementation of various types of training can be considered. Major approaches include: • Survey of available energy supplies • Survey of the quantities required and people's willingness to pay • Establishment of databases based on the above surveys • Determination of the optimal electrification methods for each location and the time for implementation • Project cost estimation • Determination of a financial plan • Economic and financial analysis • Survey and analysis related to the improvement of people's livelihoods in the region
		1.2 Promotion of participatory regional development through the appropriate implementation and promotion of electric power supply programs using renewable energy	1.2 (a) Diversification of financial resources required for the implementation and promotion of electric power programs using renewable energy for regional development	△ Proposal for the establishment of a rural electrification fund ○ Proposals for the utilization of CDM and the introduction of private capital △ Proposals for financing methods (grant aid project, collaboration with other donors, etc.)	Assistance as a part of development study or technical cooperation projects, such as for rural electrification plans using renewable energy, and the implementation of various types of training can be considered. Major approaches include: • Proposals related to the establishment and operation of development assistance funds • Feasibility studies on the reduction of operation and maintenance costs through the utilization of private capital or CDM • Proposals related to the sharing of the burden of expenditures through collaboration with other sectors

	Development Objectives	Mid-term Objectives	Sub-targets of Mid-term Objectives	Examples of the means of achieving the sub-targets	JICA's main activities
Objectives chart on renewable energy			1.2 (b) Development of systems for implementation and promotion	○ Human resources development for the validation, approval, or implementation of each program △ Establishment of and assistance in program approval and implementation systems	These include the dispatch of experts, such as policy advisers; development study for formulating plans for rural electrification using renewable energy; implementation of F/S; certain technical cooperation projects; human resources development for the central and local governments through the implementation of various types of training; and support for institutional development.
			1.2 (c) Development of mechanisms for involving the local residents	△ Dissemination activities related to the utilization of renewable energy △ Promotion and support of local industries utilizing electricity	Assistance as part of development study or technical cooperation projects, such as for rural electrification plans using renewable energy, and the implementation of various types of training can be considered. In addition, dissemination and promotion with the cooperation of Japan Overseas Cooperation Volunteers and Senior Volunteers can also be considered.
		1.3 Proper operation and maintenance of electric power facilities using renewable energy introduced for regional development	1.3 (a) Establishment of operation and maintenance	△ Proposals for electricity pricing and billing systems through economic and financial analyses △ Support for the development of operation and maintenance systems	These include development study for rural electrification plans using renewable energy, etc.; certain technical cooperation projects; support for the establishment of the operation and maintenance systems of community associations through various types of training; support for the establishment of electricity pricing and billing systems; and support for backup systems in case of failure of the electricity supply.
			1.3 (b) Accumulation of the technical capacity required to maintain electric power facilities using renewable energy	△ Analyses of the technologies and human resources development required for operation and maintenance (solar power, micro-hydropower, wind power, biomass, hybrid systems, etc.)	These include development study for rural electrification plans using renewable energy, etc.; certain technical cooperation projects; human resources development and the preparation of manuals for operation and maintenance through various types of training.
	2. Reduction of energy risk and promotion of environmental conservation by effective utilization of renewable energy as a sustainable energy, in a global scale including developing countries	2.1 Formulation of electric power development plans using renewable energy from the point of view of energy security and global warming prevention	2.1 (a) Clarification of the political positioning of the development of electric power using renewable energy from the point of view of energy security and global warming prevention	○ Support for and review of the establishment of energy policies (including energy conservation) ○ Support for and review of the establishment of policies on electric power development Support for the establishment of renewable energy policies	These include the dispatch of experts, such as policy advisors; surveys and proposals for certain development study, such as master plans for electric power development, and implementation of various kinds of training.
			2.1 (b) Clarification of the feasibility and relevancy of the development of electric power using renewable energy from the point of view of energy security and global warming prevention	△ Understanding individual potential △ Validation of projects through economic and financial analyses, including the examination of electricity prices and fundraising plans △ Survey of environmental and social considerations through EIA and SEA	These include the master plan studies for hydro power, geothermal power, etc.; surveys of the potential; environmental and social considerations; estimation of the demand for electric power; project cost estimation; establishment of funding plans; various types of training related to these.

	Development Objectives	Mid-term Objectives	Sub-targets of Mid-term Objectives	Examples of the means of achieving the sub-targets	JICA's main activities
Objectives chart on renewable energy		2.2 Appropriate implementation and promotion of the development of electric power using renewable energy from the point of view of energy security and global warming prevention	2.2 (a) Diversification of the sources of capital required for the development of electric power using renewable energy from the point of view of energy security and global warming prevention	○ Proposals for the utilization of CDM and the introduction of private capital △ Proposals for political support for subsidy systems, etc.	These include the master plan studies for hydro power, geothermal power, etc. or technical cooperation projects, and types of training related to these; support for the establishment of systems aimed at the introduction of private funds; support for feasibility studies on reducing operation and maintenance costs through the utilization of CDM; and support for the establishment of subsidy systems.
			2.2 (b) Implementation of the transfer of technologies for the development of electric power using renewable energy (geothermal power, large-scale wind generators, etc.)	△ Human resources development for validation, approval, or implementation	These include the dispatch of experts, such as policy advisors; development studies for rural electrification plans using renewable energy, etc.; or certain technical cooperation projects; development of human resources who can validate each program through various types of training related to these; and knowledge transfer required for program approval.

Chapter 1 Overview of Renewable Energy

1-1 Current situation of renewable energy

Natural energy that cannot be exhausted however much they are used, such as solar, hydro and wind power, as well as secondary energy obtained by converting these natural energies, is known as "renewable energy." Since renewable energy is just a means of supplying energy, the role that energy supply as a whole has played for developing countries must be considered before analyzing the current situation of renewable energy. When energy supply, particularly electric power supply, the commonest form of energy use, is considered, the stable supply of electric power is an essential factor for sustainable economic growth, since electric power consumption increases in parallel with economic growth. It also plays an extremely important role from the perspective of the improvement of the quality of life, such as in medical and educational services, the promotion of poverty reduction, and the rectification of disparities between regions through the supply of electric power to rural areas.

On the other hand, the United Nations, donor countries, and the Government of Japan has adopted "human security," "poverty reduction and redressing disparities," "sustainable growth," "gender" and "environmental issues" as comprehensive major goals and issues. This means that for the issue of electric power supply and renewable energy, which provides the energy source, it is essential to also consider it from these five points of view.

(1) Human security and electric power supply

As the concept of "human security" was first raised in the international society by the Human Development Report of the United Nations Development Programme in 1994, for Japan, "human security" is also one of the basic principles of its ODA Charter, and in its medium-term ODA policy this is given due consideration throughout development assistance. According to the medium-term ODA policy established in February 2005, "human security" is defined as "a way of thinking that is centered on individual human beings, and through the protection and capacity building of individuals and communities that may be, or actually are, exposed to threats, involves the creation of a society in which each person can live out a dignified life."

When electrification programs for non-electrified regions (rural electrification) are being considered, in the planning phase of electrification, it is important to properly execute electrification by involving local residents, local governments, and, as required, the central government, and to create a system for the sustainable development of local communities. After electrification, it is important to establish an operation and maintenance system for the related facilities that is led by local communities, and to develop the relevant capabilities of the local residents. This is based on the two viewpoint of human security as follows. One is to provide "assistance that contributes to the sustainable development of the counterpart countries and local communities by approaching both the level of the governments (central and local) and the level of the local society and its residents." The other is to provide "assistance by seeing people not only as the objects of assistance, but also as future 'leaders of development,' and by focusing on the empowerment of people." Therefore human security and rural electrification can be considered as operating in the same direction.

(2) Poverty reduction and redressing disparities, and electric power supply

As part of the international movement concerning poverty reduction, the UN Millennium Declaration was adopted in September 2000 as a target to be addressed by the international community of the 21st century, and thus the Millennium Development Goals (MDGs) were established. One of the MDGs to be accomplished by 2015 is the "eradication of extreme poverty and hunger." In Japan's ODA Charter and medium-term ODA policy, "poverty reduction" has also been included as a priority issue.

When electricity is considered in comparison with water, safe drinking water is essential for human life; on the other hand, electricity can be said to be in itself only a means for living that brings some benefits to people. For example, by electrifying a certain region, a cycle is started in which productive economic activities, such as local industries, are promoted and local employment is created, leading to poverty reduction, development of the region, and redress of the disparities between urban and local areas. From the aspect of the improvement of the quality of life of the inhabitants, electricity supply to local areas can be considered to have benefits, for example in the field of medicine, by enabling the cold storage of pharmaceuticals and vaccines, and providing for the possibility of medical treatment during the night. In the field of education, both the quality and quantity of services can be improved, for example, through improvements in scholastic abilities and an increase in educational opportunities (increase in the number of students to be educated) by making it possible to study during the hours of darkness. In areas that are isolated from sources of information and where there are no newspapers, a significant improvement in access to information is possible through the introduction of television and radio as a result of electrification. With regard to this aspect, the redressing of regional disparities between urban and local areas can be expected to occur. For redressing disparities, an increase in disparities in areas where only the wealthy can enjoy the benefits of electrification must be taken into consideration, and the creation of frameworks, such as the policies and systems for the most appropriate promotion of electrification as described in (1), will be important.

(3) Sustainable growth and electric power supply

In Japan's ODA Charter and medium-term ODA policy, "sustainable growth" has also been established as a priority issue, and as one of the approaches and as a specific task, the development of the socioeconomic infrastructure has been adopted.

As described earlier, sustainable economic growth is essential for the stable growth of developing countries, and in order to ensure this growth, the development of the socioeconomic infrastructure that forms the foundation of growth is an indispensable factor. For the sustainable growth of local economies, the activation of industries in the region is an important factor. The supply of electricity to a certain area means that an efficient and easy-to-use energy source is available to the local industry, and this greatly expands the potential for growth. For example, through the means of electricity supply, agricultural, forestry and fishery products would not only be treated as primary products, but can also be cold-stored and processed, and expansion of the industrial structure from primary industry to secondary industry can be expected, bringing considerable advantages to the creation and growth of income-generating activities in the local communities. Thus, electric power supply is a form of socioeconomic infrastructure that has a major impact and is essential as a means of supporting sustainable growth, and thus plays an extremely important role for developing countries.

(4) Gender and electric power supply

Concerning gender, one of the MDGs described above is "the promotion of gender equality and the empowerment of women," and the indicators for this goal include the improvement of the proportion of female students in primary, secondary and higher education. One of the basic principles of Japan's ODA Charter is the "assurance of equity," under which the viewpoint of gender equality and the empowerment of women are set out.

One of the major goals of rural electrification is poverty reduction. In fact, about 70% of the 1.2 billion absolutely impoverished people, whose daily income is less than US$1, are women. The improvement of conditions for poor women, who account for the majority of these absolutely impoverished people, is thus essential for poverty reduction. Generally, the traditional tasks of poor women in developing countries include the collection of fuel, such as firewood, and drawing water, and since they must spend a considerable amount of their time in these kinds of tasks, women, compared to men, tend to face significant limitations with regard to educational opportunities and participation in income-generating activities. For example, if the time taken for carrying out tasks such as firewood collection can be significantly reduced, this will open up possibilities for the improvement of such disadvantageous conditions. Furthermore, a large number of women suffer health hazards from harsh physical labor or respiratory diseases caused by the cooking smoke generated when using traditional fuels. Thus, liberation from hard physical labor and a reduction in health hazards can also be achieved through electrification. In addition, electrification has the effect of reducing crimes committed at night and is a positive factor in minimizing the risk to women of being victims of such crimes. The issue of electrification is therefore important from the viewpoint of gender.

BOX 1-1 Renewable Energy and Gender

When electrification by renewable energy is being considered, it is necessary to pay close attention to the social position and role of women. In the project for the promotion of PV systems in Guatemala, although the women work mainly at homes, due to the male-dominated community, only the men received instruction for battery maintenance. As a result, when the need for maintenance arises in the men's absence, the women cannot deal with the problem, and this had an adverse effect on the durability of the batteries. An NGO, Foundation Solar, in Guatemala reported that by creating an environment in which the women were able to participate in workshops without hesitation, the performance of the project improved.

(UNDP: Gender and Energy for Sustainable Development: A Toolkit and Resource Guide/ 2004)

(5) Environmental issues, electric power supply and renewable energy

Regarding environmental issues, the "ensuring of environmental sustainability" is included among the MDGs, and one of the indicators of this target is the GDP per unit of energy used (energy efficiency) or the CO_2 emissions per person. In Japan's ODA Charter and medium-term ODA policy, "efforts to deal with global problems" has been established as a priority issue. Since energy supply and environmental conditions are extremely important factors in sustainable development, it is recognized that various problems related to the

environment cannot be solved by one country alone, but must be approached on a global scale. Thus the promotion of the use of renewable energy as a clean energy has been identified as a means of achieving the goals of the improvement of the global environment, the reduction of greenhouse gases, and the reinforcement of energy security, as determined in the World Summit on Sustainable Development (WSSD) held in 2002, and international conventions, such as the International Conference for Renewable Energies of 2004, the Evian Summit of 2003, and the Gleneagles Summit of 2005.

The features of renewable energy, which is expected to become an important substitute for fossil fuels more than ever before, is now considered.

Primary energy, which provide the energy for electric power generation, include fossil fuels such as coal, petroleum and natural gas, nuclear energy, and natural energies, such as solar, hydro (including micro-hydropower), biomass, wind and geothermal power. These natural energies are generically termed "renewable energy." Compared with fossil fuels and nuclear energy supplies which rely on limited resources, renewable energy has the advantage that it is an infinite source of energy obtained from the natural environment. Unlike fossil fuels and nuclear energy which place a heavy load on the environment in terms of the emission of air pollutants and greenhouse gases and the disposal of nuclear waste, renewable energy is considered an environment-friendly clean energy. A rich endowment of renewable energy resources is often available in the rural areas of developing countries. In addition, energy supply system utilizing renewable energy is the environment-friendly system of energy supply which can be achieved by simpler technologies. Consequently, it is an effective mean of electrification promotion and social development, particularly in rural areas where development has been hampered.

As described above, from the point of view of ensuring energy security and approaching environmental issues on a global scale, electric power supply utilizing renewable energy is an important challenge to be considered.

1-2 Definition of renewable energy

Natural energies, which are never exhausted however much they are used, such as solar, wind and hydro power, and secondary energy obtained by converting these natural energies, are collectively called renewable energy. Wave power generation and waste incineration power generation are also included in this category. Although the use of renewable energy other than for electric power generation includes its use as a fuel for obtaining heat or motive power, these guidelines focus on electric power generation utilizing the most widely available forms of solar, wind, hydro, biomass and geothermal power. The definition and features of each of these sources of energy are described below. For secondary energy supply, in particular, electric power supply, which is the most common form of utilization, is summarized separately as the Thematic Guidelines on "Energy Supply."

(1) Photovoltaic (PV) power generation

The amount of solar energy reaching the earth's surface is equivalent to about 1 kW/m^2, and when it is considered in terms of the total amount of solar energy over the entire earth's surface, the amount of energy consumed by the whole world in a year is equivalent to only one hour of sun eradiation. However, the problem is that the energy density of solar energy is low, and solar energy is also affected by natural conditions.

Photovoltaic power generation refers to the conversion of solar energy into electricity using semiconductors. A PV system is composed of arrays of photovoltaic cells for converting sun eradiation into electricity, a charge controller, and a storage battery. Depending on the method of using the electricity, a direct current (DC) system or an alternating current (AC) system is used. In the case of the AC system, an inverter is required to convert the electricity produced by the photovoltaic cells from DC to AC.

Photovoltaic power generation has the following features: (1) since no air pollutants or noise are generated in the production of electric power, the environmental load is low; (2) the energy source is clean and limitless; (3) a small system can be easily moved, and the required amount of electric power can be generated in the place where it is to be used; and (4) since there is no mechanical wear, operation and maintenance are easy.

The features of photovoltaic power generation are summarized as follows:

Advantages	Disadvantages
• Generates no CO_2 • There is no possibility of exhaustion • Photovoltaic arrays can be moved as required • Operation and maintenance are easy • Technology has been established • It is an entirely domestic source of energy • As a rule, it is a source of energy that is available regardless of the regional characteristics	• Energy density is low • Affected by natural conditions • Initial investment in power generation is large • Has difficulty in providing stable supply

(2) Hydro power generation

In hydro power generation, water from a higher place falls to a lower site, and the power drives a water turbine to generate electricity. In other words, the potential energy of the water is converted to velocity energy or pressure energy to rotate the water turbine and is in turn converted to electrical energy by a dynamo.

Hydro power generation is classified into general hydro power generation and pumped storage hydro power generation. Since pumped storage hydro power generation is a system in which water is pumped up to an upper regulating reservoir using the unused electricity generated at night, and the stored water is then released to generate power when it is needed at times of peak demand for electric power, it cannot be included as a form of renewable energy.

General hydro power generation can be classified into run-of-the-river type power generation, pondage type power generation, and reservoir type power generation according to the operating method. Among these, since the pondage type and the reservoir type involve the construction of large-scale dams, cause damage to the environment in the submerged areas, and change the river environment downstream from the dams, it is a fairly contentious issue as to whether these can be considered renewable forms of energy or not. However, for nations that have hydro potential, since hydro power generation has an important role from the viewpoint of energy security as a form of energy that is entirely domestic, and its importance is widely recognized as one of the forms of energy that contribute to global warming prevention due to its very low CO_2 emissions, all types of general hydro power

generation are included in these thematic guidelines.

The features of hydro power generation are summarized as follows:

Advantages	Disadvantages
• Operation and maintenance costs are low • Relatively stable electric power can be supplied • Technology has been established • Power generation on various scales is feasible • Development in collaboration with other sectors (irrigation, soil conservation, flood control) is feasible • It is an entirely domestic source of energy • CO_2 emissions are extremely low	• Potential site is limited (distance from the locations of demand, effect of rainy and dry seasons) • When controlled by the region, technology for operation and maintenance is required • Large initial investment is required

(3) Biomass power generation

Biomass refers to the quantity (mass) of biological resources (bio), and represents organic resources produced by animals and plants that can be reused as an energy source. As long as the biomass is used in a sustainable way, the balance of atmospheric CO_2 concentration is not affected (it is carbon neutral). To utilize biomass in power generation, a gaseous or liquid fuel is created through direct combustion, methane fermentation or gasification of the biomass. Direct combustion means to burn the biomass to generate electricity using a steam turbine, and a relatively large-scale facility is required. Methane fermentation is a means of extracting methane from biomass, and combusting it to generate electric power. Gasification is a means of gasifying biomass, and the gas is combusted to generate electricity. The scale of the facility can also be reduced. In methane fermentation and gasification, the gas-engine technique is used.

Unlike photovoltaic power generation and wind power generation, biomass power generation is not affected by natural conditions, such as the weather, and power generation can always be performed.

The features of biomass power generation are summarized as follows:

Advantages	Disadvantages
• Carbon-neutral • Not affected by natural conditions • It is an entirely domestic source of energy	• Has difficulty in providing stable supply • Since it is a new technology, there are few examples • Power generation efficiency is low

(4) Wind power generation

Wind power generation utilizes the energy of the wind and converts it to electrical energy. The energy of the wind is converted to kinetic energy in the form of the rotation of the wind turbine blades, which operate a dynamo to convert it to electrical energy. From this viewpoint, it is said to be 100% renewable energy.

In recent years, the importance of global warming prevention has been recognized, and wind power generation has attracted public attention as a clean source of renewable energy that emits no greenhouse gases. In these days when petroleum prices are rising, the wind is an inexhaustible gift of nature, and wind power generation is expected to be a system that does not produce CO_2 or waste during power generation. However, utilization of wind power has some disadvantages including the instability of the supply of electricity and the limited number of potential sites for effective wind power.

The full-scale utilization of wind power started from the middle of the 1980s in the US as well as in Denmark and the Netherlands, and in recent years it has been rapidly introduced into Germany, the UK, Spain, and Italy.

The features of wind power generation are summarized as follows:

Advantages	Disadvantages
• The technology has been established • It is an entirely domestic source of energy • No CO_2 is emitted	• Has difficulty in providing a stable supply • Noise control engineering is required • Resource potential is limited • Technical capabilities for operation and maintenance are required

(5) Geothermal power generation

Geothermal energy is a source of thermal energy stored deep below the ground. The amount of energy that can be actually extracted and used is limited. The extracted geothermal energy can be directly used as a fuel, and can be used to power turbines to generate electricity as well.

The recent recognition of the importance of global warming prevention has meant that geothermal energy is also attracting public attention as a clean source of renewable energy that emits no greenhouse gases during its utilization. In these days when petroleum prices are rising, for nations with geothermal potential, the development of an entirely domestic source of geothermal energy is expected to contribute to the dispersion of primary energy sources from the viewpoint of energy security.

The features of geothermal power generation are summarized as follows:

Advantages	Disadvantages
• Available as a base power source • The technology has been established • It is a fully domestic source of energy • CO_2 emissions are extremely low • Multipurpose uses such as for heat pumps are feasible	• Fine operating adjustments to meet demand variations are difficult. • Resource potential is limited • Exploration costs and risks are high • Technical capabilities for operation and maintenance are required • Large initial investment is required

1-3 International assistance trends

(1) Assistance trends

The broad guidelines for cooperation in the field of renewable energy were provided by Agenda 21, adopted by the UN Conference on Environment and Development in 1992 (Rio Earth Summit), in which renewable energy was positioned as an important pillar of development assistance. In the conference, the operational guidelines for the Global Environment Facility (GEF) were clarified, which strengthened the subsequent approaches to renewable energy by bilateral and multilateral organizations.

At the Okinawa Summit in 2000, the G8 Renewable Energy Task Force was established, and a report on the utilization of renewable energy for the improvement of people's livelihoods was published. In the World Summit on Sustainable Development (WSSD) held in 2002, an implementation plan was adopted, and an increase in the proportion of renewable energy to total energy in the world was agreed on. Furthermore, at the International Conference for Renewable Energies (Bonn, 2004), a new international goal in which one billion people in the world should be able to use renewable energy by 2015 was established, focusing on developing countries.

After the Kyoto Protocol came into effect in February 2005, in the framework of the Clean Development Mechanism (CDM), small-scale CDM projects (with a maximum output of 15 MW or lower) utilizing renewable energy, such as micro-hydropower, wind power and biomass, attracted public attention, and private enterprises have begun to focus on renewable energy power generation connected to countrywide systems. The details will be described in Chapter 3.

As described above, the promotion and expansion of renewable energy are globally recognized as major issues. As the trends in recent years show that the technology of photovoltaic power generation and other forms of renewable electric power generation have been established to a certain extent, the focus of assistance is shifting from the stage of technical development and its demonstration to the building of mechanisms for promoting its utilization.

(2) Efforts of each donor

1) World Bank (WB)

Since 1990, the World Bank has provided financing of about US$ 2.3 billion in the field of renewable energy. About 10% of this is for projects using the GEF funds. In terms of regional trends, East Asia, Europe and Central Asia account for about 50% of the total of these loans from the WB. Furthermore, the WB is strengthening its commitment in response to the Bonn International Conference in 2004 by stating that there would be a 20% expansion in the scale of financing to support renewable energy and energy efficiency in the next five years.

In recent years, the WB has assisted Vietnam, Papua New Guinea, Laos and other nations in the establishment of action plans to introduce renewable energy, and has also assisted China in the establishment of a Renewable Energy Law.

2) UNDP

The UNDP is strengthening its assistance for the introduction of renewable energy into non-electrified areas taking various approaches, such as poverty reduction, the empowerment of women, job creation and environmental conservation. In 2001, a trust fund through which a project can be more rapidly approved than before was launched to complement the GEF. The UNDP mainly works on the installation of PV systems in non-electrified areas, promotion and dissemination through seminars, and the capacity development of government organizations. In addition, the UNDP's support has been spreading more widely in recent years, such as for the evaluation of potential geothermal resources and the implementation of a pilot project in Georgia.

3) Asian Development Bank (ADB)

In recent years, the ADB has worked on the promotion of and support for introducing renewable energy through the capacity development of the staff of the Alternative Energy Development Board (AEDB) of Pakistan, studies of the potential for renewable energy in poorer areas in the inland regions of China, and a survey on willingness to pay.

4) Bilateral assistance

(a) USA

The United States Agency for International Development (USAID) is actively promoting its assistance in the Philippines, Thailand, Vietnam, etc., focusing on support, promotion and dissemination activities for the introduction of PV systems.

(b) Germany

The German Agency for Technical Cooperation (GTZ) has been carrying out a photovoltaic power generation project since 1979, and PV systems have so far been installed in Zimbabwe, Algeria, Tunisia, Morocco and the Philippines.

(c) France

The French Agency for Environmental and Energy Management and the French Electric Power Authority have established the FACE fund (fund for depreciating rural electrification costs) for the promotion of renewable energy supply systems including PV systems in rural regions, and have promoted assistance in French Polynesia, New Caledonia, Morocco and other countries.

(d) Netherlands

The Netherlands Development Corporation is pursuing the development of fund-raising mechanisms for renewable energy focusing on photovoltaic power generation in India, Indonesia, and African countries.

5) Other organizations

Typical of the international NGOs is the Intermediate Technology Development Group (ITDG) operating in Sri Lanka and Peru. The ITDG is installing micro-hydro and pico-hydro power generators, and provides detailed training for their management, operation and maintenance to local governments and the residents. As for other organizations, the Solar Electric Light Fund (SELF) and the Natural Renewable Energy Fund (NREF) are executing projects for the promotion of PV systems in non-electrified areas in collaboration with the USAID.

1-4 Japan's assistance trends

(1) Policy guidelines

In the "Medium-Term Policy concerning Official Development Assistance (ODA)" established in 2005, energy is positioned as an element that is necessary for solving the two priority subjects of "sustainable growth" and "approach to global issues." As part of "sustainable growth," energy is stipulated as the means "to support the development of socioeconomic infrastructures contributing to the development of trade and investment environments such as the transportation infrastructure, including roads and ports; the energy-related infrastructure, including power generation and distribution facilities and petroleum/natural gas-related facilities; the information and telecommunications infrastructure; and the living environment infrastructure" from the viewpoint of development of socioeconomic infrastructures. As part of the "approach to global issues," renewable energy is addressed in particular as one of the priority fields in the specific approach to environmental issues, "countermeasures for global warming prevention, such as the suppression and reduction of greenhouse gas emissions by utilizing renewable energy and energy conservation (including assistance for the use of the Kyoto Mechanisms), and adaptation to their adverse effects resulting from climate change (including countermeasures to deal with climatic hazards) are stipulated. In the "Medium-Term Policy concerning Official Development Assistance (ODA)" (old) established in 1999, "energy" is listed as an item of priority subject; whereas in the "Medium-Term Policy concerning Official Development Assistance (ODA)" (new), the item "energy" has been deleted. Renewable energy as a whole is discussed as a tool to cope with environmental issues.

(2) Implementation of assistance by related organizations

In Japan, various organizations are involved in developing and promoting renewable energy. These will be outlined below.

1) New Energy and Industrial Technology Development Organization (NEDO)

NEDO is the largest technical development implementing organization in Japan related to the introduction and promotion of new forms of energy and energy conservation focusing on renewable energy, and for research and development on industrial technologies. NEDO promotes research and development that cannot be carried out by individual private enterprises by utilizing a wide network of industries, universities and public research organizations, supported by public funds. It performs active research and development activities in Japan as well as in foreign countries, especially in developing countries.

2) New Energy Foundation (NEF)

NEF conducts basic surveys, research and the provision of information for developing and introducing new diversified forms of energy, various support projects and public relations activities for promoting such new forms of energy, and policy proposal activities. Although its activities are focused on domestic surveys, public relations and dissemination activities, it also conducts international cooperation activities, such as holding international symposiums and consultation programs focused on feasibility studies (F/S) for overseas CDM and hydro power development projects.

3) Japan Bank for International Cooperation (JBIC)

JBIC provides “support for environmental improvement and pollution prevention” as a priority issue, and provides loans to private enterprises marketing renewable energy equipment and conducting power generation in developing countries, and as a banking facility carries out investment and loan programs for enterprises that are contributing significantly to global environmental issues including potential CDM projects and projects related to renewable energy and energy conservation. For CDM projects, JBIC provides not only investments and loans, but also positive support, such as support for the preparation of Project Design Documents (PDDs) and the provision of know-how through seminars and study meetings. In the form of yen loans, JBIC provided about ¥5.9 billion for the “Lahendong Geothermal Power Plant Project” in Indonesia, and about ¥13.5 billion to the “Zafana Wind Power Generation Program” in Egypt, in order to contribute to the reduction of the environmental load through the utilization of renewable energy.

4) Japan External Trade Organization (JETRO)

Among the various activities of this trade promotion organization, JETRO provides support for developing countries on the premise of advancing Japanese private enterprises. Among these efforts, there is a scheme called the “study on the global environment and plant activation programs,” and F/S using the technology and know-how of Japanese enterprises is carried out in the scheme, in order to promptly find and establish yen loan projects in which Japanese enterprises can participate Feasibility studies on power generation facilities using renewable energy, such as photovoltaic power generation, were

conducted in FY2005 using this scheme.

5) Global Environment Centre Foundation (GEC)

For the promotion of CDM/joint implementation (JI), the Ministry of the Environment has conducted F/S and other studies since FY1999 to identify significant projects adopting CDM or JI and to accumulate the findings for the creation of domestic and international rules. Contracted by the Ministry of the Environment, GEC serves as the secretariat for the survey, and carries out the invitation and selection of projects, survey management, project evaluation, and the compilation of the survey results for programs leading to the reduction of greenhouse gases and the reinforcement of sinks that are being carried out by Japanese private enterprises or NGOs in countries subject to CDM/JI.

6) NGOs

Environment-oriented NGOs are mainly involved in the proposal of policies for the effective utilization of sustainable renewal energy and the efficient use of energy aiming at overcoming the existing energy system based on fossil fuel.

Chapter 2 Approaches to Renewable Energy

2-1 Targets for renewable energy applications

(1) The development issues on rural electrification

Many developing countries have issues of poverty caused by disparities between urban areas and rural areas in economic and social development, and, as described in "1-1 Current situation of renewable energy," from the viewpoints of human security, poverty reduction and redressing disparities, sustainable growth, gender and environmental issues, rural electrification is an issue to be promptly dealt with.

The population density in the object regions is low, and the electric power demand is of a small-scale widely distributed form, and the economic efficiency of electrification by expanding the electric power distribution network is extremely low. As a result, the implementation and realization of rural electrification through the use of the government's own budget or through private funding is difficult for developing countries, and there are no spare available funds. In case electrification is to be implemented so that it overcomes such difficulties, as described in Section 1-1, the following plan shall be developed. That is, a detailed rural electrification plan for regional development in which the local inhabitants, local governments, and, as required, the central government, are properly involved must be formulated at the planning stage. In addition, for the proper implementation and promotion of an electric power supply program, participatory development for residents is essential, and the creation of a mechanism in which the results lead to sustainable growth in the rural society becomes even more important. To implement and promote such programs, electrification should be promoted through technology that is useful for the region and are easy to manage. After electrification, it is important to develop a community-led operation and maintenance system for the related facilities and to develop capacity of local residents. However, the actual situation is that many developing countries have issues due to the fact that the proper mechanisms for electrification have not been established, the capacity of the people involved in these rural electrification programs is insufficient, the funds to implement the program are insufficient, and the introduction of private funds is difficult. Consequently, the implementation and promotion of sustainable rural electrification programs are often difficult, and these cause issues in developing rural electrification programs utilizing renewable energy.

Particularly with regard to issues in securing financing, from the viewpoint of the improvement of profitability and expanding the participation of private businesses, the possibility of sustainable promotion, such as through the utilization of the GEF special fund, the application of CDM, and the utilization of a revolving fund or microfinance must be considered.

(2) The development issues on renewable energy

As described in Section 1-1, renewable energy cannot be depleted, unlike fossil fuels or nuclear energy, and is environmentally friendly clean energy without air pollution, emissions of greenhouse gases, and the need for waste treatment. Therefore, in view of energy security and global warming prevention, it can be said that the supply of electric power utilizing renewable energy is an important issue to be examined positively.

When rural electrification programs are reviewed, for regions where the economic efficiency of electrification is extremely low, as described in section (1) above, for example, for mountain areas and islands, electrification using independent power sources that are isolated from the power grid system is a highly practical means of rural electrification. Conventionally, although the main independent power source has been diesel power generation, the recent trend is for environmentally friendly renewable energy to be used economically, thus the movement towards the utilization of renewable energy is being intensified. For regions to be electrified using independent power sources, renewable energy becomes an effective energy source. However, generally, there are some disadvantages as follows: renewable energy has a low energy density; is more expensive than fossil fuels, and so on; has unstable supplies since it is affected by the weather; and may not cover all energy demand, depending on the scale of the electrification. Therefore, when electrification utilizing renewable energy is promoted, the issues to be dealt with include clarification of the political positioning of renewable energy within electric power development plans as a whole, clarification of the feasibility of electric power development utilizing renewable energy, and clarification of its relevance.

2-2 Effective approaches to renewable energy development

The breakdown of development issues on renewable energy presented by the Economic Development Department is as follows: "development objectives" → "mid-term objectives" → "sub-targets of mid-term objectives" → "examples of the means of achieving the sub-targets" from the viewpoint of economic development as in the Development Objectives Chart shown in the beginning. On the basis of this Development Objectives Chart, two development objectives, five mid-term objectives, and JICA's approaches will be described below.

Development Objective 1	Achievement of rural electrification and promotion of regional development through the effective utilization of renewable energy

Development Objective 1 focuses on renewable energy as a tool for regional development in rural villages. As described in Chapter 1, the electrification of non-electrified areas through the introduction of renewable energy has the effect of achieving a substantial improvement in access to medical services, education and information, and the comprehensive promotion of regional development can therefore be expected.

In order for regional development to be promoted through rural electrification utilizing renewable energy, planning for efficient electrification is first required. Then, the programs must be properly implemented and promoted through the acquisition of the funds and the establishment of the organization control on the basis of the established electrification plan. Furthermore, by adequately operating and maintaining the renewable energy power generation facilities and their operations, a cycle of "planning," "implementation," "promotion" and "operation and maintenance" for the renewable energy program is created, and its sustainable operation becomes feasible.

The following mean can also be considered as an exceptional cases: that is an already electrified village will make a profit by selling the electric power generated utilizing renewable energy to promote regional development.

From the above description, three mid-term objectives can be considered in order to achieve this development objective.

Mid-term Objective 1-1	Establishment of rural electrification plans using renewable energy for regional development

Approach to the Mid-term Objective

In the establishment of rural electrification plans using renewable energy, there are 1) the approach to policy and priority plans; and 2) the approach to the validation of the feasibility and adequacy of the introduction of renewable energy.

1) Approach to policy and priority plans

Renewable energy is positioned as a part of the entire energy policy. When renewable energy is utilized to generate electric power, it must be also positioned as part of the electric power policy that constitutes a part of the energy policy. Therefore, to promote the introduction of renewable energy, the positioning of renewable energy in the energy policy as a whole, and specifically the electric power policy, must first be clarified, and then, laws or regulations based on this positioning must be established. In addition, to establish a rural electrification plan utilizing renewable energy, it is necessary to ensure compatibility with priority plans, such as the nationwide electric power development plan and the rural electrification plan through the extension of distribution lines. As a premise for establishment of the plan, an approach to the support or review of the establishment of policies and priority plans is required.

JICA's approach

As part of its approach to policy and priority plans, the implementation of certain development studies, such as through the dispatch of experts as policy advisors, and planning and surveys for rural electrification utilizing renewable energy are included. Major approaches are as follows:

- Assistance or review for energy policy making
- Assistance or review for renewable energy policy making
- Assistance or review for electric power policy making
- Assistance or review for the establishment of electric power development plans
- Assistance or review for the establishment a rural electrification plan by extending the distribution lines
- The provision of various forms of training, such as country-focused training for counterparts (C/P), that is related to the above

2) Approach to the validation of the feasibility and adequacy of the introduction of renewable energy

When renewable energy is utilized for rural electrification, it is naturally necessary to sufficiently validate its feasibility and adequacy. The effective utilization of electricity supplied through the introduction of renewable energy into regional development must also be analyzed.

JICA's approach

As its approach to the validation of the feasibility and relevancy of the introduction of renewable energy, the implementation of surveys of rural electrification utilizing renewable energy and various training programs are considered. Major approaches are as follows:

- Surveys of available supplies (surveys of the potential of decentralized power sources, environmental and social considerations)
- Surveys of the potential consumers (surveys of energy demand and the willingness to pay through village surveys)
- Arrangement and analysis of basic data based on the above surveys (construction of databases)
- Determination of the electrification method and the timing of implementation for each locality (development of standards)
- Project costs estimation
- Establishment of a financing plan
- Validation of the feasibility and relevancy through economic and financial analyses
- Surveys and analysis related to improvements in local people's livelihoods through the utilization of electric power
- The provision of various forms of training, such as country-focused training for C/P, which is related to the above

Mid-term Objective 1-2	Promotion of participatory regional development through the appropriate implementation and promotion of electric power supply programs using renewable energy

Approach to the Mid-term Objective

Promotion of the appropriate implementation and electric power supply programs using renewable energy, involves 1) the approach to financing; 2) the approach to institutional development; and 3) the approach to the local residents.

1) Approach to financing

As described above, since the economic efficiency of rural electrification is extremely low, systematic implementation is difficult without sufficient mechanisms for securing financing, and support for this is required.

JICA's approach

Regarding JICA's approach to financing, the survey and proposal of certain development studies, such as studies of rural electrification plans utilizing renewable energy, and assistance in capacity development through technical cooperation projects are included. Major approaches are as follows:

- Assistance in the establishment of funds to secure government financing, and the establishment of the operational methods for this
- Assistance in the establishment of institution aimed at the introduction of private funds

- Assistance in investigating the feasibility of reducing operation and maintenance costs utilizing CDM
- Assistance in collaboration with other sectors, such as the health, medical, and educational sectors (sharing of expenses)
- The provision of various forms of training, such as country-focused training for C/P, that are related to the above

2) Approach to institutional development

To implement and promote rural electrification utilizing renewable energy, a system for its implementation and promotion must be established by the central government and local organizations. This includes the institutional development for the practitioners, and the institutional development in the approving organizations.

JICA's approach

JICA's approach to institutional development includes the dispatch of experts, such as policy advisors; surveys and proposals as a part of development study, such as studies of rural electrification plans utilizing renewable energy; the implementation of F/S; and support for certain capacity development through technical cooperation projects. Major approaches are as follows:

(Practitioners/central government, local governments)

- Human resources development for project implementation (including F/S)
- Support for the development of systems for program implementation
- The provision of various forms of training, such as country-focused training for C/P, which is related to the above

(Approving organization/central government)

- Human resources development for program approval
- Support for the development of systems for program approval
- The provision of various forms of training, such as country-focused training for C/P, which is related to the above

When a local government becomes the practitioner, and renewable energy is utilized for the purpose of returning the profits obtained by supplying electric power into regional development, the following approach is required in addition to support for the above practitioners.

- Support for the formulation of accounting rules
- Support for the establishment of fund utilization plans

3) Approach to local residents

In order to implement and promote rural electrification utilizing renewable energy, the creation of mechanisms to involve the residents, such as dissemination for the residents of the benefits of electricity by suggesting the improvements in livelihood that come from the utilization of electric power is required.

JICA's approach

As its approach to local residents, consideration is given to surveys and proposals as part of development studies, such as studies of rural electrification plans utilizing renewable energy, and support for capacity development through technical cooperation projects. Implementation through the cooperation of the Japan Overseas Cooperation Volunteers and Senior Volunteers should also be studied. Major approaches are as follows:

- Enlightenment and dissemination activities, such as illustrating concrete examples of livelihood improvements achieved through the actual utilization of electricity
- Promotion and assistance in local industries utilizing electricity

BOX 2-1 Master Plan Study on the Utilization of Solar Energy in Nigeria (Development study)

In this project, implemented from June 2005 to March 2007, solar home systems (SHS) have been introduced into villages in the target area to raise public awareness and promote activities by actually demonstrating the effects of photovoltaic power generation and providing information regarding distributors and prices of PV systems in cooperation with manufacturers and dealers. In addition, a TV program on the promotion of PV systems has been produced and broadcast.

Mid-term Objective 1-3	Proper operation and maintenance of electric power facilities using renewable energy introduced for regional development

Approach to the Mid-term Objective

For the proper operation and maintenance of electric power facilities utilizing renewable energy, and ensuring their sustainability, the approaches are 1) the approach to operational systems, and 2) the approach to the technical aspects.

1) Approach to operational systems

In the case of rural electrification utilizing renewable energy, the operation and maintenance may be contracted to relatively weak organizations, such as residents' organizations. For such organizations, support for the operational system is necessary in order to ensure sustainability.

JICA's approach

As its approach to operational systems, consideration is given to surveys and proposals as a part of a development studies, such as studies of rural electrification plans utilizing renewable energy; and support as a part of capacity development through technical cooperation projects. Major approaches are as follows:

- Assistance in the operation and maintenance systems of residents' organizations
- Assistance in price setting and methods of billing collection
- Assistance in the establishment of backup systems in case of failure

- The provision of various forms of training, such as country-focused training for C/P, which is related to the above

When assisting in institutional development for residents' organizations, not only is it necessary to take a direct approach to the residents' organizations by implementing a pilot project as a model case, but also the indirect approach of supporting the improvement of leadership by the central and local governments (as the promoters) for promotion of renewable energy to outlying areas. The concurrent implementation of these two approaches is a realistic measure.

2) Approach to technical aspects

Although routine inspections of the facilities are required to ensure sustainability, the technical capacity and knowledge required for operation and maintenance vary depending on the type of renewable energy. Therefore, the approach of transferring technical capacity and knowledge suitable for each residents' organization is required.

JICA's approach

In its approach to the technical capacity required for operation and maintenance, consideration is given to surveys and proposals as a part of development studies, such as surveys of rural electrification plans utilizing renewable energy, and support as a part of capacity development through technical cooperation projects. Major approaches are as follows:

- Human resources development for operation and maintenance
- Preparation of manuals
- The provision of various forms of training, such as country-focused training for C/P, which is related to the above

As in section 1), when supporting the institutional development of residents' organizations, not only is the direct approach taken to the residents' organizations by implementing a pilot project as a model case, but also the indirect approach of supporting the improvement of leadership (fostering of trainers) by the central and local governments (as the promoters) for promoting renewable energy to outlying areas. The concurrent implementation of these two approaches is a realistic measure.

BOX 2-2 Rural Electrification Project in the Philippines (Technical cooperation project)

In this project, which has been implemented as a 5-year plan since June 2004, support for off-grid electric power supplies utilizing renewable energy is being implemented to improve the sustainability of electricity supplies. In this project, capacity development is being carried out for the staff of the Department of Energy that are related to the implementation of appropriate programs, the establishment of monitoring methods, and the creation of technical support systems for residents' organizations (e.g., Electrification Associations), as well as the creation of the support systems required for sustainable operation and maintenance by the residents' organizations themselves, such as through the creation of communication systems between organizations when a failure occurs. In these activities, capacity development is being carried out for the promotion of overall rural electrification, including not only in the Department of Energy, but also among local governments and the residents.

Development Objective 2	Reduction of energy risk and promotion of environmental conservation by effective utilization of renewable energy as a sustainable energy, in a global scale including developing countries

As described in 2-1, the characteristics of renewable energy are that it is environmentally friendly clean energy without emissions of air pollution or greenhouse gases, and requires no waste treatment. Development Objective 2 focuses on the characteristics of renewable energy as a substitute for fossil fuel energy, and conceives of renewable energy from the points of view of energy security and global warming prevention. To achieve this development strategy objective, two mid-term objectives are considered.

Mid-term Objective 2-1	Formulation of power development plans using renewable energy from the point of view of energy security and global warming prevention

Approach to the Mid-term Objective

From the points of view of energy security and global warming prevention, 1) the approach to policy and priority plans, and 2) the approach to the validation of the feasibility and adequacy of the introduction of renewable energy are taken as in the Mid-term Objective 1-1 under the Development Objective 1, for the establishment of electric power development plans utilizing renewable energy.

1) Approach to policy and priority plans

Since the promotion of the introduction of renewable energy is carried out from the points of view of energy security and global warming prevention, basically, consideration is given to power generation facilities of a relatively large scale connected to the grid. These facilities must therefore be incorporated in or consistent with the countrywide electric power development plan. This is the difference with 1) in the Mid-term Objective 1-1 under Development Objective 1.

JICA's approach

In the approach to policy and priority plans, consideration is given to its implementation through the dispatch of experts, such as policy advisors, or as part of a development study, such as a study for a master plan (M/P) for electric power development. Major approaches are as follows:

- Support or review for the formulation of an energy policy
- Support or review for the formulation of a renewable energy policy
- Support or review for the formulation of an electric power policy
- Support or review for the establishment of electric power development plans
- The provision of various forms of training, such as country-focused training for C/P, which is related to the above

2) Approach to the validation of the feasibility and adequacy of the introduction of renewable energy

When renewable energy is utilized from the viewpoint of energy security and global warming prevention, its feasibility and relevancy must naturally be sufficiently validated.

JICA's approach

In its approach to the validation of the feasibility and relevancy of the introduction of renewable energy, consideration is given to the implementation of M/P studies for hydro power and geothermal power.

- Surveys of energy potential
- Environmental and social considerations
- Electric power demand forecasting (based on electric power development plans, if any)
- Project cost estimation
- Establishment of financing plans
- Cost-effectiveness analyses for energy security and global warming prevention
- The provision of various forms of training, such as country-focused training for C/P, which is related to the above

BOX 2-3 Master Plan Study for Geothermal Power Development in Indonesia (Development study)

Indonesia has turned into a net importer of petroleum since 2003, and is working out measures to promote geothermal power generation for the purpose of distributing its primary energy sources. The study will be carried out to support the establishment of a nationwide geothermal power generation develop plan (master plan) based on the quantities of resources and electric power demand to form the basis for the promotion of an Indonesian geothermal development policy and its compatibility with power source development plans. (The full-scale study will be started in March 2006.)

For the financing plan, the use of CDM is being considered, and a model project design document (PDD) related to geothermal power generation is being prepared to verify the method for conducting the approval procedures related to CDM operation. As for CDM operation of geothermal power generation, the methodology has already been approved by the CDM Council, and in Indonesia, Chevron Texaco is preparing a PDD (as of October 2005).

By clarifying the feasibility of applying CDM, and raising the return on investment, the willingness to invest in private businesses is enhanced, and it is expected that this will contribute to the development of geothermal resources. Thus, as an assistance tool, JICA is investigating the development of geothermal power generation that can easily be applied to CDM operations.

Mid-term Objective 2-2	Appropriate implementation and promotion of the development of electric power using renewable energy from the point of view of energy security and global warming prevention

Approach to the Mid-term Objective

To appropriately implement and promote electric power development using renewable energy from the point of view of energy security and global warming prevention, 1) the approach to financing, and 2) the approach to the establishment of implementation systems are being taken.

1) Approach to financing

As described above, since electric power supply utilizing renewable energy is economically inefficient compared with conventional power sources, its systematic establishment is difficult without a mechanism for securing financing, and support for this is required.

JICA's approach

In the approach to financing, consideration is given to conducting surveys and making proposals as part of a development study, such as a M/P study for hydro and geothermal power, and to support as a part of capacity development through technical cooperation projects. Major approaches are as follows:

- Assistance in system establishment aiming at the introduction of private funds
- Assistance in examination of the feasibility of reducing operation and maintenance costs through the use of CDM
- Assistance in the establishment of subsidy systems
- The provision of various forms of training, such as country-focused training for C/P, which is related to the above

2) Approach to technology

To implement and promote geothermal, large-scale wind power and biomass power generation from the points of view of energy security and global warming prevention, the central government has to have the technical capability and knowledge to determine the relevancy of each program and to approve its implementation. When the introduction of geothermal, large-scale wind power and biomass power generation are being promoted, it is assumed that the practitioner is a private business and the approval organization is the same organization as the approval organization for normal power generation facilities, which is the central government, and the establishment of an organizational system of technical support and approval for the practitioner is not considered.

JICA's approach

In the approach to technology, the dispatch of experts, such as policy advisors; surveys and proposals as a part of a development study, such as rural electrification plans utilizing renewable energy; the implementation of F/S; and support as a part of capacity development through technical cooperation projects can be considered. Major approaches are as follows:

- Development of human resources that can determine the adequacy of each project, including F/S
- Support for the development of the knowledge required for the approval of projects

The provision of various forms of training, such as country-focused training for C/P, that are related to the above

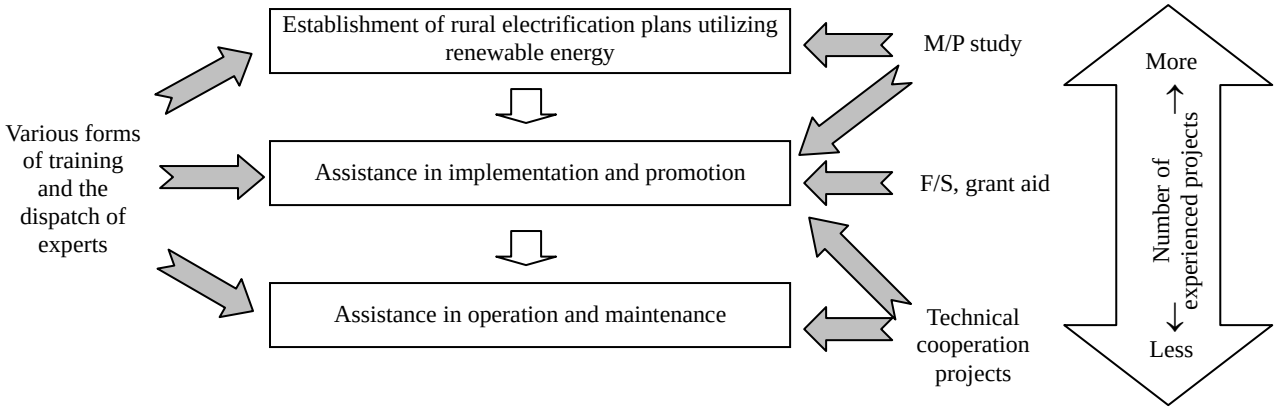
Chapter 3 Direction of JICA's Cooperation

3-1 Approaches and points to consider that are the focus of JICA's efforts

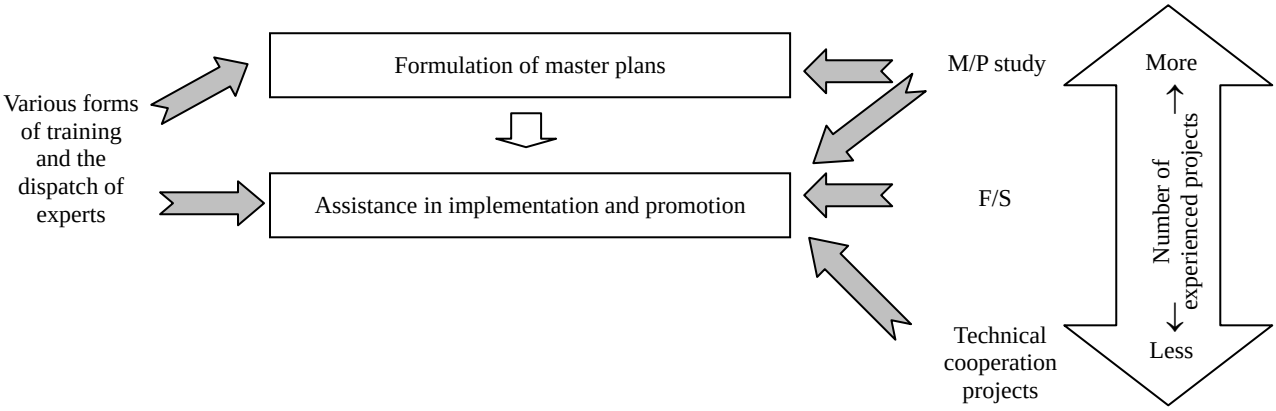
3-1-1 Priority issues

Based on the Development Objectives Chart, JICA's approach is summarized as follows:

Development Objective 1 — **Achievement of rural electrification and promotion of regional development through the effective utilization of renewable energy**



Development Objective 2 — **Reduction of energy risk and promotion of environmental conservation by effective utilization of renewable energy as a sustainable energy in a global scale including developing countries**



Development Objective 1 has been carried out focusing on the formulation of rural electrification plans utilizing renewable energy, based on M/P study. It is important to target the realization of regional development, and to consider assistance in implementation and promotion or operation and maintenance, in other words, system creation and human resources development as priority areas for cooperation in the future. In particular, cooperation combining support for improvements in

people's livelihoods through the use of electricity, and cooperation to strengthen fragile organizational structures of the residents, are important. In addition, when assistance based on M/P studies is conducted for countries where rural electrification plans utilizing renewable energy have not been formulated, cooperation in relation to regional development after electrification, such as the formulation of plans that correspond to the needs of local residents for electric power will be required.

Regarding Development Objective 2, it is feasible for the introduction of the objective, which is reduction of energy risk and promotion of environmental conservation, to be promoted through the utilization of CDM, since a reduction in CO_2 emissions can be expected. Therefore, the need to identify potential CDM-related projects through M/P studies has grown, and this should be addressed as one of the priority areas of cooperation in the future. In addition, sufficient efforts to ensure the human resources development that is required for implementation and promotion will be required so that the potential for these projects can be identified effectively.

3-1-2 Energy source-based approach

(1) Photovoltaic power generation

As described above, photovoltaic power generation is a technology for the conversion of sun eradiation, which is solar energy, into electricity, and which involves an extremely small load on the environment. Japan started cooperation with developing countries utilizing photovoltaic power generation in the 1980s. At present, Japan's production of photovoltaic cells is the largest in the world and the technical basis for this has become well established.

To utilize photovoltaic power generation for electrifying non-electrified regions, its compatibility with the electrification plans in the target countries is of primary importance. For the utilization of photovoltaic power generation, existing data on the amount of sun eradiation shall be checked, and if the data is not available, the sun eradiation potential shall be surveyed. Through this process, the potential for the utilization of solar power is assessed and after surveying this potential, including that of other renewable energy, photovoltaic power generation is introduced based on an analysis of where the utilization of solar power can be most effective.

Since a PV system is easy to operate and maintain, promotion of the system can be broadly conducted in collaboration with the Japan Overseas Cooperation Volunteers, NGOs and NPOs using user's manuals for PV system or other materials. Since the operational management of the PV system, including billing system, are important in order to ensure the sustainability of this form of development, human resources development to support this will be carried out. The quantity of electricity supplied by PV systems is limited, and, when the demand for electricity increases, PV systems will become correspondingly larger, and the installation costs will also become higher. For the introduction of PV systems, after surveying the situation, including the capacity to pay electricity charges, a sustainable operation model will be researched.

With regard to the introduction of PV systems, two methods are available. One is a centralized installation, in which electric power is supplied through a connection to the national grid, or a mini-grid with power distribution lines is used. However, mini-grids for centralized installations have the disadvantage that the electric power supply cannot be controlled to meet electricity demand. The other method is individual installations, such as a solar home system (SHS) or battery charging stations (BCS). The quantity of electricity

supply is limited, but this method is used as a means of electrification until power distribution lines will be installed, since it can be easily relocated. In developing countries, individual installations are often the most suitable. SHS involves the installation of a PV system for an individual house so that it can utilize the generated electricity. BCS is a facility with a PV system that is used exclusively for charging batteries, and the users then take the charged batteries back to their own homes for personal use. In this way, electricity can be effectively used in the home and in the fields of health, medical services, and local water supply. The details of these systems are described and introduced in the "Study on the Issues and Feasibility of Rural Electrification Utilizing Photovoltaic Power Generation (Project Study)" (July 2005).

When PV systems are utilized, the batteries must be carefully handled. For PV systems, there are two types of batteries: an exclusive battery that gradually discharges the charged electricity, and a battery for motor vehicles and motorcycles that discharges the charged electricity as the vehicle is used. They have different charge and discharge characteristics, and it is preferable to use a exclusive battery dedicated to a particular use as far as possible. All batteries must be replaced eventually, and the proper methods of use and maintenance are important, since battery life varies significantly depending on how they are used. In addition, hazardous heavy metals, such as lead, are used in batteries and the battery electrolyte solution is also a source of environmental contamination. Therefore, proper methods of handling batteries and a proper recovery system for used batteries must be established.

(2) Hydro power generation

Hydraulic power generation can be installed either on a large scale or a very small scale, and there are a wide range of methods used for its utilization.

When hydro power generation is utilized for the electrification of non-electrified regions, the electricity is chiefly supplied through mini-grids. To establish plans for this, the implementation of surveys of the potential based on topographic maps and hydrological data is required. However, since the volume of usable river water varies between the rainy season and the dry season, the potential in the dry season must be assessed. In hydro power generation, construction costs can be reduced and operation and maintenance can be facilitated through ingenuity. To reduce construction costs, it is considered important to procure machines locally at relatively low prices and to construct dams or channels through the participation of residents. For this, improvements in the technical capabilities of the machine manufacturers and human resources development for engineers who can supervise the construction are required. To facilitate operation and maintenance, the installation of facilities to reduce the labor required for dust removal, and an appropriate selection of control methods to meet the variation in electricity demand can be considered. Preparing manuals for such technical know-how and techniques required for operation and maintenance is effective.

In case of selling electricity to the grid and making profits for the purpose of promoting the regional development, one of the effective means of support is to transfer know-how concerning the effective utilization of unused energy based on the advantages of regional initiatives. An example of transferring know-how concerning the effective utilization of unused energy based on the advantages of regional initiatives is as follows; hydro power generation would be implemented and managed by local governments to use irrigation facilities, as well as flood control and soil conservation facilities.

Since hydro power generation is being developed in order to reduce energy risks and to protect the global environment, and can reduce CO_2 emissions, it is important to conduct surveys of the energy potential and carry out F/S regarding CDM. In addition, since power plants with large-scale dams have the potential to significantly affect both of the environment and the society, proper consideration according to the JICA Guidelines for Environmental and Social Considerations is required. In particular, as required, it is necessary to disclose information as well as to incorporate the stakeholders' opinions from the planning stage, regarding necessity of the project, location-selection methods, output-setting methods, operating methods, tension-easing measures, compensation and support for the relocation of residents and the others.

Japan has a long history of various approaches to hydro power generation, has technologies that are at the world's highest level, and has carried out such developments not only by the private sector, but also development that is led by the regions themselves. Therefore, Japan has comparative superiority in terms of both technologies and systems.

(3) Biomass power generation

Biomass power generation can be classified according to the raw materials into plant-based (cultivated crops), waste-based (black liquor, waste materials, etc.), and excretion-based (feces, urine, etc.). Securing the volume of biomass to convert into fuel is the most important aspect, and a survey of the volume of the biomass resources (the potential) is required first of all. In order to ensure a stable supply of the fuel, it is necessary to first provide for the collection and transportation of decentralized biomass resources and the storage of the collected resources. Therefore, except for cases in which the distribution routes have already been established, such as rice chaff (rice mills) and bagasse (sugar factories), the establishment of management systems for personnel, facilities, space, and the cultivation of new resources often arises, which requires cooperation in relation to securing financing and the creation of systems. Furthermore, to ensure the sustainable development, it is necessary to make sure that operation and maintenance are carried out by the target villages themselves, and human resources development must be provided together with the establishment of management systems.

There are two methods of generating electricity utilizing biomass: methods involving the direct combustion of the biomass, and methods in which woody biomass are processed into a form that is easy to use as a fuel by drying, grinding or solidifying, and is then combusted. The combustion facilities vary depending on the type of fuel.

In most biomass power generation facilities using the direct combustion type, the biomass is combusted in a boiler, and the steam thus obtained drives a steam turbine, and the practical application of this type is the most advanced. However, since the scale of the facilities is large and technical knowledge is required for the operation and maintenance of the facilities, technical transfer must be provided together with human resources development.

In biomass power generation facilities using methane gas recovery from feces, urine or landfill sites, since technical knowledge regarding the facilities to extract methane, the power generation facilities, such as gas engines, and their operation and maintenance are required, technical transfer and human resources development must be provided. Gasification power generation systems, in which woody fuel is gasified using a gasified gasification furnace and a gas engine or gas turbine is powered by the produced gas, are being in practical use and these

can be suitable for relatively small power generators on the scale of 50 to 200 kW.

Biomass power generation is widely used in India, but there are still few reports available up to now. To introduce the equipment described above, the means of procuring the materials and facilities must be checked. After considering these, examination from the aspects of industrial promotion and regional development should be considered, since biomass can be stored and transported if it is converted into a form in which it can easily be used as fuel by drying, grinding or solidifying, examination from the aspects of industrial promotion and regional development should be considered.

(4) Wind power generation

As described above, since wind power generation consumes no fossil fuels, and emits neither greenhouse gases nor sulfur oxides, it is a form of power generation that has great potential as a renewable source of energy.

Japan's wind power generation technology was developed substantially in the 1990s. However, since Japan started later than Europe and America, the technology is still not sufficiently advanced. European manufacturers responded to the expansion of demand for wind generators and created systems for their mass production, and Danish and German wind generators account for a large share of the Japanese market.

When wind power generation is introduced, two methods are generally adopted. One is a method in which the wind power generation facility is connected to a grid, such as transmission and distribution lines for the supply of electric power; and the other method involves individual installations. In the latter case, however, power generation utilizing wind power alone is unstable due to the variable force of the wind. Therefore, it is necessary to consider the intended purpose, and to study the possibility of hybrid types of electricity generation using combinations of energy sources, such as wind and solar power, or individual power generation facilities that incorporate a means of minimizing the variation in power generation, for example, by concentrating a large number of wind generators in a wind farm.

Until the electricity generated by wind power can be transmitted to the consumers, the following major steps must be taken.

1) Desk plan: check for wind conditions and land forms; a rough survey of the social conditions

2) Field surveys: surveys of the geographical conditions (natural conditions, social conditions); assumption of the scale of introduced wind generators

3) Detailed check of wind conditions: observation of wind conditions; evaluation of wind characteristics and the quantity of available energy

4) Basic design: determination of wind generator sites; determination of the scale of introduction; evaluation of the impact on the environment; studies on the economic efficiency

5) Execution design: precise surveys; geological surveys; equipment design; work design; work management

6) Procedures for the related organizations: laws and standards related to electric power generation and environmental issues; negotiations on systems with the electric power companies

7) Construction work: civil engineering work; wind generator installation work; electrical work; test runs; inspections

8) Operation and maintenance: maintenance and inspection of the electrical facilities; maintenance and inspection of the wind generator facilities

When the construction and operation of wind power plants through private investment is assumed, support from public organizations related to environmental management and information provision to attract investment can be considered. In the above steps, the preparation in advance of information for easily performing checks on the wind conditions and landforms in "1) Desk plan" and "6) Procedures for related organizations" is effective.

To operate wind power generation, an average wind velocity of 6 m/s or more at an altitude of 30 m above sea level is generally desirable. In terms of landform requirements, a large area of flat land is required.

A wind conditions map of Japan, in which data from the Japan Meteorological Agency shows the annual average wind velocity on a grid of about 1 km square for the whole country, has been effective. By checking the wind conditions from the wind conditions map along with the landform map, the selection of prospective sites that combine appropriate wind conditions and landforms can be facilitated, leading to a reduction in the risk of failure.

There are problems with the stability of electricity power generation using wind power alone, and the risks can be reduced to some extent through the construction of a large number of wind power generators concentrated in a certain area. However, since the construction of a large number of wind power generators is rare when they are used as a decentralized power source, coordination with other types of power sources is necessary. Therefore, when a connection to the transmission lines is required, the prior disclosure of information concerning the power systems to be used is desirable.

The public organizations that promote wind power generation must prepare and disclose the technical information described above, and must arrange for the necessary legal procedures in advance.

(5) Geothermal power generation

Japan is one of most volcanically active countries in the world and is blessed with abundant sources of geothermal energy, and the technology for the development and utilization of geothermal energy (geothermal resources) is well developed.

An overview of the series of cycles related to the development and utilization of geothermal resources will be given below. The operation of geothermal power can be considered to be divided into the upstream cycle up to obtaining the steam to drive the power generation turbine, and the downstream cycle for power generation. The downstream portion is substantially the same as for an ordinary thermal power plant.

In general, to develop and utilize geothermal energy, the bottleneck for geothermal energy

development is the exploration of geothermal resources, above all, the huge cost and risks of drilling surveys. At present, it is said that the probability of reaching a promising underground geothermal resource ("geothermal reservoir" that stores steam and hot water) through a drilling survey is 50%.

To reduce the exploration risks related to such drilling, various surveys are normally combined. Generally, since a region with geothermal reservoirs characteristically has rocks that have been transformed into clay or the like by hot water, and the electrical resistance of the rocks is low and their density is low, places with geothermal resources potential can be estimated by examining such characteristics. For this purpose, geological surveys and physical investigations are carried out, and geochemical exploration to examine the temperature of the potential sites of geothermal reservoirs and the intensity of this geothermal heat is also carried out.

After estimating the sites where geothermal resources are present, the intensity and scale are measured more accurately, and finally, a production well is drilled to extract the geothermal resources (steam and hot water) from the geothermal reservoir. At this time, through measurement of the pressure, temperature, etc. in the well (borehole) formed by drilling, and a geological investigation (geological borehole survey) of the rocks obtained in the course of the drilling work, the state of the well is checked in greater detail, and the data for conducting a "reservoir evaluation" is collected.

When a reservoir is discovered by drilling, a "fumarolic test" is carried out to find out the eruption quantity, temperature, pressure, and chemical components of the steam and hot water, and data for a further detailed evaluation of the quantity of geothermal resources is collected.

A favorable geothermal reservoir can be found as a result of such exploration in order to eventually utilize the geothermal resources for power generation, and only the steam for driving the power generation turbines is extracted. The hot water containing harmful compounds is generally returned to the underground reservoir through a separate well (feedback well) (excluding cases of "steam-dominated" geothermal resources, such as geothermal resources in certain regions of Indonesia). The power generation facilities are substantially the same as those for thermal power plants. (In a normal thermal power plant, the turbines are driven by steam generated through the combustion of coal or petroleum; while in a geothermal power plant, the turbines are driven by steam extracted from the underground reservoirs.)

When the optimum scale of a power plant is to be determined, the size and intensity of the geothermal resource based on various sources of data obtained from the surveys described above are measured in a "reservoir evaluation" that is conducted through a reservoir simulation using a computer. Based on the results, a simulation for optimizing the scale of power generation and an evaluation of its economic efficiency are carried out.

Regarding materials and equipment for the survey subjects described above, many transportable items will be taken from Japan to the site, and will then be brought back to Japan after completion of the survey. For most analyses, since the samples will be brought back to Japan and analyzed using analytical instruments in Japan, only the sampling tools will be required at the site. Drilling rigs are the only exception. Since the transportation costs for drilling rigs are very high, and due to the high related personnel costs and actual costs related to the rigs, geothermal well drilling costs in the case of Japan are said to be more than twice those of other industrialized countries. The method of subcontracting well drilling to a

local drilling company, including the rigs and the drilling crew, will therefore be more economical. This also applies to the procurement of the drilling tubes and the fumarolic gas testing apparatus.

Finally, in order to clarify the points to consider for JICA to address this matter, the technically comparative superiority of Japan in the development of geothermal resources will be described.

According to geothermal energy experts, Japan's technical superiority is said to have been established a little longer than for other countries with regard to geothermal energy exploration, well drilling and reservoir evaluation. As far as geological surveys are concerned, for example, although there are minor technical disparities in the traditional procedures between Japan and developing countries, Japan's satellite remote sensing techniques, such as the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), and the environment for the usage of such techniques, are significantly advanced. Consequently, the transfer of various techniques is feasible, such as those concerning the implementation of efficient geological surveys utilizing satellite remote sensing techniques, or the direct extraction of data on abnormally high temperature areas using satellite thermal infrared imaging.

This also applies to geochemical exploration, and since Japan's techniques using analytical instrumentation, such as inductively coupled plasma (ICP) analysis, inductively coupled plasma-mass spectrometry (ICP-MS) analysis and isotope analysis, are highly advanced, it leads in the precision of its data analysis.

In addition, regarding well drilling, a well drilled in the Kakkonda geothermal field in Iwate Prefecture in Japan set the world record for a bottom-hole temperature of more than 500°C, and Japan's high-temperature drilling technology is equal to the highest level in the world.

With regard to reservoir evaluation, Japan has established procedures to trace which part of the reservoir contributes to production of geothermal energy not only by using simple reservoir simulations, but also by combining the dynamic variation of the reservoir with changes in microgravity and its natural potential. The scale of power generation evaluation (reserve evaluation) and economic studies are critical aspects when drawing up development programs, but developing countries often conduct these studies using simple procedures. In Japan, under the guidance of the NEDO, the NEF and other organizations, highly sophisticated procedures have been established through the consolidation of various data, such as the results of well surveys and the results of reservoir simulations, and these will be the focal object of the technical transfer.

Furthermore, concerning environmental research, since Japan's environmental regulations are among the strictest in the world, Japan's control techniques, such as the use of desulfurization equipment when the fumarolic gas contains high levels of hydrogen sulfide (H_2S), and arsenic removal equipment in the hot-water supply business, are at the most advanced level in the world.

Regarding the plant design and plant construction technology for geothermal power plants, turbines produced in Japan account for 75% of the global geothermal market. In addition, of such technologies related to power generation and power source system connections, a very large number of technologies can be transferred to developing countries.

3-1-3 Cross-cutting points to consider

(1) Reinforcement of the program approach

1) Need for the program approach

Up to this time, JICA has conducted technical cooperation including individual development studies, technical cooperation projects (TCP), individual projects, and grant-aid projects on the request of the counterpart agency. At present, when improvements in the efficiency and the quality of ODA are required, the more effective execution of JICA's technical cooperation is also required. One of the means of achieving this is enhancement of the program approach, and the program of cooperation items has recently been promoted.

With cooperation packaged as a program, outcomes that may be difficult to identify in each unit of the program can be clarified further and the impact can be enhanced through the integrated execution of more than one project under a common program objective. If an effective program is established, the outcomes and impacts can be achieved that much more efficiently. In addition, since an optimal approach is taken considering the priority given to the issues and the relationship between these issues to accomplish the targets of the program, it is possible to avoid the failure to achieve sufficient outcomes due to the uncertain preconditions for cooperation that could be the case when a single cooperation project is carried out. Furthermore, by optimally combining development assistance schemes, such as grant aid, development studies, technical cooperation projects, Japan Overseas Cooperation Volunteers, senior overseas volunteers, group training, and country-focused training, so as to utilize the specific characteristics of each scheme, the individual items of optimal cooperation can be designed more flexibly.

In programming, the issues to be overcome to achieve the targets of the program, the direction taken to overcome the issues, and the scenario must be clarified, and to this end the problems related to the proposed program must be analyzed at the beginning. By analyzing these issues, each of the aspects of the required assistance (such as legal systems, organizations, development plans, technical and human resources, facilities, etc.) are clarified, and cooperation scenarios, the details of cooperation with respect to individual items, the cooperation schemes used, and the timing of the cooperation are studied in the form of a program in order to develop cooperation schemes in which all the factors forming the inputs are effectively combined.

On the other hand, since implementation of large-scale projects for countrywide rural electrification, is difficult to achieve through JICA's cooperation schemes alone, programming in which the cooperation encompasses a broader perspective that envisages loans from the JBIC, the World Bank, the ADB, etc. must also be studied. At present, information sharing is promoted at each phase of the study in collaboration with the JBIC or other organizations when individual development studies are carried out. In a similar way, in the case of collaboration through a program, information sharing and collaborative programming are desirable from the initial stage, and programming through an ODA task force is considered effective.

2) Programming of cooperation in the field of renewable energy

For program cooperation in the field of renewable energy, the analysis of the issues is also important, as described above. Among these issues, excluding those with a low need for cooperation, such as items already dealt with by the government or other donors, programming is concentrated on those of areas considered suitable for development cooperation taking into account the level of priority and the relationship between the projects. For example, when Development Objective 1 is the project goal based on the Development Objectives Chart, the issue for achieving the objective of "1. Achievement of rural electrification and promotion of regional development through the effective utilization of renewable energy" needs to be analyzed. When specific items according to the Development Objectives Chart are being considered, for example, when the achievement of each sub-target is analyzed, the need for cooperation must be determined and the approach to be taken examined. Specifically, for seven sub-targets: 1) clarification of the political positioning; 2) clarification of the feasibility and adequacy; 3) diversification of financial resources required for the implementation and promotion of electric power programs; 4) development of mechanisms for self-reliant promotion involving the local residents; 5) development of mechanisms for returning funds to the local society; 6) establishment of operation and maintenance systems; and 7) accumulation of the technical capacity required to maintain electric power facilities using renewable energy, the present issues and approach by the counterpart government need to be confirmed. For issues that other donors or the counterpart government are working on, it is necessary to know the progress and evaluate the effects on JICA's cooperation programs.

For items that are required in order to achieve the objectives based on the results of thematic analyses, the required details of cooperation, and suitable cooperation schemes need to be considered. For example, for construction of the system, the utilization of experts or development studies; for the examination of the feasibility and relevancy or examination of the funding sources, development studies; and for the development of mechanisms for the promotion self-reliance involving the local residents, the utilization of Japan Overseas Cooperation Volunteers, etc. should be examined. For the establishment of operation and maintenance systems and the development of technical capacity, the implementation of technical cooperation projects should be considered. Cooperation programs optimally combining the schemes and cooperation details are to be achieved taking the features of each country and the capacity and cooperative structure for the programs of the counterparts into account, with the timing of the inputs and the scenario for achieving the targets of the programs in mind.

Specific examples of the program approach in which various schemes are combined will be described below with reference to cases in the Philippines, Ghana, and Malawi, where cooperation has been already been implemented.

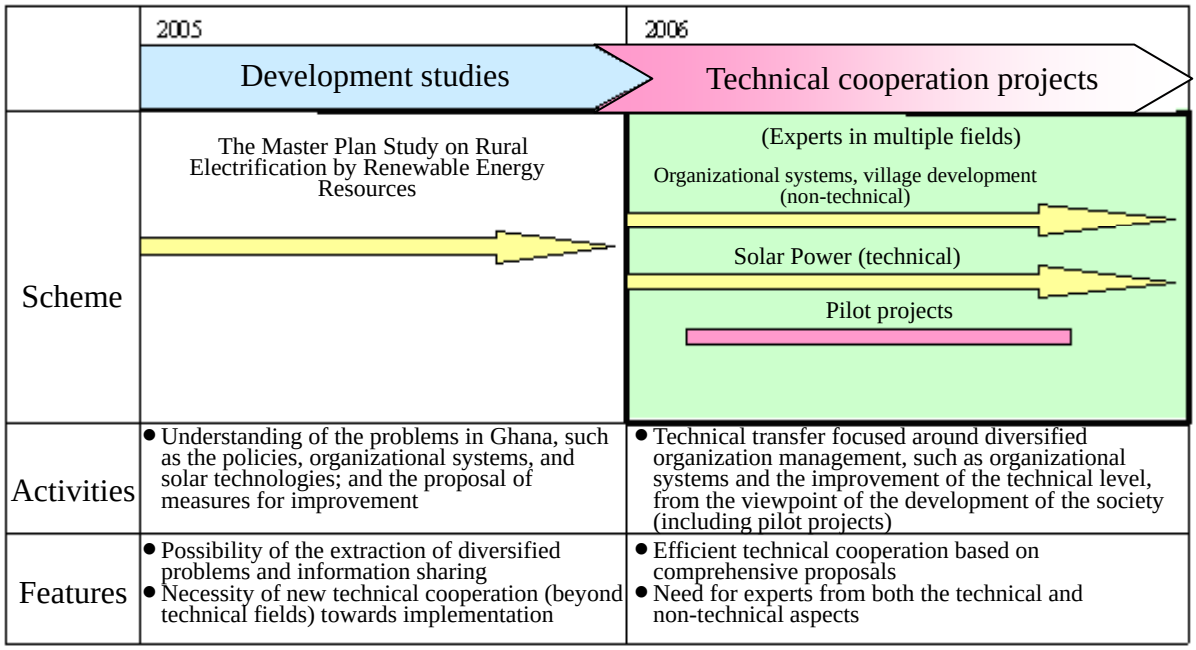
i) Case in the Philippines

In this case, long-term experts implement technical guidance on rural electrification using mini-hydro/micro-hydro power, technical cooperation projects are being planned for solving problems that have been clarified in the process, and technical transfer in a broad range of fields has been provided by multiple experts.

	2001	2004
	Long-term experts	Technical cooperation projects
Scheme	Rural electrification using mini-hydraulic/micro-hydraulic power	(two long-term experts) Mini-hydraulic/micro-hydraulic power Solar Power
Activities	● Sustainability through technical transfer, such as technical transfer related to mini-hydraulic/micro-hydraulic power; site surveys and evaluation; operation and maintenance; and organization management	● Dispatch of solar power experts for the effective promotion of the achievement of electrification targets in the Philippines ● Technical transfer focused around the improvement of the on-site technical level and the management of organizations
Features	● Possibility of detailed technical guidance over an extended period of time ● Understanding of problems of institutional development through technical transfer, and their proposal for other fields	● Possibility of detailed technical guidance with close consideration of the site ● Necessity of sharing information related to universal problems

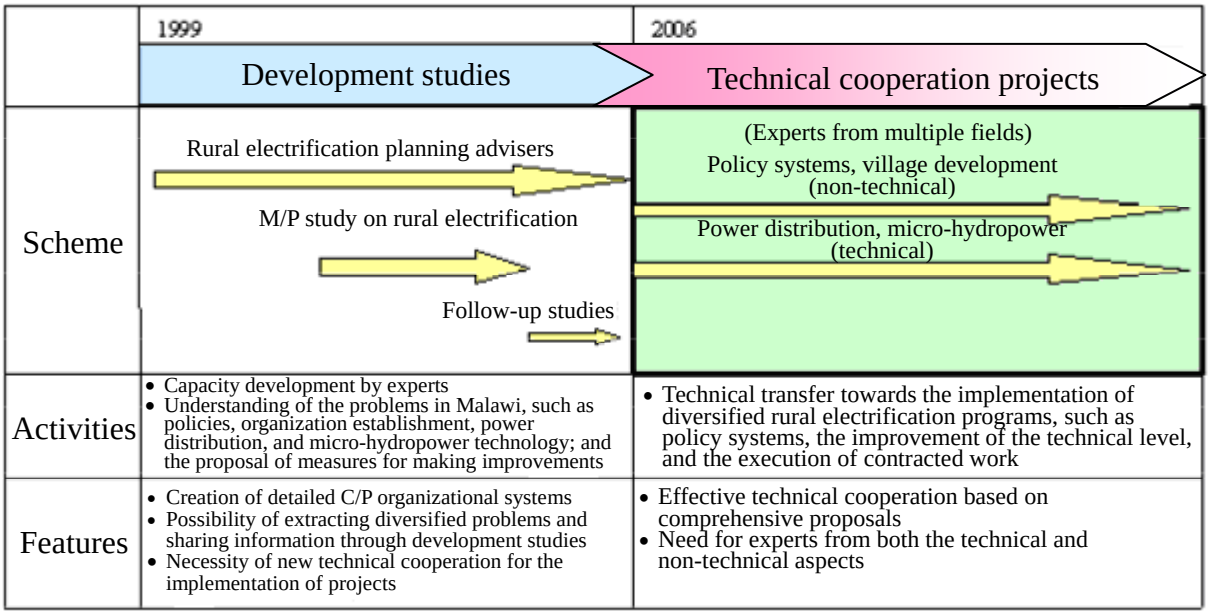
ii) Case in Ghana

In the case in Ghana, firstly, through M/P studies for rural electrification utilizing renewable energy, widespread current problems in policies, organizational systems, and technical fields have been elucidated, and plans to solve these problems have been established. In response to the results, comprehensive technical cooperation projects have been designed, and the implementation of cooperation through the dispatch of multiple experts, not only in technical fields, but also on aspects of structure and systems has been studied.



iii) Case in Malawi

In Malawi, long-term experts (rural electrification planning advisers) assisted in the establishment of organizations and systems for promoting rural electrification, and at the same time, a rural electrification M/P was established by development studies through parallel efforts. When the technical level of the C/P is low and the organizations are fragile, the dispatch of such long-term experts seems to be effective. In the future, technical cooperation projects for the establishment and integration of organizations and systems, and the technical transfer of individual technologies (power distribution, micro-hydropower) are anticipated.



In the three cased described above, the image of the programs and the cooperation scenario were not necessarily clear at the time of starting cooperation. In principle, as described above, it is desirable that the targets of the program be established, and, based on issue analyses, cooperation is implemented along with the previously prepared cooperation scenarios. In the actual situation, however, it can be considered that long-term experts are to be initially dispatched as advisers, and programs are prepared as part of the activities of the experts as in the case of the Philippines and Malawi.

3) Necessity of cross-cutting cooperation programs

As described in Chapter 2, rural electrification utilizing renewable energy is a means for the realization of human security and poverty reduction, and is aimed at the achievement of livelihood improvements by improving access to water, health and medical care, and the food essential for human lives, as well as the fostering of agriculture and local industries. On the other hand, although the final objective of the programs described above was the realization of human security and poverty reduction, village development and livelihood improvements were not the direct objectives of the programs.

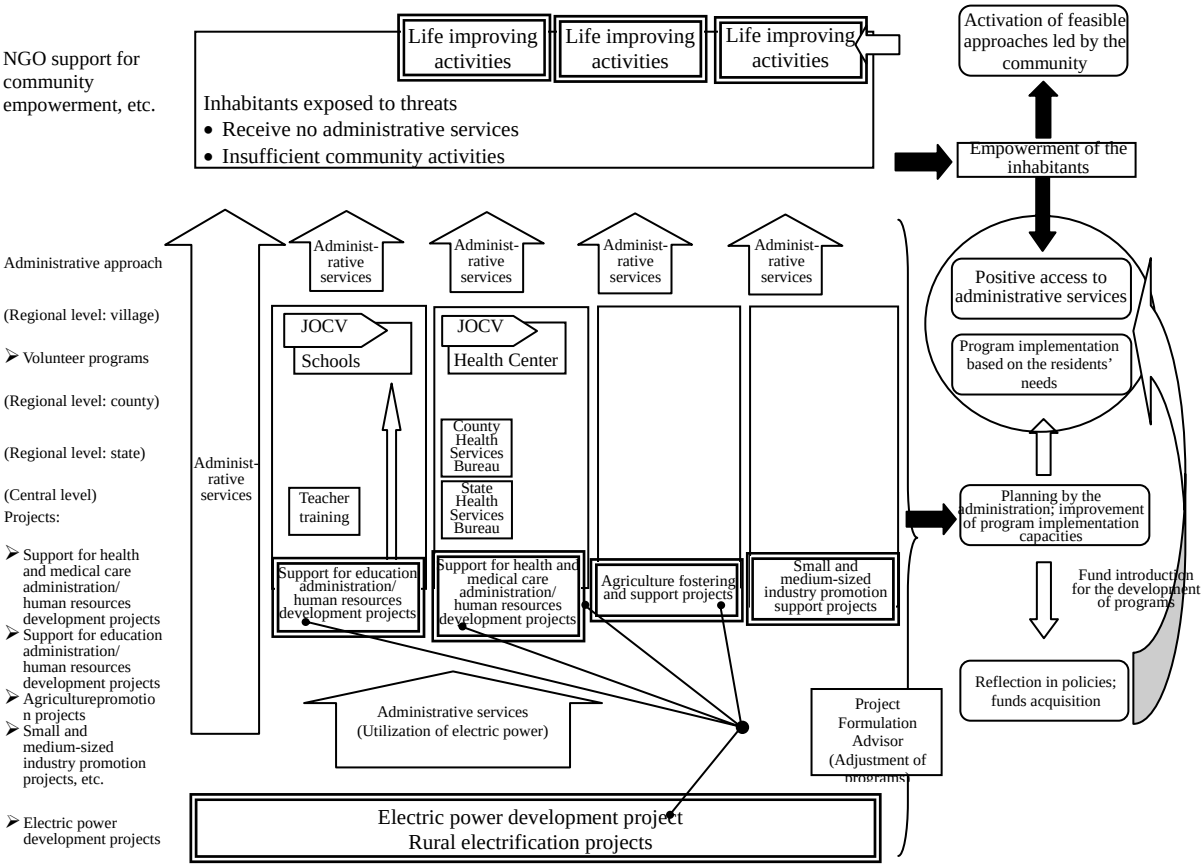
At present, while the approach to human security and poverty reduction is being intensified, cross-cutting cooperation programs requiring regional development and poverty reduction are being examined. Achievements have been made from the pilot approach for livelihood improvements through cooperation hitherto implemented so far as described in the following box. In future, cooperation aimed at fill-scale, sustainable village development will be required.

When a cross-cutting cooperation program, including rural electrification utilizing renewable energy, is considered, to realize human security and poverty reduction, a program including cooperation projects, such as water supply in combination with electrification, health and medical care, industry promotion utilizing irrigation and agricultural machinery, the fostering of local industries, education, and human resources development in the villages should be considered. In programs, the construction of a large sector cross-cutting cooperation program for a specific region can be considered from the beginning. However, the following approach should also be considered in practice; the approach to implement an electrification program with regional development in mind, to collaborate with existing or new cooperation projects simultaneously with the realization of electric power supply, and to formulate more comprehensive programs as a new regional development program.

BOX 3-1 Rural Electrification Utilizing Renewable Energy and Livelihood Improvements

According to studies for rural electrification utilizing renewable energy implemented so far, for livelihood improvements in the pilot regions, the use of electric power for medical treatment in hospitals at night, for the storage of vaccines, the use of audio-visual equipment in schools, groundwater pumping, utilization in local/domestic industries, as well as the electrification of houses has been proposed, and the actual effects have also been confirmed in these surveys.

As an example of a cross-cutting program, in the electrification M/P study on rural electrification by renewable energy resources in the north part of Ghana, the formulation of plans for rural electrification positioned as basic infrastructure that contributes to the livelihood improvement program, such as education, health and medical care, the fostering of agriculture, and the promotion of small and medium-sized enterprises in the North Ghana support program (see the chart below), which is a cooperation program for poverty reduction in North Ghana, have been achieved. Through the implementation of cooperation projects by other sectors in collaboration with electrification programs after the M/P study, the realization of livelihood improvements and poverty reduction can be expected.



(2) Viewpoint of capacity development (CD)

Capacity development (CD) in cooperation in the field of renewable energy is defined as "the process in which the capacity of the developing countries to deal with issues related to renewable energies is improved as a whole at multiple levels, such as individuals, organizations and the society." By clarifying this capacity (hereafter abbreviated as "Cap."), specifically, as aspects of the capacity of "developing countries to deal with issues related to renewable energy" and at "multiple levels, such as individuals, organizations and the society" and redefining Cap. according to the characteristics of cooperation in the fields of renewable energy and determining this as the target, the concept of CD can be introduced into cooperation in the field of renewable energy. The methods for implementing this will be described below.

In the concept of CD, attention is given to the presence of the "improvement of Cap." between inputs and outputs. It is considered that an output is not achieved directly from an input, but the input improves the Cap. and the output is achieved by the improved Cap.

1) Image

i) General concept: Input → Output

ii) Concept of CD: Input → Cap. improvement → Output

For example, in M/P studies for rural electrification that are frequently implemented by JICA, the creation of an M/P by Japanese consultants is an "input," and the actual promotion of rural electrification is an "output." What is implemented by JICA is up to the level of the proposal of the M/P, and rural electrification is promoted by the governments of the developing countries themselves by utilizing it and applying it to policies.

On the other hand, in the CD concept, an "input" refers to the capacity development measures which are taken not only by the governments, but comprehensively, including all the factors forming the Cap. of rural electrification by photovoltaic power generation and an "output" refers to the promotion of rural electrification by the Cap. of developing countries themselves, having developed their capacities as a result. This will be expressed in the form of a PDM as follows.

2) General approach

i) Overall goals: The promotion of the use of PV systems in rural areas

ii) Project purpose: The formulation of a M/P

iii) Outputs, activities, and inputs: Various survey activities

3) CD approach

i) Overall goal: The promotion of the use of PV systems power generation in rural areas

ii) Project purpose: Comprehensive CD at each level of the society (energy law systems, rural electrification law systems, incentives, environmental consciousness, etc.); the organizational level (central and local governments, research institutions, village organizations, private enterprises, environmental NGOs, etc.); and at the individual level (staff working at the organization level, individual researchers, etc.)

iii) Achievements, inputs, and activities: Assist in CD at each level of the project purpose described above (formulation of a rural electrification M/P, the capacity building of sectors in charge of rural electrification in the central and local governments, education and promotion activities for villages, the implementation of pilot projects, etc.)

The main features of the CD approach are "comprehensiveness," "interaction," and "spontaneousness." Comprehensiveness is the concept by which Cap. is translated as a comprehensive concept including each level of the society, organizations, and individuals. Based on this, for example, to promote electrification using solar panels in rural areas, it is considered that the completion of an M/P is not sufficient, but various changes at each level of the society, organizations, and individuals are required, such as the development of knowledge on PV systems in central and local governments, non-profit organizations, and private enterprises; and the development of the operation and maintenance capacities in autonomous village organizations.

The second feature, interaction, is that the CD of each of the social, organizational and individual levels is deeply related to and influences each other. For example, the CD of a key person in the rural electrification agency of a certain developing country simultaneously means the CD of the rural electrification agency, and the CD of the rural electrification agency leads to the development of the rural electrification capacity of the whole country. In CD, the favorable utilization of the interactions and their linkages is important. For example, for CD at the social level, cooperation at the social level itself, such as the formulation of an M/P is not necessarily required, and it can also be achieved by CD of the section or person in charge of the establishment of legal systems at one lower level of organization.

The third, spontaneousness, is the concept of CD and the spontaneous process of development by the developing countries themselves. When CD is decided on as the project purpose, the spontaneousness of C/P is essential for the achievement of the purpose, which is fundamentally different from what can be achieved by JICA alone, such as the formulation of an M/P. The main role of JICA is defined as the fulfillment of its role as a "catalyst."

Since CD is a broad concept including various suggestions, and in fact, studies on the methodology for incorporating it in implementation processes have been carried out, individually, studies based on the latest results of research are desired. By redefining CD and placing it as the target for each project considering the aspects as described above, the starting point for the introduction of the concept of CD into cooperation in the field of renewable energy can be obtained. An example of the CD approach in the field of

renewable energy is the "Rural Electrification Project in the Philippines" described in Box 2-2 in Chapter 2.

(Reference: Examples of the redefinition of CD in rural electrification projects using photovoltaic power generation)

- Definition of CD: The process in which the capacity to promote rural electrification utilizing renewable energy (photovoltaic power generation, micro-hydropower generation, wind power generation, etc.) in the counterpart country of cooperation is developed as the sum of multiple levels, such as the individual, organizational, and societal levels
- Definition of Cap.: Social level (energy laws, rural electrification laws, poverty reduction policies, renewable energy markets, subsidy systems using public funds, public-private partnership (PPP), consciousness of the village inhabitants, etc.); organizational and individual levels (central and local governments, village organizations, private enterprises related to photovoltaic power generation, environmental NGOs, universities, etc.)
- Definition of the subjects of CD assistance: At the societal level, enactment of rural electrification laws; at the organizational level, the policy bureau of the rural electrification agency, rural electrification agency of XXX State, village organizations in XXX State; and at the individual level, the persons in charge of the rural electrification agency, and researchers in photovoltaic power generation institutes

(3) Fundraising

In order to improve the potential for the realization of electrification programs utilizing renewable energy, the solution to the long-term financing problems of the entire program is important. Since the initial investment is large, and there is a possibility that consumers may have no capacity to pay the electric power charges, a situation in which the program itself is unprofitable can be considered. In particular, electrification programs using small-scale independent power sources have a low beneficial effect, and statuary and private corporations that require a return on their investment tend to keep their distance and consider it as an unattractive business. To deal with these issues, the government of the counterpart country is required to consider measures to protect the corporations and consumers, such as by the appropriation of subsidies and the utilization of donor funds. Therefore, an important factor for raising the potential for the realization of implementation of an electrification plan is to validate the funding issue for each of the nation, corporations, and consumers, and to clarify the methods for procuring electrification funds.

On the other hand, since it is difficult to depend completely for these funds on the budget of the government of the counterpart country itself or through capital assistance from ODA, in recent years, various fundraising methods have been examined as mechanisms for sustainable operations by power utilities. In public and private business developed through public-private partnership (PPP) that introduce private funds, schemes such as subsidies by the counterpart country and assistance from multilateral assistance agencies, need to be sought. In rural areas where the population density of consumers is generally low, and the capacity of the consumers to pay electric power charges is also low, it is difficult for private businesses to carry out electrification utilizing renewable energy on a self-paying basis. The introduction of private funds is expected not only to reduce the need for public funds, but also to lead to greater efficiency in investment, management, operation and maintenance, the avoidance of

public risks, and the expansion of business opportunities for private corporations.

Up to now, in the field of renewable energy, technical cooperation, grant aid and loan assistance have been provided by Japan, and aid through the NEDO's research cooperation or the JETRO's surveys on the global environment and plant activation have also been implemented. Since the population to take benefits, the scale of the budget and assurance of the sustainability of the operation would be the prerequisites of grant aid, these issues must be clarified first. In particular, in small-scale projects for regional development, rural electrification must be perceived as a part of the development of the basic social infrastructure, such as schools and hospitals, and broad benefits must be achieved. On the other hand, when the utilization of loan assistance is a prerequisite, it is necessary to consider conformity with the scale of the amount of the loan, and to sufficiently assess financial independence.

This includes assistance from international organizations, such as the GEF jointly operated by the WB, the UNDP and the UNEP. The GEF provides funds required for the protection of the global environment in the form of grant aid or especially preferential loans. The ADB adopts the promotion of renewable energy as a policy related to the energy sector, and provides loans.

(4) Coordination with grant aid

The achievements in the field of renewable energy through grant aid assistance are limited, and they are roughly classified into photovoltaic power generation facilities and micro-hydropower generation facilities, as described below.

1) Photovoltaic power generation facilities

According to the achievements of the photovoltaic power generation facilities projects over the past 20 years, the only successful examples were i) an example of its use as the power source for a pumping system in a groundwater supply project; ii) an example in which solar refrigerators were installed as a part of cold-chain equipment for the storage of vaccines in a health and medical care project; and iii) an example of its use as a small power source in a local communications project.

At present, in all the projects described in the above i) to iii), photovoltaic power generation facilities are not positively included in the component of grant aid cooperation, and its adoption is merely examined under extremely limited conditions.

The main reasons for its limited adoption are that no operation and maintenance systems, including the collection of charges from local inhabitants, have been established; the response to the repair of damaged inverters and the securing of spare parts, including the replacement of batteries, are difficult; solar panels are stolen or damaged (vandalized); the construction of battery recycling systems is difficult and their illegal disposal results in environmental contamination.

In the case of SHS, since the power generation capacity is limited due to its characteristics, it is suitable as a power source for illumination or for devices incorporating small motors. However, since the capacity is apparently insufficient as a power source for appliances contributing to labor saving in housekeeping, the improvement of the living environment, or the reduction of the consumption of fuelwood, it is necessary to consider the possibility of not being able to satisfy the needs of the local

inhabitants or the fulfillment of a previous agreement with the inhabitants related to the detailed preliminary survey and the use of electric power. In a recent study in Bhutan, it was found that the needs of remote inhabitants for the use electric power is not only for illumination, but also for cooking (electric heaters, rice cookers), and also from the point of view of basic human needs (BHN), when introducing photovoltaic power generation facilities in regions where the electricity grid cannot be extended cautious judgment is required to decide the required electric power demand as their real needs..

Therefore, when the introduction of photovoltaic power generation facilities using grant aid is examined as a power source for the inhabitants of remote regions in F/S or other studies, the measures above become major premises. Specifically, due to the establishment of participatory management, operation and maintenance systems by the residents (charge collection and routine maintenance), securing the budget for the renewal of equipment (periodical maintenance) and the establishment of a management organization are essential, and it is necessary to cautiously proceed through collaboration in the form of prior technical cooperation after accumulating successful examples through technical cooperation.

2) Micro-hydropower generation facilities

There have been cases of micro-hydropower generation facilities in Bhutan, Peru, and Guatemala mainly in the 1990s, and a project is currently being implemented in Cambodia. Basically, implementation is considered in the countries with actual examples, or when the positioning is determined in priority plans. However, in the current situation, this is only examined under limited conditions as in the cases of photovoltaic power generation facilities.

When its introduction is examined, the capacity of the facility must be determined on the basis of the inhabitants' needs after surveying the effects on rivers, specifically, the relationship between the quantity of water intake and the flow rate of the river, the effects on the ecosystem (especially the effects of water shortages in the dry season), and confirming the completion of procedures related to environmental and social considerations. At the same time, since a hydro power plant will be constructed even if it is on a small scale, the security of the route for the transportation of materials and equipment, and checking of the conditions related to the construction and installation of the facilities and equipment will be also important, and examination, including the determination of these conditions, is required in the development studies.

(5) Region-based strategy

The causes of the deterioration in energy supplies, the potential of renewable forms of energy, and the feasibility of cooperation in each region are summarized in the following table.

	Socioeconomic conditions	Issues in the energy sector	Potential of renewable energy	Orientation of cooperation
Southeast Asia	Rapid economic growth from the 1980s to the early 1990s Execution of policies for promoting renewable energy	Increase in energy consumption due to rapid economic growth	• Abundant biomass resources • Potential of geothermal sources in the Philippines and Indonesia • Vital private and NGO activities • Past achievements of JICA's support for rural electrification	Promotion of cooperation by regional bases centered on the implementing organizations of past JICA cooperation
East Asia	Opening up of access by the global economy, promotion of reforms in the rural economy Decline and exhaustion of forest resources Promulgation of a Renewable Energy Law (China)	Increase in energy consumption by countries whose economy has been rapidly growing, such as China Inefficient use of energy due to the utilization of outdated equipment	• Abundant biomass resources • Potential for geothermal, micro-hydro, and wind power	For countries with high economic growth, support for development using their own technologies; for countries with delayed economic growth, the implementation of studies for the potential of renewable energy
Central Asia, Caucasia	Shift from a planned economy to a market economy Infrastructure constructed by the former USSR	Abuse of energy supplies due to economic priorities; and inefficient use of energy due to the decrepit equipment	• Biogas production using livestock manure • Potential for wind power generation in the border areas of China	Reinforcement of the technical, organizational, and operational aspects for improving the thermal efficiency
Southwest Asia	Absolute poverty and population growth Decline and exhaustion of forest resources	Extension of poverty issues due to the population density Inefficient use of energy due to the use of coal fuel or decrepit production equipment	• Promotion of biomass power generation • Fifth largest wind power generation capacity in the world (India) • Potential of geothermal sources in India	For countries with high economic growth, support for development using their own technologies
Oceania	Small population; lack of resources other than primary products and tourism	Increased demand for energy due to changes in lifestyles	• Limited biomass resources and water resources • Abundant sun eradiation	Active introduction of renewable energy so as not to destroy the environment
Central America, Caribbean	Severe socioeconomic situation due to revolutionary movements and armed conflicts	Increase in energy demand associated with an increase in the urban population	• Undulating land • Abundant water and geothermal resources	Implementation of studies for the potential of renewable energy
South America	Weak economic structure dependent on exports of specific primary products Decline and exhaustion of forest resources	Exhaustion of natural resources; increase in energy demand associated with an increase in the urban population	• Abundant biomass resources • Undulating land	Implementation of studies for the potential of renewable energy

	Socioeconomic conditions	Issues in the energy sector	Potential of renewable energy	Orientation of cooperation
Africa	Increase in accumulated debt due to the oil crisis and a fall in the prices for primary products; economic collapse Progressive desertification; decline and exhaustion of forest resources Aggravation of water issues	Destructive logging of forest resources for timber; increase in energy demand associated with an increase in the urban population	• Abundant sun eradiation • Depending on the country, there is potential for biomass utilization (livestock manure); certain feasibility of the introduction of micro-hydropower	Introduction of renewable energy as a means of contributing to poverty reduction
Middle and Near East	Economic disparities between oil-producing countries blessed with petroleum and natural gas, and the non-oil-producing countries Aggravation of water issues	Reckless consumption of energy by the oil-producing countries	• Abundant sun eradiation	Implementation of studies for the potential of renewable energy
Eastern Europe	Admission to the EU after the end of the cold war	Decrepit and inefficient production facilities Inefficient utilization of heat in buildings		Reinforcement of organizations and management, such as the improvement of thermal efficiency

Based on the region-based overview of renewable energy above, two regions, Southeast Asia and Africa, which have i) different levels of economic growth, and ii) many experiences of renewable energy cooperation with JICA, are compared below, with summary of JICA's cooperation policies in the regions.

1) Renewable energy cooperation policies in Southeast Asia

i) Renewable energy cooperation policies

In Southeast Asia, an estimated 220 million people live in conditions where they cannot use "electricity", which can be said to be the foundation of modern life.

The general features of this region are that there is relatively abundant hydro potential, and micro-hydropower generation can be expected to be developed as a renewable form of energy.

There is potential for biomass power generation using livestock and agricultural products by many members of the communities due to the large agricultural village population. Since settlements in non-electrified areas are relatively concentrated, the possibility of efficient electric power distribution can also be considered.

Since sustainable development cannot be achieved without the positive participation of the community receiving electric power supply, it is considered effective to disseminate among the local inhabitants their need for the project itself, and establish ownership of the project by the community through discussions with the community from the planning stage of cooperation. In this region, the relationships of mutual

trust are often deep among the inhabitants in non-electrified areas, and the positive participation of local inhabitants in the project can be expected.

For example, motorbike batteries or battery recharging devises are often sold in relatively large numbers in non-electrified areas. This means that it is possible to effectively utilize equipment, such as motorbike batteries, that are already owned by the local inhabitants in photovoltaic power generation projects, since the inhabitants generally take good care of their own property with their own responsibilities, and the sustainability of the project can thus be enhanced.

Since there have been a large number of experiences of cooperation with JICA in this region, it is necessary to promote region-based cooperation centered on existing cooperation with implementing organizations.

In this region, since cooperation with Japanese research institutes, private enterprises, NGOs, etc. is active, the realization of renewable energy programs is improved by implementing positive collaboration with these parties from the early stages.

ii) Method of implementing the projects

[Strategic implementation of projects (selection and concentration)]

For the efficient implementation of renewable energy projects in Southeast Asia in future, the selection of and concentration on certain countries, and the narrowing of the scope of renewable energy cooperation in each country is required.

(cf. materials at the end)

2) Renewable energy cooperation policies in Africa

(Renewable energy cooperation policies)

The features of this region are that the electrification rate is low, and rural areas are not electrified since the total area of many of these countries is vast. Some areas have the potential for micro-hydropower generation.

As one of the means of promoting agricultural development in the region, photovoltaic power generation for small-scale irrigation is feasible; and as one of the means of providing health and medical care services to the local communities, there is potential for the application of photovoltaic power generation to drinking water supply. There is also potential for the application of small-scale biomass power generation using livestock manure.

Since the possibility of cooperation with Japanese private enterprises and research institutes is estimated to be low, a search for cooperation through ODA programs alone, or through collaboration with other assistance donors, such as the WB, the UNDP, and the GEF through poverty reduction initiatives should be considered.

(6) Considerations for an environment-oriented society

In general, renewable energy is evaluated as a source for electric power generation that has little adverse effect on the natural and social environment. However, issues that need to be considered can be foreseen for each source of electric power, as the following table shows. Therefore, JICA must pay particular attention to the implementation of projects based on the JICA Guidelines for Environmental and Social Considerations, and provide support for taking this into consideration by conforming to the laws and regulations related to environmental impact assessment in the counterpart countries.

It is desirable that environmental and social considerations should incorporate various impacts on the natural and social environment as the objective of surveys, and should be studied from the early stage of developing the policies or plans related to the program. Specifically, it is desirable that items that have an impact on the environment should be introduced in the study criteria for the M/P study that comprehensively validates the feasibility of introducing renewable energy, and the priority order of the basis for development also needs to be comprehensively assessed.

It is also desirable that consideration for the natural environment, such as consideration for nature reserves designated by the counterpart country, should be assured during feasibility assessment. In addition, the meaningful participation of the stakeholders, such as women, poverty groups and minority groups, who expect to enjoy the benefits of rural electrification, should be secured, and the opinions of the stakeholders needs to be reflected in the decision making.

	Examples of typical impacts
Photovoltaic power generation	• If lead acid batteries are disposed of without proper treatment, heavy-metal contamination can occur and the sulfuric acid can affect the pH of the soil • Visual impact on the landscape due to the installation of solar panels
Hydro power generation	• Alteration of rivers, and effects on the stream regimes • Forest clearance and the felling of individual trees associated with the laying of distribution lines from the power plants to the consumers • Impacts on the environment associated with the construction of roads for power plant construction
Biomass power generation	• Impact of odor generation associated with the collection of biomass materials
Wind power generation	• Visual impact on the landscape due to the installation of structures for wind turbines • If lead acid batteries are disposed of without proper treatment, heavy-metal contamination can occur and the sulfuric acid can affect the pH of the soil
Geothermal power generation	• Forest clearance and the felling of individual trees associated with the laying of distribution lines from the power plants to the consumers • Impacts on the environment associated with the construction of roads for power plant construction • In the case of the utilization of hot water underground resources, the release of hazardous components, such as arsenic, into the rivers (normally returned to the underground aquifer through a feedback well)

(7) CDM

As an approach to improving the feasibility of program implementation, the approach in which benefits can be obtain through the sale of the greenhouse gas emission credit (Certified Emission Reduction: CER) generated by the application of CDM is attracting attention.

In projects involving large-scale hydro, wind and geothermal power generation, since the gain on the sale of CER contributes to the stability of business income and expenditures, CDM has potential as a mechanism for attracting private capital. Reductions in greenhouse gases are also considered to be an issue that should be positively approached also from the point of view of global environmental conservation and for their contribution to global warming prevention.

On the other hand, in small-scale projects for regional development, such as rural electrification, the gains from the sale of CER through the application of small-scale CDM (maximum output of 15 MW or less) can be credited to operation and maintenance expenses, and has the potential to provide financial resources to improve the sustainability of the program. Compared with normal CDM programs, small-scale CDM projects are considered to have the benefit of reducing costs through the simplification of approval procedures and bundling, in which multiple similar projects are combined. Already in rural electrification M/P studies, development cooperation, such as support to prepare CDM project designs, has been started. In many small-scale projects, even if the initial investment is supported by an aid agency, since the procurement of the operation and maintenance expenses is not yet in sight, there are many cases in which the establishment of a program is difficult. Thus, as an option for obtaining the financial resources, the utilization of small-scale CDM has potential.

In the present system, since the transaction costs such as the cost of application procedures, including the cost of feasibility studies for the CDM application procedures, business registration expenses, and verification and authentication expenses is high. CDM is considered a system that is still being established, because it involves a large amount of work for the application and a long validation period. However, it is expected that this will improve in future. Since it is not approved to divert ODA funds to CDM programs, careful assessment is required for implementation of cooperation in this field.

3-2 Issues for future investigation

In the future, in the implementation of cooperation in the field of renewable energy, it is necessary to pay attention to international trends, such as the trends in technical development, the trends in assistance provided by related organizations for research and development (R&D), the approach of the government of each country towards the expansion of financing options, and the state of implementation of small-scale CDM.

As described above, since the operation of large-scale programs, such as nationwide rural electrification programs, is difficult through JICA's cooperation schemes alone, the utilization of the GEF special funds, and the formation of programs using loans from the WB, the ADB, etc. need to be examined. On the other hand, to ensure that the utilization of renewable energy in remote areas is self-supporting, the role of NGOs etc. which provide careful technical assistance for the inhabitants should not be neglected. When individual projects are implemented, it is desirable to share information among other donors from the initial stage, and to establish an effective program implementation system through positive collaboration.

Appendix 1 Major Cases of Development Cooperation

No.	Country	Project	Period	Form	Outline
1. Solar power					
1	Indonesia	Study on Utilization of Photovoltaic Hybrid Systems in Rural Areas	1989-1993	M/P	Through three stages including identification, implementation and evaluation stages; the installation of a photovoltaic -diesel power generation hybrid system and a photovoltaic-micro-hydropower generation hybrid system in two locations; and technical transfer related to its operation and maintenance
2	Kiribati	Study of Utilization of Photovoltaics for Rural Electrification	1992-1995	M/P	Comparison of photovoltaic and diesel power generation based on an estimation of the demand for electrification by the consumers; and the formulation of rural electrification plans
3	Syria	The Study for the Introduction of Integrated Photovoltaic System	1995-2001	M/P	• Introduction of rural electrification, groundwater pumping, and desalination systems utilizing PV systems in the Aleppo region • Livelihood improvements in remote areas through the provision of facilities, the administration of operations, and the development of local and domestic industries • Confirmation of the feasibility of photovoltaic systems with regard to the aspects of technology, economics, financing, social systems, organizations, administration, and the environment • Establishment of measures to improve livelihoods in remote areas utilizing photovoltaic systems that can be promoted and applied to support livelihoods in semi-arid and non-electrified regions
4	Morocco	Master Plan Study on Decentralized Rural Electrification on Haouz Region	1996-1998	M/P	Formulation of an electrification M/P through an inventory survey including the means of electrification utilizing photovoltaic power generation, diesel power generation, and micro-hydropower generation for 120 villages in the Hauz area; implementation of pre-F/S for the locations identified as being suitable for micro-hydropower generation; and improvement of the Moroccan capacity for the formulation of such plans
5	Zimbabwe	Study on the Promotion of Photovoltaic Rural Electrification	1997-1999	M/P	Formulation of a rural electrification plan utilizing PV systems, and a proposed plan to electrify 150,000 households over 20 years by adopting the ESCO system
6	Laos	Study on Rural Electrification Project by Renewable Energy	1998-2000	M/P	• Formulation of a rural electrification M/P utilizing PV systems for the whole land area of the country of Laos • Formulation of a rural electrification M/P that adopts micro-hydropower generation for the Vientiane and Bolikhamsai provinces

No.	Country	Project	Period	Form	Outline
7	Mongolia	Master Plan Study for Rural Power Supply by Renewable Energy	1998-2000	M/P	• Formulation of electric power supply plans utilizing renewable energy up to 2015 for 167 Som centers throughout the country not connected to the central power supply network • Implementation of validation tests based on three solar-wind power hybrid pilot plants; and the reflection of the observation data in the M/P • Establishment of relevant installation, operation and maintenance systems, and organizational systems • Implementation of the transfer of technology related to rural electric power supply plans utilizing renewable energy • Resource conservation based on the development and effective utilization of renewable energy • Examination of the extent of the contribution of the country to global environmental conservation
8	Senegal	Study on Photovoltaic Rural Electrification Plan	1999-2002	M/P	• Formulation of a rural electrification implementation plan utilizing solar power • Preparation of PV system operation manuals; and proposal for methods of implementing rural electrification jointly led by the public and private sectors
9	Bolivia	Rural Electrification Implementation Plan by Renewable Energy	1999-2001	M/P	Formulation of a rural electrification implementation plan utilizing renewable energy in La Paz and Oruro from 2002 to 2012; implementation of technical transfer through the implementation of pre-F/S for micro-hydropower generation; wind power generation
10	Botswana	Study on the Photovoltaic Rural Electrification	2000-2003	M/P	• Implementation of related information collection, and a survey of the rural social economy; implementation of a PV promotion program validating programs in three villages for evaluating the adequacy of the established measures related to rural electrification; and the revision of the original plan through monitoring • Formulation of a final rural electrification M/P using photovoltaic power generation based on the above
11	Ghana	Rural Electrification by Renewable Energy Resources in the Northern Part of Ghana	2005-2006	M/P	Proposal of policies for rural electrification utilizing renewable energy; the formulation of action plans for promoting sustainable off-grid electrification utilizing renewable energy
12	Cambodia	Master Plan Study on Rural Electrification by Renewable Energy	2005-2006	M/P	Clarification of measures for promoting electrification programs in remote agricultural villages, joint implementation of M/P formulation and Pre F/S surveys Technical transfer for promoting rural electrification programs to Cambodian C/P by compiling the technology in the form of manuals

No.	Country	Project	Period	Form	Outline
13	Nigeria	Master Plan Study on the Utilization of Solar Energy	2005-2007	M/P	Proposal of measures for promotion of the utilization of solar power to the government through the formulation of M/Ps and various proposals related to the utilization of solar power; capacity development of organizations playing major roles in the utilization of solar power
14	Indonesia	After-care Program for Study on Utilization of Photovoltaic Hybrid Systems in Rural Areas	2000	After-care	Implementation of field surveys for the PV systems installed in Mayarenka Province and Lombok Island regarding the following items: 1. Operating state of the systems; 2. Current situation regarding system installation; 3. Current situation of the management, operation and maintenance of the systems; 4. Current situation of the operation and maintenance of the installation; 5. Current situation of the operation and maintenance of the systems; 6. Problems related to the continuous utilization of the systems; 7. Collection of information on Indonesian companies when materials and equipment for improving the systems are procured
15	Kiribati	After-care Program for Study of Utilization of Photovoltaics for Rural Electrification	2000	After-care	• Confirmation of national policies and plans for rural electrification; clarification of issues to consider in the current stage for the SEC (Solar Energy Company) in promoting rural electrification using PV systems; confirmation of operation and maintenance systems with respect to both technical and non-technical • Proposals for the expected replacement of batteries and the expansion of the PV systems • Adjustment of issues concerning the method for the disposal of used batteries, and examination of countermeasures
16	Philippines	Rural Electrification Projects	2004-2009	Technical cooperation projects	Technical cooperation projects for promoting rural electrification in the Philippines (solar and micro-hydropower); implementation of a 5-year plan from June 2004; assistance for improving the sustainability of off-grid electric power supplies utilizing renewable energy Capacity development of officials in the Energy Department related to the implementation of suitable programs, the establishment of monitoring methods, and the development of technical assistance systems for residents' organizations (electrification associations, etc.); the development of organizational systems required for sustainable management and maintenance, such as the development of inter-organizational communication systems in the event of trouble

No.	Country	Project	Period	Form	Outline
2. Micro-hydropower					
1	Malaysia	Feasibility Study on Sarawak Small Scall Hydroelectric Power Project	1985-1988	F/S	F/S on power plants to supply stable electric power to Kapit and Linpang, which are isolated locations of electric power demand (Muco: 2.32 MW, Mudamit: 5.1 MW)
2	Tanzania	Feasibility Study on Small-Scale Hydroelectric Power Development Project in Kilimanjaro	1986-1987	F/S	Implementation of F/S by selecting two sites at Kikuletwo No. 1 and 2 from nine potential sites
3	Laos	Feasibility Study on Xe Katam Small-Scale Hydroelectric Power Development Project	1990-1991	F/S	F/S for the electrification of the So Kong and Attapeu areas
4	Malaysia	Feasibility Study on Small Scale Hydroelectric Power Development Project at Upper Liwagu River Basin in Sabah	1991-1992	F/S	F/S for micro-hydropower plants to supply electric power (1.6 MW) to eastern Malaysia
5	Nepal	Feasibility Study on Ilam Small Hydropower Project	1992-1993	F/S	F/S for micro-hydropower plants to supply electric power (7 MW) to the easternmost part of Nepal
6	Indonesia	Master Plan Study on Cooperative Rural Electrification in Aceh and North Sumatra	1992-1994	F/S	Formulation of four micro-hydropower generation plans for the electrification of regions where no grids are available, one of which has been realized using general grant aid
7	Cameroon	Feasibility Study on the Development of Micro Hydropower Rural Electrification	1997-1999	F/S	Pre F/S surveys for micro-hydropower generation in Cameroon; strong technical factors in rural electrification
8	Myanmar	Study on Introduction of Renewable Energy to Rural Areas	2000-2003	M/P	Preparation of rural electrification guidelines, and operation and maintenance manuals on micro-hydropower generation with a view to establishing organizations and systems or using other power sources (such as PV)
9	Indonesia	Study on Rural Energy Supply with Utilization of Renewable Energy in Rural Areas	2000-2003	M/P	Preparation of the guideline for rural electrification utilizing renewable energy; implementation of pilot projects for micro-hydropower generation
10	Vietnam	Renewable Energy Master Plan Study in The Northern Part of Socialist Republic of Vietnam	2001-2002	M/P	Confirmation of the current situation in non-electrified regions through field surveys in 17 states that are the subjects of the study; formation of a social economy database for communes isolated from electric power systems; selection of communes that are a priority for electrification from the communes isolated from electric power systems; examination of the feasibility of micro-hydropower generation taking organization management into consideration

No.	Country	Project	Period	Form	Outline
11	Malawi	Master Plan Study on Rural Electrification in the Republic of Malawi	2001-2002	M/P	Formulation of rural electrification plans including rural electrification policies and organization systems; surveys for the potential of micro-hydropower generation and implementation of technical transfer
3.	**Geothermal power**				
1	Guatemala	Survey on Geothermal Power Development Project (phase III)	1971-1973, 1976-1977	M/P	Geological surveys, electrical power sources exploration, and earthquake exploration for the Snir area where the prevalent signs of geothermal activity have been confirmed by the first and second studies; elucidation of geothermal reservoirs and implementation of the selection of test drilling sites
2	Chile	The Pre-Feasibility Study for the Puchuldiza Geothermal Development Project	1978-1981	M/P	Consideration of the scale and depth of geothermal reservoirs; determination of the location of the well to be investigated next and the drilling depth; instruction in well logging
3	Indonesia	Feasibility Study for the Lempur Geothermal Development Project	1981-1983	M/P	Surveys on the potential of small-capacity geothermal power generation plants of the 5-MW class
4	Argentina	Northern Neuquen Geothermal Development Project	1981-1984	M/P	Understanding the endowment of hot-water-steam mixed geothermal resources that are predominant in the Domuyo area from the results of three surveys within an area of 15,000 km^2 in the northern Neuquen State that is to be surveyed; and the selection of promising sites for drilling test wells to validate the above
5	Thailand	Pre-Feasibility Study for the San Kampaeng Geothermal Development Project	1981-1987	M/P	Implementation of geological surveys, geochemical surveys, physical surveys, heat flow surveys, test well drilling, and reservoir analysis at the project site in the Sankampeng area jointly with the Electricity Generating Authority of Thailand (EGAT)
6	Philippines	Feasibility Study for Acupan-Itogon Geothermal Development Project	1982-1985	M/P	Implementation of various surveys for assessment of the reserves of geothermal power in the Acupan-Itogon area in Benguet State
7	Turkey	Pre-Feasibility Study for the Dikili-Bergama Geothermal Development Project	1985-1987	M/P	Implementation of a global science survey (JICA, MTA) and test-well drilling survey (MTA) for investigating the feasibility of geothermal power generation development in the Dikili-Bergama geothermal zone, jointly by JICA and the General Directorate of Mineral Resources and Exploration the Turkish government (MTA)
8	Indonesia	Feasibility Study for the Kerinci Geothermal Development Project	1986-1988	M/P	F/S for resource evaluation and engineering survey for geothermal power generation programs in the Duabelas area selected from the results of a wide-area geothermal resources development study in the Lumpur area of Jambi State in Sumatra (1981), and the conditions of the site
9	Argentina	The Pre-Feasibility Study for the Northern Neuquen Geothermal Development Project	1987-1989	M/P	Implementation of the evaluation of geothermal energy (electric power) development potential in the Cobawe area, the formulation of development plans, and technical transfer through the implementation of these surveys while performing F/S for a 30 kW power plant

No.	Country	Project	Period	Form	Outline
10	Guatemala	Feasibility Study on the Amatitlan Geothermal Development Project	1997-2001	Dispatch of experts	Surveys on the extent of the geothermal resources in the Amatitran area situated about 40 km southwest from Guatemala City, the capital city of the country; implementation of technical cooperation related to the formulation of an optimum geothermal power generation plan
4.	**Training**				
1	Specially offered training	Solar Power Generation & ITS Application System (Oceania)	1996-2000	Training	Acquisition of generalized knowledge on the principles and practice of photovoltaic power generation for utilizing solar power Acquisition of the techniques of storing and generating electric power and converting it to motive energy, and knowledge related to the technical systems for utilizing these forms of energy in response to various demands related to livelihoods and industry, while conserving the natural environment Training required to study and determine the feasibility and adequacy of the introduction of photovoltaic power generation; to introduce, install, and operate systems for photovoltaic power generation and application systems; and to promote the improvement of living conditions and the activation of local industries by introducing photovoltaic power generation in the participating countries
2	Specially offered training	Small Scale Hydropower Engineering	1999-2003	Training	Accomplishment of planning methods related to the construction of a micro-hydropower plant, and methods for developing participatory operation and maintenance systems and organization of the residents
3	Country-focused training	Solar Power Generation and Application Technology (Oceania)	2001-2005	Training	To offer basic knowledge on photovoltaic power generation that is essential for the development of electric power resources aimed at the effective utilization of solar power, and provide opportunities for generalized training in practical technologies for engineers in developing countries
4	Group training	Small-Scale Hydro Power and Clean Energy Power Engineering	2004-2008	Training	To gain a better comprehension of clean energy with the operation and maintenance of micro-hydropower plants and reductions in CO_2 emissions, in which Japan excels; and to improve the technical level
5	Group training	Tropical Biomass Utilization	2005-2009	Training	To introduce multistage utilization technology, such as the utilization of renewable biomass and the utilization of other forms of energy, to working-level people who carry out technical research on agriculture and forestry in tropical and subtropical regions, and develop human resources to form the core of the creation of an environment-friendly society

Appendix 2 Approaches taken by the Major Donors

Achievements of the World Bank projects (Projects started from 1995)

Region	Country	Project name	Project period
East Asia and Southeast Asia	China	Renewable Energy Development Project - GEF	Jul. 1999 - Jun. 2007
	China	Renewable Energy Scale-up Program (CRESP)	Jun. 2005 - Sept. 2010
	China	CN-PCF Xiaogushan Hydropower Project	Jun. 2005 -
	Philippines	Supplemental Project to the Rural Power Project	Dec. 2003 - Dec. 2009
	Philippines	Northwind Bangui Bay Project	Dec. 2004 -
	Indonesia	Solar Home Systems Project	Jan. 1997 - Dec. 2003
	Indonesia	Renewable Energy Small Power (RESP) Project	Jun. 1997 - Oct. 2001
	Laos	Lao Nam Theun 2 Power Project	Mar. 2005 -
	Cambodia	Renewable Energy Development Project	Dec. 2003 - Jun. 2009
	Vietnam	System Efficiency Improvement, Equitization & Renewables Project (GEF Renewable Component)	Jun. 2002 - Dec. 2007
Southwest Asia	Sri Lanka	Renewable Energy for Rural Economic Development	Jun. 2002 - Jun. 2008
	Sri Lanka	Energy Services Delivery Project	Mar. 1997 - Dec. 2002
	Bangladesh	Renewable Energy Development Project	Jun. 2002 - Jun. 2008
	India	Energy Efficiency Project	Jun. 2000 -
Oceania	Papua New Guinea	Rural Energy Fund	Sept. 2005 -
Europe, Middle East, and Central Asia	Moldova	Renewable Energy frim Agricultural Waste (Bioass)	Jun. 2005 - Dec. 2007
	Ukraine	Hydropower Rehabilitation Project	Jun. 2005 - Jun. 2012
	Turkey	Renewable Energy Project	Mar. 2004 - Jun. 2010
	Bulgaria	Wood Residue to Energy	Sept. 2003 -
	Macedonia	Mini-Hydropower Medium-Sized GEF Project	Nov. 1999 - Jun. 2004
Latin America and the Caribbean	Mexico	Renewable Energy for Agriculture Project (GEF)	Dec. 1999 -
	Mexico	Methane Gas Capture and Use at a Landfill - Demonstration Project	May 2001 - Mar. 2006
	Mexico	Waste Management and Carbon Offset Project	Mar. 2005 -
	Guatemala	El Canada 43MW Hydroelectric Project	Aug. 2003 -
	Honduras	La Esperanza Hydro Project	Dec. 2004 -
	Nicaragua	Renewable Energy and Forest Conservation Project: Sustainable Harvest & Processing of Coffee & Allspice (GEF-MSP)	Sept. 2000-
	Nicaragua	Offgrid Rural Electrification (PERZA)	May 2003 - Dec. 2008
	Costa Rica	Umbrella Project for Renewable Energy Sources	Dec. 2002 -
	Columbia	Jepirachi Carbon Off Set Project	Dec. 2002 -
	Columbia	Amoya River Environmental Services	May 2004 -
	Ecuador	Umbrella of Hydro Projects	Dec. 2004 -
	Peru	Poechos Hydropower Project	Dec. 2004 -
	Peru	Santa Rosa Hydro Carbon Finance	Mar. 2005 -
	Bolivia	Decentralized Infrastructure for Rural Transformation	Jun. 2003 - Dec. 2007
	Argentina	Renewable Energy in the Rural Market Project	Mar. 1999 - Dec. 2006

Region	Country	Project name	Project period
Africa	Mali	Household Energy and Universal Access (GEF) Project	Nov. 2003 -
	Guinea	Decentralized Rural Electrification Project	Jul. 2002 - Dec. 2006
	Cape Verde	Energy and Water Sector Reform and Development Project - GEF	May 1999 - Dec. 2006
	Mozambique	Energy Reform and Access Program	Sept. 2003 -
	Djibouti	Power Access and Diversification	Nov. 2005 -
	South Africa	Durban landfill Gas-to-Electricity Project	Jun. 2004 -

Source: World Bank's website (http://www.worldbank.org/)

Appendix 3 Basic Check Items

In rural electrification utilizing renewable energy and the adoption of CDM, typical items to be checked for finding out the current situation or issues are shown below. Although the survey items differ depending on the social and economic conditions or needs for development in the target countries, these can be utilized as the basis for "understanding and analyzing the current situation of the regions."

Major item	Medium-level item	Minor item	Remarks
1. General conditions	1-1 General information	(1) Population	1) Total number, number of households, number of communities 2) Future perspectives
		(2) Basic indices	1) GDP 2) HDI 3) GDI 4) Cash income sources 5) Income distribution, average income
		(3) Industrial structure	1) Primary industry 2) Secondary industry 3) Tertiary industry
		(4) Rural communities	1) Village locations, housing density, means of access 2) Self-governing organizations in the villages 3) Life and customs (daily and annual life patterns, gender roles)
	1-2 Electrification rate	(1) Village electrification rate	1) Current situation 2) Trends in the village electrification rate
		(2) Housing electrification rate	1) Current situation 2) Trends in the housing electrification rate
	1-3 Renewable energy potential	(1) Solar power	1) Landscape, amount of solar radiation 2) Promotion rate of batteries 3) Developable potential
		(2) Micro-hydropower	1) Landscape, rainfall, stream regime 2) Definition of micro-hydropower (method for classification according to the scale of power generation, compartmentalization) 3) Developable potential
		(3) Biomass	1) Types of fuels and their potential
		(4) Wind power	1) Wind conditions 2) Developable potential
		(5) Geothermal power	1) Developable potential 2) Feasibility of binary power generation 3) Feasibility of small-scale power generation

Major item	Medium-level item	Minor item	Remarks
2. Policies and systems	2-1 National plans and systems	(1) National development plans (poverty reduction strategies)	1) Social and economic development targets 2) Need for electrification 3) Positioning of renewable forms of energy 4) Environmental countermeasures (including CDM)
	2-2 Energy policy	(1) Energy development and utilization plans	1) Petroleum and natural gas 2) Coal 3) Hydropower 4) Nuclear power 5) Renewable forms of energy 6) Energy conservation
	2-1 Electric power policies	(1) Comprehensive electric power development	1) Prospects for the demand and supply of electric power (plan) 2) Innovation and privatization of electric power structures
		(2) Related systems, laws and regulations	1) Electric power law (rural electrification law) 2) Financial resources for electrification, funds, subsidies 3) Promotional organizations and systems (governments, quasi-governments, research institutions, etc.)
	2-2 Electrification policies and systems	(1) Electrification policies	1) Targets of electrification 2) Rural electrification policies 3) Renewable energy promotion policies
		(2) Electrification plans	1) Rural electrification plans 2) Compatibility of on-off grids 3) Renewable energy development plans
		(3) Electrification systems	1) Government (ministries, agencies), governmental organizations 2) Electric power suppliers (electric power corporations and companies, electrification associations, etc.) 3) Other private companies 4) Others (research institutions, universities, educational organizations, NGOs, etc.)
		(4) Utilization of renewable forms of energy	1) Development objectives 2) Promotional organizations and systems (governments, quasi-governments, research institutions, etc.) 3) Preferential treatment for development

Major item	Medium-level item	Minor item	Remarks
2. Policies and systems	2-3 Environmental policies and systems	(1) Regulations and laws	1) Environmental standards (air, water, etc.) 2) Development restrictions (type, scale, etc.) 3) Environmental impact assessment procedures
3. Records of introduction	3-1 Trends among assistance agencies	(1) General	1) Major fields of assistance 2) Record in the relevant countries
	3-2 Trends in entire projects	(1) Progress of plans	1) Consistency with national plans, effectiveness 2) Impediments (political, financial)
		(2) General	1) Development and introduction quantities (solar power, micro-hydro, biomass, wind power, geothermal power, hybrid) 2) Project-based and program-based overview • Objectives (social development, economic development) • Data (locations, on-off grids, outputs, etc.) • Program implementation entity
		(3) Support systems (organizational systems)	1) Assistance agencies (government, municipalities, NGOs, research institutions, etc.) 2) Relationship to national policies 3) Financing (resources, funds, funding systems) 4) Operation and maintenance systems 5) Charge setting, charge collecting rate
		(4) Technologies	1) Simplification (standardization, local equipment and machinery) 2) New technologies
		(5) Impediments to sustainability	1) Policies, systems, support systems 2) Operation and maintenance 3) Charge setting (economic efficiency)
		(6) Utilization of CDM	1) Adoption performance 2) Relationship to rural electrification

Major item	Medium-level item	Minor item	Remarks
3. Records of introduction	3-3 Special items based on the power source	(1) Solar power	1) Presence or absence of battery recovery routes 2) Limited electric power supply 3) Procurement routes for photovoltaic power generation systems 4) Burden of initial costs
		(2) Micro-hydropower	1) Ideas for design flow rates according to differences between on-grid or off-grid systems 2) Environmental considerations, such as the accumulation of silt 3) Cost reductions in water turbines and dynamos
		(3) Biomass	1) Selection of appropriate fuels 2) Stable fuel supplies
		(4) Wind power	1) Economic efficiency of decentralized small-scale wind power generation 2) Hybrid with photovoltaic power generation, etc.
		(5) Geothermal power	1) Drilling costs 2) Feasibility of decentralized power generation

Appendix 4 Renewable Energy in the Southeast Asian Region

	Priority country	Index				Policies, plans, etc. of individual governments	Objectives of policies, plans, etc.	JICA	Current situation of renewable energy, etc.	Solar power		Biomass (unit: million tons)		Geothermal		Wind power		Micro-hydropower	
		Electrification rate (%)		GDP 2001	HDI 2001														
		Villages	House-holds					Cooperation programs			KWh/m^2		10 thou. kW		10 thou. kW		10 thou. kW		10 thou. kW
Indonesia	○	84.0	53.4	2,940	0.682	National energy policy (2003 – 2020)	Power generation utilizing renewable energy, excluding large-scale hydropower, will be increased to 5% by 2020.	Support for the development of the rural infrastructure	The consumption of renewable energy, excluding hydropower, was about 43 million tons (in petroleum equivalent). Of the geothermal power generation potential of 20 GW, 4% of its development has been realized. Rural electrification programs utilizing micro-hydropower and solar power are under way.	○	4.8	○	439	○	1,966		929	○	7,498
						Green Energy Policy	Preferential treatment for renewable energy costs, etc.												
Malaysia	△	90.0		8,750	0.790	Eighth 5-year plan (2001-2005) Five fuel diversification policy (2000) Small-scale renewable energy power (SREP) program Bio Gen program	The capacity of facilities using renewable energy was 5% of potential at 500 MW in 2005.		Biomass resources, such as rice chaff, wood chips, coconut husks and bagasse equivalent to 488 MW is available. Sixty-two projects (355 MW) were approved. Two projects (12 MW) started operation in 2005. Rural electrification programs utilizing micro-hydropower and solar power are under way. The first wind farm (24.75 MW) in the country was introduced in June 2005.	○		○						2,900
Philippines	○	83.1	54.0	3,840	0.751	Medium-term national plan (2004-2010)	Self-sufficiency in energy through the development of renewable energy, alternative fuels, etc.	Promotion of sustainable electric power programs, and rural electrification	Utilization of renewable energy is expected on the islands. Wind power generation is planned for North Luzon. In Panai-Negros, since the construction of coal thermal power plants with a large environmental load is difficult, the construction of a biomass power plant is planned. In 1999, 22% of total energy consumption was covered by geothermal energy.	○	5.1	○	89	○	205	○	3,820		1,231
						Renewable Energy Policy Framework	100% increase in the development of renewable energy by 2013												
Thailand	△	99.5	98.5	6,400	0.768	Renewable energy strategic plan (2003)	The utilization of renewable energy will be increased to 11% of primary energy and 4% of the capacity of power generation facilities by 2011.	Programs for supporting efficient electric power systems	Experiments for geothermal development and wind power generation in northern Thailand	○	5.1	○	67				304		701

Appendix 4 Renewable Energy in the Southeast Asian Region

	Priority country	Index				Policies, plans, etc. of individual governments	Objectives of policies, plans, etc.	JICA	Current situation of renewable energy, etc.	Solar power		Biomass (unit: million tons)		Geothermal		Wind power		Micro-hydropower	
		Electrification rate (%)		GDP 2001	HDI 2001														
		Villages	House-holds					Cooperation programs			KWh/ m^2		10 thou. kW		10 thou. kW		10 thou. kW		10 thou. kW
Vietnam	○	79.9	77.4	2,070	0.688	National Energy Policy (draft)	The percentage of renewable energy used in power generation will be 2% by 2010, 3% by 2020. The target of geothermal power generation is 200 MW by 2020.	Development plans for electric power supply facilities	Experiments for wind power generation in coastal areas; photovoltaic power generation in mountainous areas and remote islands A considerable number of hydropower generation facilities of 200 to 500 W with a head of 1 to 1.5 m have been installed. Although these can be constructed at a cost of about US$300 per unit, their life time is extremely short.	○	4.5	○	49		20	○	11,192	○	1,770
Cambodia	○	10.0	12.0	1,860	0.556	Renewable Energy Action Plan			Cooperation from NEDO and SIDA focusing on photovoltaic power generation	○	5.1	○					138		860
Myanmar	○	10.0	10.0	1,027	0.549	National Energy Policy (2001)	Promotion of the utilization of renewable energy	Electric power development programs	Experiments for wind power generation in coastal areas; experiments for biomass power generation using rice chaff, bagasse, etc.	○		○							3,700
Laos	○	25.0	43.0	1,620	0.525	Electric Power Sector Policy Statement (2001)	Maintenance and expansion of economically efficient, reliable and sustainable electric power supply for promoting socioeconomic development		Photovoltaic power generation is being put to practical use.	○	4.6	○	46			○	2,710	○	1,800

Criteria for narrowing down the priority countries: Electrification rate of 80% or less, clear establishment of objectives for policies, plans, etc.

Electric power industries in overseas countries in 2005: Japan Electric Power Information Center, Inc.(JEPIC)

Biomass power generation in AIST Chinese Center: From Asian Research Strategy, June 2005, Table 3.1

Micro-hydropower potential: Surveyed by the Renewable Energy and CDM Investigation Team

Village electrification rate
Cambodia: Electric Development in Cambodia, July 2005
Myanmar: FY 2003 Basic Survey of the Electric Power Situation in Myanmar, JEPIC, December 2003
Laos: Current Situation and Future Trends in Energy and Electric Power, IEEJ, October 2003

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"White Paper on Energy 2004": Ministry of Economy, Trade and Industry

"All About New Energy Illustrated": The Society of Chemical Engineers, Japan, SCE.Net

Ministry of Economy, Trade and Industry (METI): http://www.meti.go.jp/

Agency for Natural Resources and Energy: http://www.enecho.meti.go.jp/

New Energy and Industrial Technology Development Organization (NEDO): http://www.nedo.go.jp/

New Energy Foundation: http://www.nef.or.jp/

Japan Bank for International Cooperation (JBIC): http://www.jbic.go.jp/japanese/index.php

Japan External Trade Organization (JETRO): http://www.jetro.go.jp/indexj./html

Global Environment Centre Foundation: http://gec.jp/

World Bank: http://www.worldbank.org/

United Nations Development Programme: http://www.undp.org/

Inter-American Development Bank: http://www.iadb.org/

Global Environment Facility: http://www.gefweb.org/

"Glossary of International Cooperation, Third Edition": International Development Journal

Terminology and Abbreviations

Terminology and abbreviations	Outline
Terminology used in renewable energy sector	
1-km mesh distance	A small square lot formed by dividing the national land area along latitudes and longitudes into about 1-km squares in accordance with the Administrative Management Agency Announcement No. 143, 12 July 1973, is referred to as the (tertiary) mesh
Primary energy	Energy directly taken from nature, and used as it is; examples include coal, petroleum, oil shale, natural gas, and geothermal heat.
Income generation	To increase the income of a household by carrying out a particular activity
Inverter	A device to invert DC (direct current) to AC (alternating current); when DC is inverted to AC, the DC is periodically intermitted.
Greenhouse gas emission credit	Units of emissions that can be used to achieve targets for greenhouse gas emission reduction stipulated in the Kyoto Protocol; there are the following four units: • Assigned Amount Units (AAUs): Amount initially assigned to industrially advanced countries • Emission Reduction Units (ERUs): Credits issued through joint implementation • Certified Emission Reductions (CERs): Credits issued through the CDM • Removal Units (RMUs): Credits issued through absorption source activities
Carbon neutral	The concept of carbon circulation in which although plants emit carbon dioxide through combustion, they absorb the carbon dioxide in the air through photosynthesis in the growing process; therefore, the carbon dioxide balance is even.
Kyoto Mechanisms	Economic mechanisms for more flexibly reducing greenhouse gases determined in the “Kyoto Protocol” adopted at the Third Conference of Parties to the United Nations Framework Convention on Climate Change (COP3) held in Kyoto, Japan in 1997; it is divided into the “Clean Development Mechanism” (CDM), “Joint Implementation” (JI), and “International Emissions Trading” (ET).
Grid	Electric power distribution network installed so as to connect the locations to which electric power is supplied for the purpose of distributing electricity
Cold chain system	A system designed for storing vaccines at a low temperature, such as ice packs, refrigerators, and vaccine carriers
Study on willingness to pay (WTP)	Study to clarify the amount of money that an individual is willing to pay when a charge must be paid for using a certain service, through hearing, questionnaire, etc.
Means selection criteria	Criteria for judgment when the specific means for the introduction of renewable energy is selected
Solar home system (SHS)	Small photovoltaic power generating facility for household use installed on individual houses, in which the basic components are panels of photovoltaic cells, a charge-discharge controller, and lead batteries
Turbine	A kind of motor to convert the thermal energy of steam and so on into rotating kinetic energy, used for operating electric generators
Battery	A cell that can be repeatedly used if it is recharged after discharge using an external cell
Site selection criteria	Criteria for judgment when an appropriate site for the introduction of renewable energy is being selected
Diesel-powered electricity generation	Electric power generation using a diesel engine and characterized by low fuel costs, high thermal efficiency, and a low failure rate; it is used in places where normal electric power supply is difficult, such as isolated islands, and its use in combination with natural energy, such as wind power generation, is being put into practical use due to the environmental issues of diesel power.
Secondary energy	Energy that has undergone energy conversion, such as petroleum refining, electric power generation, and city gas manufacturing

Terminology and abbreviations	Outline
Battery charging station (BCS)	A concentrated facility for recharging a large number of storage batteries; it basically consists of panels of photovoltaic cells and a charge-discharge controller, and for recharging, lead storage batteries are brought to the facility by the users.
Wind conditions observation	Observation of the wind velocity and wind direction is carried out at a site that is a candidate site for installing wind-driven turbines. Based on such observation data, the wind condition characteristics and the energy potential are evaluated, the economic efficiency is validated, and the feasibility of wind power generation is investigated. The period of observation is normally one year or more.
International Conference for Renewable Energies Bonn 2004 (Natural Energy 2004)	An international conference on natural energy sponsored by the German government held in Bonn, Germany in June 2004, after the failure to agree on numeric targets for renewable forms of energy at the "World Summit on Sustainable Development" held in 2002. Government delegations from 154 countries participated, and a political deal was concluded.
Methane fermentation	A phenomenon in which organic matter is decomposed through the action of microorganisms to generate methane under anaerobic conditions
Pumping power generation system	A facility for pumping river water or underground water using an electric pump, etc. to reserve or supply water
Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)	A sensor for resources exploration developed through a joint project of the National Aeronautics and Space Administration (NASA) of the US and the Ministry of Economy, Trade and Industry (METI) of Japan
Clean Development Mechanism (CDM)	One of the Kyoto mechanisms; this is a mechanism by which an industrialized country and a developing country jointly implement a project for the reduction of greenhouse gases within the developing country, and the industrialized country acquires a part of the reduction that is produced as a credit in exchange for a domestic reduction in emissions.
Project Design Document (PDD)	A design and planning document for JI/CDM projects, including base-line setting, monitoring validation plans, consistency with the JI/CDM Project Standards and consistency with the technical standards
Photovoltaic (PV)	In these thematic guidelines, PV means "photovoltaic power generation."
Terminology used in development assistance sector	
Agenda 21	Concrete action plan to be realized by countries and international organizations adopted to achieve sustainable development in the 21st century, in response to the "Rio Declaration on Environment and Development" adopted by in the "UN Conference on Environment and Development (UNCED, Earth Summit)" held in Rio de Janeiro, Brazil in June 1992
Japan's Official Development Assistance (ODA) Charter	The government charter for development assistance adopted at a Cabinet meeting in June 1992 to clarify the philosophy and principles of Japan's Official Development Assistance (ODA); it was reviewed in December 2002 to enhance the strategic characteristics, flexibility, transparency and efficiency of ODA, promote broad public participation, and deepen domestic and overseas understanding of Japan's ODA.
ODA task force	This is a task force established to strengthen overseas roles and systems in the process of policy decision making. Each task force is composed of embassy staff and the field staff of JICA and the JBIC, with JICA experts and members of government organizations, such as the JETRO and the Japan Foundation, participating as required. ODA task forces have been established in 68 countries and they work on surveys and the analysis of development needs, etc, the planning and investigation of assistance policies, the formation and selection of candidate projects, collaboration with assisted communities in the field, etc.

Terminology and abbreviations	Outline
Capacity development	A process in which the capacity of a developing country to deal with its problems is , enhanced at multiple levels, such as the level of individuals, organizations and communities; "Capacity" is defined as the "capacity of a developing country to deal with development issues using its own skills," which is perceived as the "aggregate of diversified factors including institutions, policies, and social systems," and emphasizes the independent efforts of the developing country itself (intrinsic efforts).
Gleneagles Summit	The G8 Summit held at Gleneagles, Scotland in July 2005; "Africa" and "climate change" were discussed as the main agenda items, as well as the world economy, trade, intellectual property rights, peace in the Middle East, North Korean problems, UN reform, etc.
UN Millennium Declaration	The declaration adopted by 189 participating countries in the UN Millennium General Assembly held in September 2000, in which various targets to be realized in the 21st century, such as poverty reduction and the role of the United Nations, were established
Gender	The sex of human beings; while the term "sex" is used to indicate biological sexual differences, the term "gender" is used to indicate cultural and social sexual difference, such as differences in the social roles and interrelationships between men and women.
Study on social economy	A series of processes to collect, analyze, and publish data in order to clarify social problems and to understand social phenomena
Investment and loan program	A program to invest or accommodate funds required for economic activities managed according to certain objectives and plans
Human security	The concept of strengthening the approach to emphasizing safety centered on "human beings," in order to protect individuals from threats related to the survival, life and dignity of individuals, and to realize the abundant potential that is inherent in each individual
Pilot project	A project that involves a pioneering and trial approach
Feasibility study (F/S)	A study of the feasibility, validity, and investment effects of a project, which normally objectively verifies whether the project is socially, technically, economically and financially feasible or not
Micro finance	Financial services to provide poverty groups with financing mechanisms, such as small credit loans and savings, for the operation of small businesses to promote self-sufficiency
Master plan (M/P)	A study to establish a comprehensive development plan for a whole country or specific region, or a sector-based long-term development plan
Millennium Development Goals (MDGs)	International development goals compiled in the 1990s by the United Nations, the Organization for Economic Cooperation and Development (OECD), the World Bank, and the International Monetary Fund (IMF), which were revised and adopted at the UN Millennium General Assembly held in September 2000; the important goals for the establishment of the basic conditions for the future prosperity of human beings by 2015 include the following eight items: 1) the eradication of poverty and hunger; 2) universal access to primary education; 3) the attainment of gender equality and the empowerment of women; 4) the reduction of childhood mortality; 5) the improvement of maternity health; 6) prevention of the spread of diseases, such as HIV/AIDS and malaria; 7) the creation of a sustainable environment; and 8) the construction of a global development partnership.
Grant aid	One of the means of providing Official Development Assistance (ODA), in which funds without the obligation to repay are donated to the government of the country that is receiving the assistance; it is a particularly desirable means of assistance for countries with delayed development.
Revolving fund	Named from the cycling of funds whereby a certain activity is carried out by employing funds collected for the activity, money earned from the activity is then returned to the fund, and this money is then employed to provide funds for the next activity

Terminology and abbreviations	Outline
Basic human needs (BHN)	The basic needs of human beings to be able to live humanely, such as clothing, food and housing, education, medical care and health, and infrastructure
Environmental Impact Assessment (EIA)	This is an assessment activity to investigate the impact on the environment of a project before its implementation from the viewpoint of the consideration of environmental issues, and to check whether considerations regarding the environment have been properly included in the design of the project.
Gender development index (GDI)	An index to measure the state of gender equality (or inequality) in a certain country; from the viewpoint of human development, three basic factors (average income, average life expectancy, and school enrollment rate) are noted as in the human development index.
Gross Domestic Product (GDP)	The amount of added value produced as a result of domestic economic activities, which is used as an index of the purely domestic economic activities of a country
Human development index (HDI)	An index proposed by the UN Development Programme (UNDP) in its "Human Development Report" to indicate the development level of a certain country; the index notes diverse aspects of human development, and the basic factors are average income, average life expectancy, and school enrollment rate.
Non-Governmental Organizations (NGO)	Conceptually, organizations that act for the benefit of other people, which includes the general public interest and the socially weak, from a non-governmental and non-profit standpoint; however, there is no internationally common definition. In Japan, the term NGO often means a citizen-led organization to deal with international issues on a non-governmental and non-profit basis.
Non-Profit Organizations (NPO)	An organization having the same basic philosophy as an NGO; in Japan, NPO often means an organization that particularly deals with various domestic or local problems, or welfare issues.
Strategic Environmental Assessment (SEA)	Comprehensive analysis and assessment of the impact on the environment and the society in the planning stages of large-scale programs or policies involving multiple projects; while conventional Environmental Impact Assessment (EIA) is normally applied to individual projects, SEA is designed to forecast and assess the impact of multiple related projects and their alternatives on the environment and society, including the synergistic effects.
World Summit on Sustainable Development (W SSD)	This summit on sustainable development was held in Johannesburg in September 2002, and is also called the "Johannesburg Summit."
Assistance agencies and related organizations	
Asian Development Bank (ADB)	An international financial institution providing loans on a sub-commercial basis to promote development in developing countries of the Asian region
Global Environment Facility (GEF)	This is a facility to provide multilateral assistance for the financing of developing countries in the form of grants or long-term low-interest loans to achieve objectives in the four fields of global warming prevention, the conservation of biological diversity, the prevention of the contamination of international waters, and the protection of the ozone layer. It is jointly managed by the UNDP, the UNEP, and the World Bank.
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)	The German Agency for Technical Cooperation, which is wholly funded by the German government, conducting consulting work, human resources development, and equipment and materials procurement and transportation related to technical cooperation
New Energy and Industrial Technology Development Organization (NEDO)	An organization to carry out programs to develop, introduce and promote new forms of energy and energy conservation technologies, and the programs related to the research and development of industrial technologies

Terminology and abbreviations	Outline
New Energy Foundation (NEF)	A foundation whose major services are basic investigative studies and information provision for the development and introduction of new forms of energy, various assistance projects and public relations activities to promote these, as well as the proposal of new energy policies for Japan
Japan Bank for International Cooperation (JBIC)	A government-affiliated financial institution playing a major role in Japan's export and import trade, international financing for the promotion of overseas economic activities, and the execution of loan assistance, such as yen credits
United Nations Development Programme (UNDP)	The largest central financing organization in the world that promotes technical cooperation activities in the UN system
United Nations Environment Programme (UNEP)	The central organization in the United Nations system in relation to environmental conservation
US Agency for International Development (USAID)	A unified organization providing assistance and set up as an extra-cabinet bureau of the US Department of State
World Bank (WB)	The term often used to refer to both the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA). What is often called the "World Bank Group" consists of five organizations including these two plus the International Finance Corporation (IFC), the Multilateral Investment Guarantee Agency (MIGA), and the International Centre for Settlement of Investment Disputes (ICSID).
Terms for JICA programs	
Development study	This is a study provided by JICA as part of its technical cooperation involving the dispatch of investigation teams to prepare public development plans that have an important role on the social and economic development of developing countries, and drawing up blueprints for development. Studies for the formulation of master plans, and feasibility studies are included. The results of the studies are used as the basic data for policy making by the government of the developing country involved, or as basic data for the government of the developing country to request financial assistance from advanced countries or international institutions.
Counterpart (C/P)	This refers to executive officers or engineers of the countries that receive technical transfers or political advice through the dispatch of experts, technical cooperation projects, or other international cooperation programs implemented by Japan in developing countries
Technical cooperation projects	Projects in JICA's technical cooperation programs that are intended to achieve certain favorable results in a certain period of time, and that are implemented and managed based on previously agreed cooperation plans; the projects seek to flexibly select the optimum combination of the period, scale, etc., and to apply various patterns of cooperation to yield greater results according to the area of need.
Country-focused training	This refers to training based on programs that have been individually developed according to a request from a developing country. It includes country-focused specialized training that directly corresponds to individual human resources development needs, and is conducted on an individual basis to meet the needs of the counterparts of the country related to the specific technical cooperation, such as through the dispatch of experts, technical cooperation projects, and development studies.
Senior Volunteers (SV)	These are volunteers who are publicly recruited by JICA and are then dispatched to a developing country in response to a request from the developing country for technical assistance. The qualifications required are that they are between 40 and 69 years of age when dispatched and have the technical skills, knowledge, and experience to contribute to the economic and social development of developing countries and regions. Public participation is invited twice a year. The period of dispatch is one to two years.

Terminology and abbreviations	Outline
JICA Guidelines for Environmental and Social Considerations	These are guidelines introduced by JICA in 1990 for screening and scoping in relation to the implementation of preliminary studies for a development study and from time to time are revised by the Environment Guidelines Revision Committee since 2002 taking into consideration the need for review in relation to the environmental and social conditions.
Group training	This is training that is conducted in groups in selected fields where there is a great need common to many developing countries and involves the establishment of training courses for each field. The training is conducted through a system in which G/I (general information) describing the details of the training, the qualification requirements for participation, etc. are provided to the governments of certain countries through Japan`s overseas diplomatic offices, and applications are received from these countries.
Japan Overseas Cooperation Volunteers Program (JOCV)	These are volunteers dispatched by JICA as part of its technical cooperation on a governmental basis to developing countries. The objective of the JOCV is to contribute to the development of developing countries, as well as the personal development of the volunteers themselves through such cooperation activities. The categories cover 160 fields including agriculture and fisheries, maintenance and operations, education and culture, civil engineering and construction, sports, and health and medical care. Recruitment and screening are conducted twice a year for applicants 20 to 39 years of age (as of January 2006), and they are dispatched to developing countries for about two years.