(Provisional translation)

JICA's Strategy Paper for Energy Sector

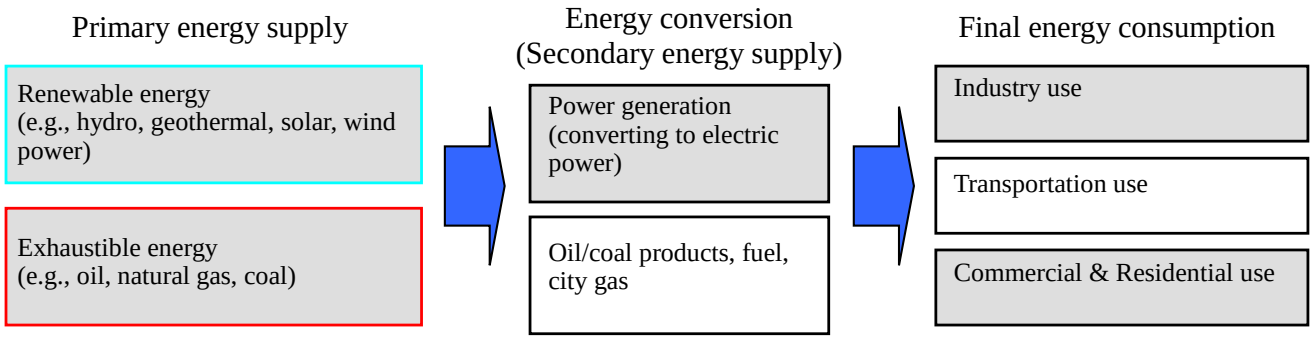
May 2013

Japan International Cooperation Agency

Definition of targeted area of energy

In considering the form of final energy consumption in general, energy use can be roughly divided into the three categories of industry, transportation, and commercial & residential use. The energy for commercial & residential use is further classified into two groups: commercial use (mainly intended for consumption by corporate management divisions and tertiary industry), and residential use. The primary energy can also be categorized into two groups: exhaustible energy (e.g., oil, natural gas, coal, nuclear power) and renewable energy (e.g., hydro, geothermal, wind, solar, wave, tidal, biomass power).

JICA widely provides support for stably ensuring and efficiently providing these energies. Most of the practical needs for cooperation are associated with supplying power for the industrial divisions and commercial & residential use as a secondary energy, and ensuring the primary energy necessary for the supply of power. Another need that follows this is to disseminate energy conservation technology in those divisions. To reflect such situations, this Strategy Paper mainly deals with power supply. It also includes the issues related to primary energy and the dissemination of energy conservation technology.



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1-1 Introduction

Modern life cannot function without modern energy. A stable energy supply is indispensable for any country in achieving the wide range of purposes and economic activities to satisfy basic human needs and to provide the infrastructure necessary for industrialization. Economic growth shows a strong positive correlation with higher energy consumption. That is why ensuring a stable and affordable energy supply is a crucial and important developmental task for developing countries in their efforts towards socioeconomic stabilization and sustainable growth.

(1) Measures against the unavoidably increasing use of fossil energy

According to the World Energy Outlook[1] 2012 published by the International Energy Agency (IEA), energy use is expected to increase dramatically from 2010 to 2035 in developing countries. In the electric power sector, for example, the annual amount of power generation in all non-OECD nations is expected to increase by 2.2 times, with the use of coal increasing by 1.8 times (accounting for almost 40% of total power generation) and the use of natural gas also increasing by 2.2 times (accounting for more than 20% of total power generation). At the same time, the widely expected use of renewable energy[2] will undergo a significant increase of more than 3.2 times. The 2035 sectional projections of annual power generation indicates that hydro power accounts for a significant share of 17%, while wind power accounts for a mere 5%, geothermal for 1%, and solar and other power sources for 6%, thus suggesting that a high dependency on using fossil fuels (accounting for more than 60%) for power supply is unavoidable.

Table 1 Trends of power generation according to the primary energy by region (2010-2035)

	OECD nations					Non-OECD nations					Whole world				
	2010		2035			2010		2035			2010		2035		
	Amount of power generation (TWh)	Share (%)	Amount of power generation (TWh)	Share (%)	Change (%)	Amount of power generation (TWh)	Share (%)	Amount of power generation (TWh)	Share (%)	Change (%)	Amount of power generation (TWh)	Share (%)	Amount of power generation (TWh)	Share (%)	Change (%)
Coal	3,745	35%	2,794	21%	-25%	4,940	47%	9,114	39%	84%	8,687	41%	11,908	33%	37%
Oil	309	3%	90	1%	-71%	591	7%	465	2%	-33%	1,000	5%	555	2%	-44%
Gas	2,544	23%	3,517	25%	38%	2,216	21%	4,949	21%	123%	4,760	22%	8,466	23%	78%
Nuclear power	2,288	21%	2,460	19%	8%	468	4%	1,906	8%	307%	2,756	13%	4,366	12%	58%
Hydro power	1,351	12%	1,622	12%	20%	2,079	20%	4,054	17%	95%	3,431	16%	5,677	15%	65%
Wind power	269	2%	1,423	11%	429%	73	1%	1,258	5%	1633%	342	2%	2,681	7%	585%
Geothermal	43	0%	155	1%	282%	25	0%	149	1%	503%	68	0%	315	1%	362%
Other renewable energy sources	296	3%	1,225	9%	313%	69	1%	1,444	6%	1997%	365	2%	2,669	7%	631%
Total	10,848	100%	13,297	100%	23%	10,560	100%	23,340	100%	121%	21,408	100%	36,637	100%	71%

Source: prepared based on World Energy Outlook 2012

Judging from this projection, it is quite important to promote the introduction of renewable energy as much as possible in order to mitigate climate change. In addition, it is also quite significant to improve the efficiency of coal-fired and gas-fired power generation, which account for a large share, and to promote low carbon growth.

[1] IEA publishes it every November. The report analyzes projections of the world's energy supply/demand. The World Bank and other aid agencies utilize data from this report. This Strategy Paper is prepared on the basis of the "New Policy Scenario," which is based on the hypothesis that international society will implement a range of published policies for reducing greenhouse gases.

[2] For example, hydro, wind and solar power, as well as biomass

(2) Measures for stabilization and sustainable growth in developing countries/regions

In developing countries, a challenging development issue is to improve the electrification ratio, which is essential for realizing sustainable growth and social equity. Table 2 lists the electrification ratios in non-OECD nations as of 2009, based on materials published by IEA. According to the table, East Asia and North Africa maintain relatively high electrification ratios both in urban and rural areas, while other regions show significant gaps between urban and rural areas. In Sub-Saharan Africa, the electrification ratio is low in urban areas that are expected to function as a driving force for socioeconomic development. The low electrification ratios in these areas are at the same level as in rural areas of South Asia. Thus, as one short-term effort for these areas in the future, initial access must be improved.[3] It is also quite important to promote the provision of a sufficient amount of electric power[4] because an inadequate supply of electric power will be detrimental to sustainable socioeconomic development. As mid- and long-term efforts, it is necessary to promote permanent electrification by expanding electric power transmission and distribution networks.

Table 2 Electrification ratios of non-OECD nations as of 2009

	Urban area		Rural area		Total	
	Electrification ratio (%)	Population in unelectrified area (million persons)	Electrification ratio (%)	Population in unelectrified area (million persons)	Electrification ratio (%)	Population in unelectrified area (million persons)
Non-OECD Asia	94%	79	73%	596	81%	675
East Asia	96%	32	86%	150	91%	182
South Asia	89%	48	60%	446	68%	493
Latin America	99%	4	74%	26	93%	31
Middle East	98%	2	72%	19	89%	21
Africa	69%	121	25%	466	42%	587
Sub-Saharan Africa	60%	121	14%	465	31%	585
North Africa	100%	0	98%	1	99%	2
Non-OECD nations	91%	207	63%	1,108	75%	1,314
World	94%	207	68%	1,111	81%	1,317

Source: prepared based on World Energy Outlook 2012 etc.

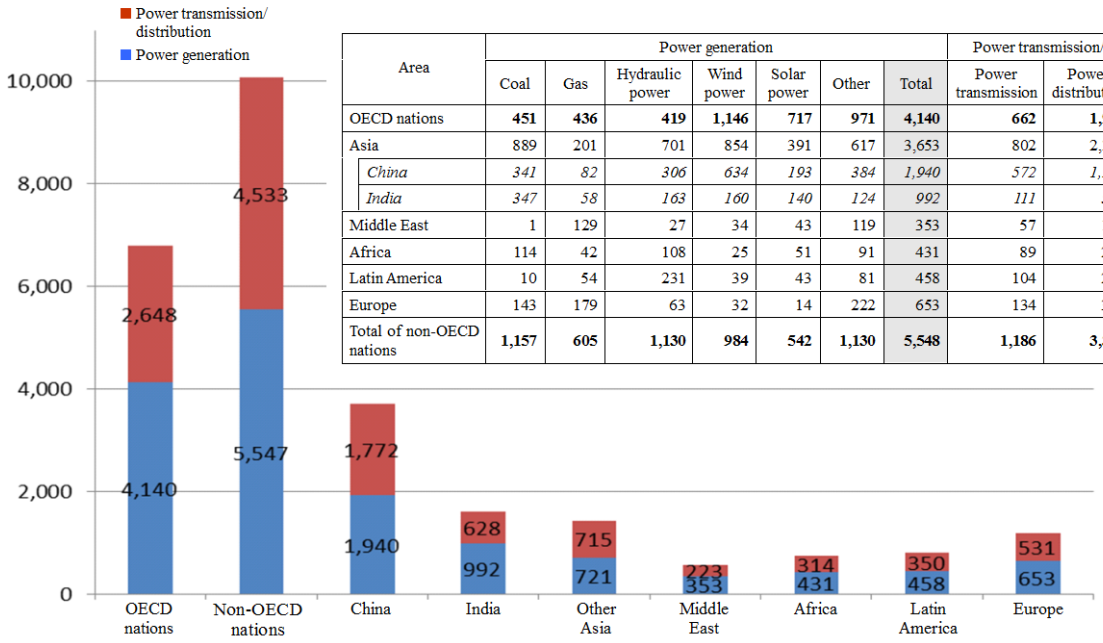
(3) Efforts to satisfy the needs for high technology and huge funding

A huge investment is required to improve the supply of electric power.[5] According to calculations conducted by IEA, non-OECD nations need an investment of 10,081 billion dollars in the electric power sector by 2035. IEA also points out that in the future, investments made in power generation (5,548 billion dollars) and for power transmission/distribution (4,533 billion dollars) will become very important. It is practically impossible to fulfill such a huge investment from public funding alone, such as development aid. Thus, private funding for countries and fields (e.g., power generation) where profit is expected must be promoted. At the same time, in order to properly utilize the latest energy technology that is constantly advancing, it is also important to proactively utilize the know-how and technology developed by the private sector for the operation, maintenance and management of electric power facilities.

[3] Initial supply of small amounts of electric power to areas yet to be electrified (e.g., introduction of electric lamps by using off-grids.

[4] IEA adopts 500 kWh/year in urban areas, and 250 kWh/year in rural areas as the amounts of electric energy necessary per household soon after power grid connection.

[5] As general figures, investments of 100 million yen/MW for constructing an electric power plant, and 10 million yen/km for installing electric power cable are necessary.



Area	Power generation							Power transmission/distribution			Grand total
	Coal	Gas	Hydraulic power	Wind power	Solar power	Other	Total	Power transmission	Power distribution	Total	
OECD nations	**451**	**436**	**419**	**1,146**	**717**	**971**	**4,140**	**662**	**1,986**	**2,648**	**6,788**
Asia	889	201	701	854	391	617	3,653	802	2,313	3,115	6,768
China	*341*	*82*	*306*	*634*	*193*	*384*	*1,940*	*572*	*1,200*	*1,772*	*3,712*
India	*347*	*58*	*163*	*160*	*140*	*124*	*992*	*111*	*517*	*628*	*1,620*
Middle East	1	129	27	34	43	119	353	57	166	223	576
Africa	114	42	108	25	51	91	431	89	225	314	745
Latin America	10	54	231	39	43	81	458	104	246	350	808
Europe	143	179	63	32	14	222	653	134	397	531	1,184
Total of non-OECD nations	**1,157**	**605**	**1,130**	**984**	**542**	**1,130**	**5,548**	**1,186**	**3,347**	**4,533**	**10,081**

Source: prepared based on World Energy Outlook 2012 etc.

Figure 1 Investment required by the world's electric power sector in 2010-2035 (billion USD)

As explained above, solving the issues of the energy sector in developing countries requires advanced technology, know-how, and a huge investment. However, developing countries lack such resources. Human resources who can formulate and implement policies are also scarce. In addition, developing countries are also expected to switch to using less carbon energy. The technology for energy use is becoming more sophisticated and entails a higher cost year after year. It is now essential to obtain cooperation from advanced nations that are both technologically and financially affluent, and have abundant experience and know-how as accumulated through history.

(4) Using Japanese experience and technology for the world

Japan's electric power industry has a history that spans more than 100 years, and provides electric power of very high quality. Moreover, the entire nation has addressed the issue of energy conservation ever since the oil crisis in the 1970s. Energy consumption by industry has been controlled at the level of the 1970s for the past 30 years, thus achieving the world's highest level of energy efficiency. Japan has experience in formulating policies that have made such achievement possible. And many world-class manufacturers in Japan's energy industry have technologically supported energy conservation. Without the R&D results jointly achieved by industry, academia and government since the oil crisis, it would be impossible to acquire the technologies for power generation using renewable energy, such as the recent worldwide proliferation of solar power generation, geothermal power generation now undergoing rapid development, and the application of highly efficient coal technology. Furthermore, it would be no exaggeration to say that Japan's ODA is a pioneer[6] in disseminating state-of-the-art energy technologies among developing countries.

As stated above, Japan has numerous excellent technologies and achievements in the energy sector to

[6] Regarding photovoltaic (PV) power generation, Japan's Official Development Assistance (ODA) introduced off-grid rural electrification in the early 1990s. Thereafter, Japan's ODA introduced a power system interconnected to the national grid in more than 20 developing countries that never had this technology before, and thus set a precedent for disseminating technology in developing countries. Japan's ODA also played a leading role in international aid activities by assisting Southeast Asia, Latin America, and Africa in the field of geothermal development. And with regard to the highly efficient use of coal, Japan's ODA has been leading international aid organizations in cooperating on technology to utilize low quality coal and encouraging electric power companies in developing countries to implement Ultra Super Critical (USC) coal-fired power generation. Japan's ODA also provides cooperation toward disseminating and promoting such technologies in developing countries as low-loss power grids and adjustable speed pumped storage, both of which are new technologies in those countries.

help developing countries solve the difficult issues that they face. It is quite significant for Japan to continuously promote international cooperation, and contribute not only to developing countries and regions but also to a bright future for the entire world.

1-2 Purpose

The purpose of JICA's cooperation entails the following three points:

(1) Contribution to realizing a low-carbon society that can develop sustainably

Realizing a low-carbon society that can develop sustainably is a task common to international society that includes Japan, and is not limited to developing countries and regions.

Against a backdrop of soaring crude oil prices since the mid-2000s, the stable provision of affordable energy—a fundamental requirement for economic growth—has been at risk. In developing countries, it is important to satisfy the three requirements of low cost, low carbon, and low risk, while protecting the global environment.

JICA will provide support by recognizing that Japan's support, with its excellent technologies and achievements in the energy sector, is necessary to solve this difficult energy supply task.

(2) Contribution to inclusive growth and poverty reduction by improving energy access

Disparity adjustment and poverty reduction through inclusive growth are prerequisites for stability and the sustainable growth of international society that includes Japan, and are not limited to developing countries and regions.

International society now recognizes that extensively improving access to modern energy is an essential factor for helping developing countries and regions to grow inclusively.[7]

In order to fulfill its responsibility as a member of international society, JICA will improve energy access and contribute to solving issues in order to achieve goals.

(3) Contribution to boosting global vigor by utilizing Japan's excellent technologies and know-how

In the energy sector, developing countries also face some very difficult issues—the same ones faced by developed nations. Solving these issues will significantly contribute to boosting the global vigor that affects Japan too.

Today, Japan has many excellent resources in the energy sector, and the world expects Japan's contribution in this field.

JICA will continue to be a pioneer aid organization in the energy sector, utilize the technologies in which Japan excels, as well as Japanese experience and know-how that have been accumulated through history, and contribute to boosting the global vigor that also affects Japan, and is not limited to developing countries and regions.

[7] In September 2011, Ban Ki-moon, Secretary General of the United Nations, under the recognition that access to "Affordable Modern Energy" is indispensable for sustainable development and the achievement of MDGs, proclaimed "Sustainable Energy for All" (SE4A), and designated the following initiatives to be achieved by 2030 based on the partnerships among public sector, private sector and civil society: [1] Improve access to modern energy for all people; [2] double the ratio of introducing renewable energy; [3] double the energy efficiency. The World Bank, EU, and other bilateral donors are making moves to comply with the initiatives.

2. JICA's Cooperation Policies in the Energy Sector

2-1 Basic Policies

In light of the previously stated outline of JICA's cooperation in the energy sector, JICA has set up the following basic policies: Energy with Low-Cost, Low-Carbon, and Low-Risk (3L Policies). The purpose of these policies is described below. Satisfying all three conditions is a challenging task for all nations, but is much more difficult for a developing country to achieve alone. The policies are based on the recognition that developing countries urgently need Japan's technology and funding.

"3L Policies"

The "Low-Cost" Policy refers to reducing the total cost, not just limited to the initial investment. More specifically, while introducing technology for excellent environmental performance with low carbon, high efficiency, and high reliability, the policy contributes to reducing the total cost that includes the life cycle cost and external diseconomies. In order to avoid overdevelopment, the policy also contributes to utilizing commercial investments under an appropriate development plan.

The "Low-Carbon" Policy refers to realizing low carbon emissions. More specifically, it targets the core power system (i.e., major source of CO_2 emissions), and contributes to CO_2 reduction as much as possible by utilizing Japan's excellent technologies, introducing such low-carbon power sources as highly efficient thermal, hydro, geothermal, and other sources of renewable energy, reducing loss from power grids, and promoting energy conservation.

The "Low-Risk" Policy refers to reducing risks that threaten a stable supply of energy. More specifically, the policy contributes to stably securing the primary energy, realizing the best mix of energy, avoiding or reducing climate risks, and ensuring power system stabilization.

As the soundness of the energy sector hugely affects the macro economy of a country, the major premise of the policies above is to develop appropriate support in cooperation with other donors from the standpoint of public financial management as well as from a technological standpoint.

2-2 Promoting cooperation by featuring Japan's strength and JICA's characteristics

There are many players other than donors in the energy sector today. For example, NGOs and private companies develop their operations in the field of rural electrification, and private capital helps to fund large-scale power development. In such an environment, JICA will promote support by featuring Japan's strength and JICA's characteristics.

First, as stated before, Japan has excellent technology and abundant experience, and can thus utilize these advantages to tackle the difficult issues faced by developing countries. However, Japan is not always so advantageous in all fields that include the cost aspect. It is necessary to select tasks while always assessing Japan's strength that constantly changes with the times, and to consider collaborating and sharing roles with other donors.

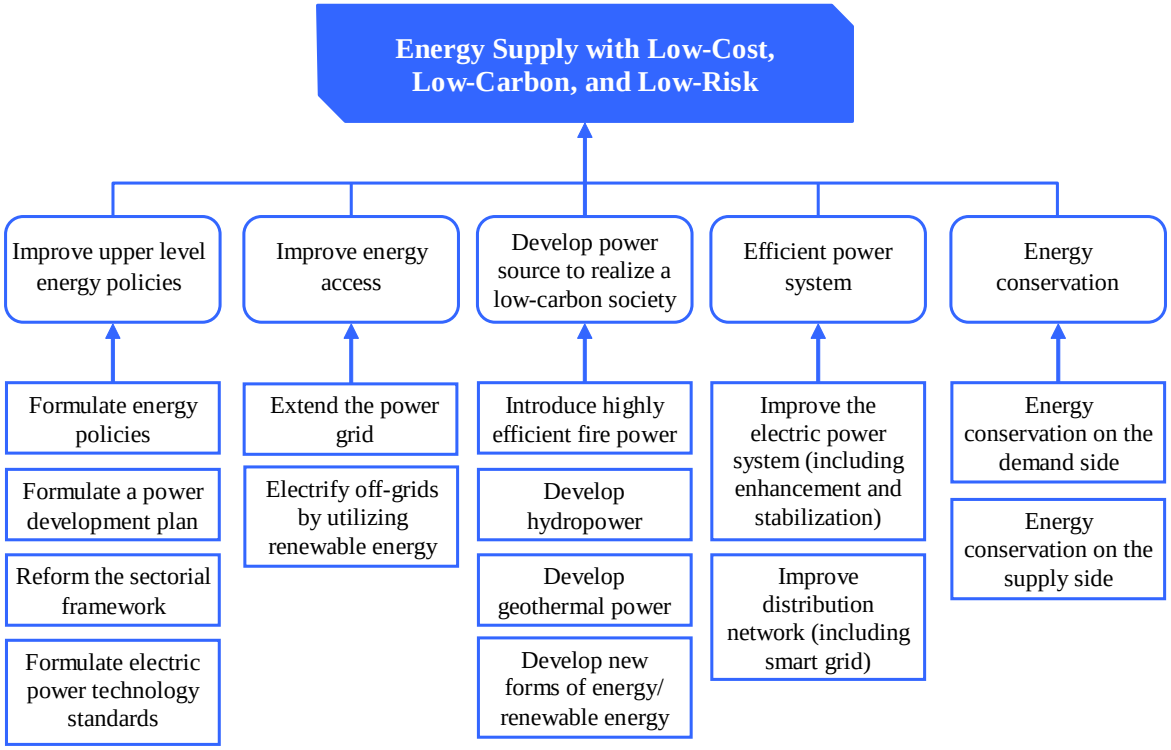
Along with the World Bank, regional development banks and some other donors, JICA is one of the rare donors with relatively abundant financial resources that can support large-scale development requiring high technology and development with high risks in the energy sector. At the same time, JICA is not a multilateral donor like the World Bank and other international organizations, but a bilateral donor that functions as part of Japan's foreign policy. Its mission is to fully utilize Japan's experience and technology to address global issues. In order to feature its characteristics, JICA will selectively and intensively distribute its resources to specific targets. This can be considered an attempt to enhance the advantage of divisional cooperation with other aid organizations.

From the viewpoints mentioned above, JICA will, in principle, fully utilize Japan's experience and technology set the national grids[8] in developing countries as major targets, and intensively distribute management resources to the field that will contribute to enhancing, expanding, and stabilizing those national grids. At the same time, as a pioneer supporter in this field, JICA will provide the benefit of its accumulated experience and know-how to those who need it relative to off-grids separated from the national grid, while enhancing collaboration with other donors and private sectors, and developing indirect support.

2-3 Systematic diagram of the development issues, and cooperation policies by sub-issues

(1) Systematic diagram of the development issues

In order to achieve the development issues of the "3L Policies," it is necessary to solve the issues indicated in the systematic diagram below. However, the status of issues to be solved varies among countries. Appropriate support will thus be provided based on analysis by the country.



[8] National power system that includes power generation and power systems.

(2) Cooperation policies by sub-issues

1) Improve upper level energy policies

JICA will promote the improvement of upper level energy policies in collaboration with international organizations based on the recognition that contributing to upper level policies in the energy sector will promote optimal public investment, and thus improve the management of public finance in developing countries, and that such contribution is also important because it prevents power shortages that pose a bottleneck for economic growth.

JICA has been providing support for formulating energy master plans and power development plans, and will continue to focus on those tasks. In that regard, JICA will provide support based on the "3L Policies" (i.e., Low-Cost, Low-Carbon, Low-Risk), while considering the global energy trends of energy changes and the moves made by the Conference of Parties (COP) to the United Nations Framework on Climate Change (UNFCC).

Regarding power sector reform, JICA will support policies that can present desirable options for the power sector (as based on technical, financial, and economical evidence) by providing support for formulating power development plans through collaboration and role sharing with international organizations.

Regarding human resource development in the power sector, JICA will provide support that meets the needs of individual countries (e.g., ability to formulate optimal power development plans, capacity of national grid system management, capacity of national power supply management, ability to maintain distribution system).

Lastly, regarding support for establishing technical standards in the electric power sector, JICA will not further expand support in this field because international organizations have already initiated such support and JICA will avoid duplicating the support rendered by other organizations.

2) Improve energy access

Energy access can be improved in two ways: expanding the grids or electrifying off-grids by using renewable energy, etc. JICA has been a world-leading pioneer in terms of the latter. Luckily, other donors, NGOs, private companies, and many other players have already developed operations regarding the electrification of off-grids.

Only limited donors with sufficient financial resources and technology, however, can enhance and expand the power source of a large-scale national power system. As one such donor, JICA will focus on this approach from now on. However, expanding the grids and improving the off-grids complement each other, and thus should be conducted in coordination. Therefore, JICA will provide indirect support and collaborate with other donors and private organizations that provide support for off-grid electrification.

3) Develop a power source to realize a low-carbon society

The cooperation policies by each power source are described below.

[1] Oil-fired power

Regarding this power source, JICA mainly targets diesel power generation, a most reliable power source that is generally used in rural areas and islands in many developing countries and regions. However, due to soaring fuel prices, those countries are facing the tasks of less fuel required generation and developing alternative power sources.

In order to address these issues, JICA will mainly target island nations that use diesel power generation as the national core power source, provide support to foster human resources capable of properly managing power generation, transfer know-how for efficient operation to reduce fuel costs, and introduce the combined use of other power sources such as renewable energy.

[2] Natural gas-fired power

Natural gas-fired power generation has relatively low environmental impact among the various types of thermal power generation. As countries that produce natural gas have

advantages in terms of both cost and a stable supply, this is an important option in power generation. This can also be expected to absorb any fluctuations in output when using an intermittent power source.

Japan has technology of the world's highest standard in terms of both efficiency and environmental performance. JICA will proactively provide support that includes new development, rehabilitation, and replacement for countries that have appropriate conditions to construct gas-fired power plants.

[3] Coal-fired power

Coal-fired power generation produces more SOx, NOx, dust, and CO_2 than oil or gas-fired power generation. However, a significant expansion of coal-fired power in developing countries is considered unavoidable in the future. What is necessary in such a situation is to reduce CO_2 emissions as much as possible by utilizing every available technology.

As Japan leads the world with this technology and is one of the few donors who can provide relatively large-scale funding for this field, JICA expects to play a significant role in disseminating the technology.

JICA will promote the introduction of technology for highly efficient coal-fired power generation in developing countries by utilizing Japan's experience and technology. It will also introduce technology to reduce CO_2 emissions, promote the development and utilization of brown coal and other types of low-grade coal, strongly promote cooperation to support a stable supply of coal resources, and thus lead the world in this field.

[4] Large-scale hydropower

For developing countries that have undeveloped water resources with development potential, developing hydropower means securing purely domestic energy, which is good for a nation's macro-economic management. It is also favorable as a measure against global warming and in terms of ensuring energy security. Such resources should be developed before the use of fossil fuel expands, with appropriate environmental and social considerations being prerequisite. Since hydropower can deal with peak consumption and has high load following capability, it is also important for its function to absorb any fluctuations in output when using a intermittent power source and for its capacity to store electric power (water pumping).

As the method of this power generation is commonly used worldwide and technologically established, however, Japan lacks superiority in this field from the aspect of cost effectiveness. And because the development of large-scale hydropower generation has a huge impact on the environment and society, support should be promoted in careful consideration of these points.

[5] Small hydropower

Small hydropower has low output, and entails relatively higher construction cost for its power generation capacity. However, as it is clean and relatively easy to maintain and manage, such power is urgently needed in rural electrification as electric power that is locally generated and consumed. At the same time, such power does not require any high technology, and is not a field where Japan's ODA can demonstrate its superiority in terms of construction cost.

JICA focuses on targeting cases where Japan considers highly significant and at the same time JICA promotes collaboration and indirect support with small- and medium-size companies and NGOs that are interested in this field.

[6] Geothermal power

Geothermal power is clean and stable source of base power. Japanese companies have overwhelming superiority in the field of turbine generators. JICA will continue its support for Indonesia and Latin America, and focus on the African Rift Valley where many areas are undergoing new development.

When developing geothermal power, the greatest bottleneck involves risks at the exploratory drilling stage. Measures to solve this bottleneck are risk hedge by financial scheme, and risk

mitigation by improving technological level of recipient countries.

JICA will respond to both financial and technical needs for support. For technical needs, it will focus on fostering human resources to improve the success rate of exploratory drilling and the accuracy of evaluating geothermal reservoirs.

[7] Wind power

Wind power generation has an affordable unit cost of power generation relative to other forms of renewable energy. And wind power generation is generally superior to solar power, as it generates more electric power per year relative to solar power with the same installed capacity. Consequently, it is considered a promising renewable energy power source, but remains dependent on the progress of future technical development and cost reduction.

At the same time, Japan also leads the world in terms of component technologies, but lacks the expertise or extensive know-how regarding the system as a whole. However, Japan is propelling large-scale technological research and development for large-scale floating offshore wind power generation systems. JICA will continue monitoring the trends of Japan's technology, and promote discussions on the details of its cooperation.

[8] Solar power

Solar power generation is clean, low-carbon power source, with a short development lead time and affordable running cost. These factors make solar power generation very attractive for developing countries. Conversely, its economic efficiency is still inferior when adding the cost for introducing initial facilities, taking measures to stabilize the system, and including the additional function of electricity storage. The introduction of solar power requires appropriate decision-making by comparing it with other power source options.

JICA has served as a pioneer in disseminating solar power generation, and thus taken the initiative in disseminating various models, starting from an off-grid system to interconnected systems. JICA will shift to more difficult problems, such as measures against system instability associated with the full-scale introduction of solar power by utilizing Japan's technologies, and continue contributing to the world.

[9] Wave power/tidal power

Wave power/tidal power generation remains in the R&D stage, and thus quite unlikely to be a target of ODA cooperation. However, depending on the level of its future application, it could be put to practical use in Pacific Basin nations. It is therefore necessary to monitor the progress of development in the future.

[10] Biomass power

The amount of power generation from biomass cannot be expected so much due to various constraints. However, it has the potential to become an important power source in some regions. Technical and economic problems, as well as many social institutional problems, should first be addressed in order to disseminate biomass power.

JICA will provide support by utilizing Japan's science technology expertise to address problems regarding the use of biomass energy. Cooperation will be promoted while avoiding competition with the field of food production, and with the economic performance of the operation being carefully assessed.

[11] Waste power

For many developing countries, waste disposal is a major problem, but waste power generation offers an attractive means of solution. However, the stable collection of waste and an established disposal system are prerequisite for any introduction of waste power. Support for introducing waste power generation will be considered after confirming the prerequisites.

4) Improve an efficient power system

Improving the efficiency of the power system and electric grids entails unavoidable issues in achieving effective energy use and a stable power supply. These are issues that also require

constant, ceaseless effort for improving full-scale energy access.

Japan has power transportation systems of the world's highest level, as well as the resources to support developing countries in formulating improvement plans and improving system management. JICA will promote cooperation in the fields where Japan's superiority can be utilized, such as in expanding electric grids, improving the reliability of power supply, and reducing losses.

5) Promote energy conservation and energy efficiency

As a pioneer in energy conservation, Japan is highly expected to fulfill its role of promoting cooperation in this field. As there are many players that internationally promote energy efficiency (that is included in the concept of energy conservation), however, redundancy in support must be carefully avoided. In particular, energy efficiency led by the private sector and based on market principles should be promoted, while carefully considering role sharing with the World Bank and other donors.

For this purpose, JICA will focus on formulating energy conservation master plans, and establishing such frameworks as an energy management system, energy conservation labeling system, and energy conservation support system. It also promotes financial support to disseminate technologies for energy conservation.

2-4 Points to be considered in implementing cooperation

(1) JICA Country Analysis Paper for individual countries

When discussing the specific contents of support for individual countries, it is quite important to undergo the processes of formulating support strategies and extracting specific cases through an analysis of individual countries. The energy sector is also an indispensable element for economic activities. The soundness of sector management and the scale of investment have a huge impact on the macro economy. From the standpoint of managing public finance, it is therefore necessary to maintain a policy to minimize negative impact on the national finance of the governments of developing countries, and cooperate with IMF and other international organizations.

(2) Collaborating with other donors and the private sector

For cooperation in this field, it is necessary to cooperate and share roles with other donors so that optimal investment as a whole can be made in the target nation. While concentrating on national grids, JICA will also pay attention to collaborating with other donors, NGOs, and the private sector that work on off-grids and indirect support. JICA will enhance indirect support in particular, by proactively utilizing schemes to support small- and medium-size Japanese companies.

In the support for national grids, it is necessary to proactively discuss collaborative funding with other donors, as well as utilizing the Public Private Partnership (PPP) scheme where power plants are maintained by private funding, and power grids and peripheral infrastructure are maintained by public funding.

Electric power sector reform is highly likely to be deeply involved in private funding and associated with the interests of multiple nations. This should be carefully addressed while paying attention to collaboration with support mainly from international organizations.

(3) Environmental and Social Considerations

When developing individual operations, compliance with the guidelines for environmental and social considerations should be properly ensured, and gender considerations properly addressed.

3. JICA's Efforts and Examples of Cooperation

Energy policies

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Viet Nam	Development Study	The Study on National Energy Master Plan	2006-2008
Philippines	Development Study	Capability Enhancement on Energy Policy and Planning for a More Effective and Comprehensive Philippine Energy Plan (PEP) Formulation	2007-2008
Saudi Arabia	Technical Cooperation	Measure of Energy Efficiency and Conservation	2006-2007
Indonesia	Loan Aid	Climate Change Program Loan (I - III)	2008, 2009, 2010
South Africa	Development Study	Energy Efficiency Improvement	2011-2012
All countries	Training and Dialogue Program	Energy Policy	2013-2015

Power development plans

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Indonesia	Development Study	The Study on the Optimal Electric Power Development and Operation in Indonesia	2001-2002
Viet Nam	Development Study	The study on National Power Development Plan for the period of 2006-2015, Perspective up to 2025	2005-2006
Viet Nam	Technical Cooperation	Technical Assistance for Power Development Plan 7	2010
Sri Lanka	Development Study	Master Plan Study on the Development of Power Generation and Transmission System	2004-2006
Indonesia	Development Study	The Study on Optimal Electric Power Development in Java-Madura-Bali	2008
Laos	Development Study	The Study on Power Network System Plan	2008-2009
Zambia	Development Study	Study For Power System Development Master Plan	2008-2009
Bangladesh	Development Study	Master Plan Study on Coal Power Development in Bangladesh	2009-2010
Uganda	Development Study	Project for Master Plan Study on Hydropower Development	2009-2011
Turkey	Development Study	The study on Optimal Power Generation for Peak Demand	2010-2011

Power sector reforms

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Philippines	Development Study	Study on the Institutional Capacity Building for the DOE under a Restructured Philippine Electric Power Industry	2002-2004
Sri Lanka	Loan Aid	Power Sector Restructuring Program	2002
Bangladesh	T/A Pro. related to ODA Loan	Strengthening Management and Performance Standards in Power Sector of Bangladesh through Promotion of TQM	2006-2010
Uganda	Loan Aid	Bujagali Interconnection Project (Co-financing with AFDB) * with WB Partial Risk Guarantee (PRG) of Hydro Power	2007
Philippines	Development Study	Study on the Assets and Liabilities Management of PSALM and the Administration of Universal Charge Funds	2009
Sierra Leone	Technical Cooperation	The Project for Capacity Development for Maintaining Power Supply Facilities	2011-2014

Fostering human resources for electric power; establishing the criteria for electric power technologies

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Jordan	Technical Cooperation	Rehabilitation of National Electric Power Co. Training Center	2004-2005
Viet Nam	Technical Cooperation	The Project on Electrical Engineers Training for African Countries (EETA)	2001-2006
Laos	Technical Cooperation	The Project on Electric Power Technical Standard Establishment in the Lao People's Democratic Republic Assistance for Promotion of Lao Electric Power Technical Standard	2000-2003 2005-2008
Cambodia	Development Study	The Study for Establishment of Electric Power Technical Standards and Guideline	2002-2004

Electrification by expanding the power grid

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Zambia	Development Study	The Study for Development of the Rural Electrification	2006-2008
Zambia	Loan Aid	Increased Access to Electricity Services Project (Co-financing with WB)	2009
Bhutan	Development Study	The Integrated Master Plan Study for Dzongkhag-wise Electrification	2003-2005
Bhutan	Loan Aid	Rural Electrification Project (Co-financing with ADB)	2011

Off-grid electrification by utilizing renewable energy (including a micro-grid)

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Cambodia	Grant Aid	The Project of Operation and Maintenance of Rural Electrification on Micro-hydropower in Mondul Kiri	2006
Ghana	Development Study	MP Study on rural electrification by renewable energy resources in the northern part of the Republic of Ghana	2004-2005
Cambodia	Grant Aid	The Project of Operation and Maintenance of Rural Electrification on Micro-hydropower in Mondul Kiri	2006
Peru	Development Study	Master Plan for Rural Electrification through Renewable Energy	2006-2007
Kenya	Technical Cooperation	Project for Capacity Development for Promoting Rural Electrification Using Renewable Energy	2011-2015

Oil-fired power (diesel power)

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Kiribati	Grant Aid	The Project for Upgrading of Electric Power Supply in Tarawa Atoll	2001
Cambodia	Grant Aid	The Project for Expansion of Electricity Supply Facilities in Siem Reap	2002
East Timor	Grant Aid	The Project for Rehabilitation of Power Supply in Dili	2004
Kiribati	Grant Aid	The Project for Upgrading of Electric Power Supply in Tarawa Atoll (Phase II)	2004
Tuvalu	Grant Aid	The Project for the Upgrading of Electric Power Supply in Funafuti Atoll	2005
Solomon	Grant Aid	The Project for the Improvement of the Honiara Power Supply	2005
Sierra Leone	Grant Aid	Project for Urgent Improvement of Power Distribution System in Freetown	2007
Palau	Grant Aid	The Project for Enhancing Power Generation Capacity in the Urban Area in the Republic of Palau	2012
Liberia	Grant Aid	The Project for Rehabilitation of Monrovia Power System	2012
All countries	Training and Dialogue Program	Fuel-reduced Operation By Economical Load Distribution of Multiple Diesel Generators	2012-2014

Natural gas-fired power

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Uzbekistan	Development Study	The Detail Design Study on Tashkent Thermal Power Plant Modernization Project	2002-2004
Indonesia	Loan Aid	Muara Tawar Gas Fired Power Plant Extension Project	2003
Indonesia	Loan Aid	Tanjung Priok Gas Fired Power Plant Extension Project	2004
Bangladesh	Loan Aid	New Haripur Power Plant Development Project	2007
Bangladesh	Development Study	The Study on Bheramara 450 MW Combined Cycle Power Station in Bangladesh	2008-2009
Uzbekistan	Loan Aid	Talimarjan Thermal Power Station Extension Project	2010
Iraq	Loan Aid	Al-Alkkaz Gas Power Plant Construction Project	2010
All countries	Training and Dialogue Program	Improvement of Maintenance Skills for Gas Turbine and Coal Fired Steam Turbine Thermal Power Engineering	2011-2014

Coal-fired power

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Mongolia	Development Study	JICA Development Study Supporting the Rehabilitation Project of the 4th Thermal Power Plant in Ulaanbaatar, Mongolia	2001-2002
Turkey	Technical Cooperation	The Project for Energy Efficiency Improvement of Power Plant in Turkey	2006-2008
Indonesia	Development Study	Project for Promotion of Clean Coal Technology (CCT)-Promotion of Coal Fired Power Plants with higher efficiency	2010-2012
Romania	Loan Aid	Turceni Thermal Power Plant Pollution Abatement Project	2005
Viet Nam	Loan Aid	Ninh Binh Thermal Power Plant Construction Project (I) (II)	2005, 2006
Viet Nam	Loan Aid	Nghi Son Thermal Power Plant Construction Project (I)	2007
Bosnia and Herzegovina	Loan Aid	Flue Gas Desulphurization Construction Project for Uglevik Thermal Power Plant	2009
Viet Nam	Loan Aid	Thai Binh Thermal Power Plant and Transmission Lines Construction Project (I)	2009
Viet Nam	Loan Aid	Nghi Son Thermal Power Plant Construction Project (I) (II) (III)	2006, 2010, 2011
Serbia	Loan Aid	Flue Gas Desulphurization Construction Project for Thermal Power Plant Nikola Tesla	2011
All countries	Training and Dialogue Program	Improvement of Maintenance Skill for Gas Turbine & Coal Fired Steam Turbine	2011-2014
All countries	Training and Dialogue Program	Alternative Power Generation Technology for Low Carbon Society	2012-2014
Indonesia	Loan Aid	Indramayu Coal Fired Power Plant Project (E/S)	2012

Hydropower (excluding small hydropower)

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
India	Loan Aid	Umiam Stage 2 Hydro Power Station R&M Project	2004
Sri Lanka	Loan Aid	Upper Kotmale Hydro Power Project (II)	2010
Nigeria	Grant Aid	The Project for Emergency Repair and Overhaul Works for the Jebba Hydro Power Station	2011
All countries	Training and Dialogue Programs	Promotion of Hydropower Development	2013-2015

Small hydropower

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Cambodia	Grant Aid	The Project for Construction and Rehabilitation of Small Hydropower Plants in Rattanakiri Province	2013
Philippines	Grant Aid	Mini-Hydropower Development Project in the Province of Ifugao	2013
Philippines	Grant Aid	Mini-Hydropower Development Project in the Province of Isabela	2013
Honduras	Grant Aid	Micro-Hydroelectric Power Generation Project in Metropolitan area of Tegucigalpa	2013
Laos	Grant Aid	Mini-Hydropower Development Project	2013

Geothermal power

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Kenya	Loan Aid	Olkaria I Unit 4 and 5 Geothermal Power Project	2010
Indonesia	Development Study	Master Plan Study for Geothermal Power Development in the Republic of Indonesia	2006-2007
Indonesia	Loan Aid	Lumut Balai Geothermal Power Plant Project	2010
Indonesia	T/A Pro. related to ODA Loan	Capacity Building for Enhancement of the Geothermal Development	2010-2013
Bolivia	T/A Pro. related to ODA Loan	Preparatory Project for Laguna Colorada Geothermal Power Plant Construction Project	2011-2013
Peru	Development Study	Master Plan for Development of Geothermal Energy in Peru	2010-2011
China	Development Study	The Study for Yangbajain Geothermal Subterranean Development in the Tibet, China	2001-2006

Wind power

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Egypt	Loan Aid	Gulf of El Zayt Wind Power Plant Project	2010

Photovolotaic (PV) power

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Philippines	Technical Cooperation	Sustainability Improvement of Renewable Energy Development in Village Electrification	2004-2009
Tunisia	Loan Aid	Photovoltaic Rural Electrification and Water Supply Project	2005
Nigeria	Development Study	The M/P and F/S for Rural Electrification by Solar Power and Other Solar Technology	2005-2007
Ghana	Technical Cooperation	The Project on Human Resource Development for disseminating PV systems	2007-2011
Maldives	Development Study	The Project for Clean Energy Promotion in Male	2008-2009
All countries	Grand Aid	The Project for Introduction of Clean Energy by Solar Electricity Generation System	2010
All countries	Training and Dialogue Program	Solar Power Generation Technology	2011-2013
All countries	Training and Dialogue Program	Training for Planners to the Promotion of Photovoltaic Power Generation	2012-2015

Solar thermal power

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Egypt	Loan Aid	Kuraymat Integrated Solar Combined Cycle Power Plant Project (Co-financing with Global Environment Facility: GEF)	2006

Wind power/tidal power (no examples of cooperation)

Biomass power

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Brazil	SATREPS	Research on ethanol production from sugarcane wastes	2009-2013
Thailand	SATREPS	Innovation on Production and Automotive Utilization of Biofuels from Non-Food Biomass	2010-2015
Thailand	SATREPS	Development of New Biodiesel Synthesis	2011-2015
Viet Nam	SATREPS	Sustainable Integration of Local Agriculture and Biomass Industries	2009-2014
Viet Nam	SATREPS	Multi-beneficial measure for the mitigation of climate change in Vietnam and Indochina countries by development of biomass energy	2011−2016
Mozambique	SATREPS	Sustainable Production of Biodiesel from Jatropha	2011−2016
Botswana	SATREPS	Information-based optimization of Jatropha biomass energy production in the frost- and drought-prone regions of Botswana	2012−2017
All countries	Training and Dialogue Program	Promotion and Dissemination of Biomass Utilization Technology	2012-2014
All countries	Training and Dialogue Program	Sustainable Biomass and Bio-Fuel Utilization in Tropics	2013-2015

Waste power (no examples of cooperation)

Improvement of electric power transmission systems

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Pakistan	Loan Aid	Load Dispatch System Upgrade Project	2005
Egypt	Loan Aid	Energy Control System Upgrading Project in Upper Egypt	2008
Laos	Development Study	The Study on Power Network System Plan	2008
Viet Nam	Development Study	The Study on Technical and Safety Standards for Electric Power Industry	2006
Cambodia	T/A Pro. related to ODA Loan	Project for Improvement of Transmission System Operation and Maintenance	2012
Tanzania	Grant Aid	The Project for Reinforcement of Transmission and Distribution Facilities in Oyster Bay Substation (Phase II)	2009
All countries	Training and Dialogue Program	Electric Power System Engineering	2011-2014
India	Loan Aid	Tamil Nadu Transmission System Improvement Project	2012

Improvement of power distribution systems

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Tanzania	Technical Cooperation	The Project for Capacity Development of Efficient Distribution and Transmission Systems	2009-2013
Rwanda	Grant Aid	The Project for Improvement of Substations and Distribution Network	2011
Cameroon	Loan Aid	Project to Strengthen and Extend the Electricity	2011
India	Loan Aid	Andhra Pradesh Rural High Voltage Distribution System Project	2011
All countries	Training and Dialogue Program	Power Transmission and Distribution Project	2010-2012

Energy conservation

Country	Scheme	Project Name	Term of Cooperation/ FY Signed
Thailand	Technical Cooperation	The Project on the Practical Energy Management Training Center	2002 -2005
Saudi Arabia	Development Study	Master Plan Study on Energy Conservation in the Power Sector	2007-2008
Viet Nam	Development study	Master plan for energy conservation and effective use	2007-2009
Sri Lanka	Technical Cooperation	Project for Promoting on Energy Efficiency Improvement	2007-2011
Indonesia	Development Study	Study for Promoting Practical Demand Side Management Program	2010-2012
Viet Nam	Technical Cooperation	Establishment of Energy Management Training Center (Stage 1)	2011-
India	Loan Aid	Micro, Small and Medium Enterprises Energy Saving Project 2	2011
All countries	Training and Dialogue Program	Policy Planning for Energy Efficiency & Conservation	2011-2013
All countries	Training and Dialogue Program	Energy Conservation in Public and Private Sector	2011-2013
All countries	Training and Dialogue Program	Energy Conservation Technology & Machine Condition Diagnosis Technique – for Productivity Enhancement and Cleaner Production	2011-2013
All countries	Training and Dialogue Program	Promotion of Energy Conservation in Commercial and Residential Sector	2012-2014