Simplified Ex-Post Evaluation for Grant Aid Project

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Project Name	The Project for Upgrading and Extension of Electricity Supply Facilities in Phnom Penh	October 2011 – April 2012

I Project Outline

Country Name	Kingdom of Cambodia	
Project Period	November 2004 – February 2006	
Implementing Agency	Electricite du Cambodge (EDC)	
Project Cost	Grant Limit: 359 million yen	Actual Grant Amount: 359 million yen
Main Contractors	Marubeni Power Systems Corporation	
Main Consultants	Yachiyo Engineering Co., Ltd	
Basic Design	July 2004	
Related Projects	<JICA / Technical Cooperation Projects> ・Study on Rehabilitation and Reconstruction of Electric Supply in Phnom Penh and Siem Reap (1992-1993) ・Feasibility Study on the Sihanoukville Combined Cycle Power Development Project (1999-2001) ・The Study for Establishment of Electric Power Technical Standards and Guidance (2002-2004) ・Capacity and Institutional Building of the Electric Sector (2004-2007) <JICA / Grant Aid Projects> ・The Project for Rehabilitation and Upgrading of Electricity Supply Facilities in Phnom Penh (Phase 1 & Phase 2: 1993-1999) ・The Project for Siem Reap Generating Facilities (2002-2003) <Other donors> Grant Aid ・Rehabilitation of the Transmission Network in Phnom Penh (Ireland, 1995) ・Rehabilitation of the Power Supply System in Phnom Penh (1993-1996, France) ・Rehabilitation of the Transmission Network in Phnom Penh and Provincial Areas (1996-1998, France) ・Rehabilitation of the Transmission Network in Phnom Penh (1995-1996, Belgium) ODA Loan ・Power Rehabilitation Project (1995-1996, Asian Development Bank) ・Project for the Rehabilitation of Power Equipment in Phnom Penh and Provincial Cities (1997-2000, ADB) ・Phnom Penh Power Rehabilitation Project (1996-2000, WB)	
Project Background	Since most of the Cambodian electric power network was destroyed during the protracted civil war, the construction of expensive-to-run diesel engines and power purchased from independent power producers (IPPs) have supported vital economic growth and reconstruction after the civil war. However, the utilization of such small-scale power facilities, high fuel costs for diesel engines and high costs of electric power from IPPs have forced the unit price of electricity in Cambodia to the highest level in Asia, which is thought to be one of the factors hindering economic growth.	
Project Objective	Generation costs are reduced through fuel system conversion from diesel oil to cheaper heavy oil for existing generating equipment (5 MW x 2 units) in Phnom Penh, Cambodia.	
Output (Japanese Side)	1. Procurement and installation of power generating facilities at an existing C5 power station (existing No.1 & No.2 units) of EDC, Phnom Penh i) Procurement of equipment related to two diesel engine electricity generating units (output 5 MW x 2 units) for fuel conversion and installation work on the existing equipment ii) Procurement of the mechanical auxiliary equipment necessary for the relevant facilities and installation work 2. Soft-component activities "Technical guidance for fuel conversion diesel engine power plants" "Guidance on the combustion control of fuel oil C and its operation"	

II Result of the Evaluation

Summary of the evaluation
<Limitations of the evaluation study> At the time of the ex-post evaluation, the power generating facility installed in this project is utilized as the final power source during the peak period, which is different from the function supposed at the time of planning, as a result of large changes in the external environment, such as a rapid rise in fuel prices and electricity importation from the neighboring countries. Under the limitations of the comparison between the situations at the time of ex-post evaluation and at the time of planning due to the changes in the function of the power plant, the plant load factor was considered as an appropriate measure for 'effectiveness'. Therefore, this project was evaluated as stated below, but the evaluation result does not imply that C5 power plant was underutilized at present. As mentioned below, the power generating facility has played an important role to provide stable power around Phnom Penh during the peak period. In this light, the effort of the Cambodian government for the effective utilization can be highly recognized. (Refer to "Effectiveness / Impacts" for more details) ＜Overall evaluation＞ The project was implemented to reduce high generation costs caused by the use of expensive-to-run diesel engine generators and the high cost of purchasing electricity from IPPs. The project has been relevant to the country's development needs both at the time of planning and ex-post evaluation, as well as Japan's ODA policy at the time of planning. However, in terms of the policy of Cambodia, the country is assuming to reduce dependence on petroleum-based fuel and increase the proportion of hydroelectric and coal-fired power generation, and the function of the C5 power plant will be reconsidered after the nationwide generation capacity becomes sufficient. The project outputs, project period, and project costs were within the plan, therefore the efficiency of the project is high. Regarding the project objective to reduce generation costs, the project has reduced unit generation costs, considering the significant changes in external factors such as escalating fuel prices, and the generator has provided constant electric power in response to power shortages during the dry season and power outages in the supply area. However, the plant load factor of the generators rehabilitated under the project has been low due to the start of electricity imports from Vietnam and the purchase contracts for electricity from IPPs. Therefore, the effectiveness of the project is low. In terms of the environmental aspect, no problems have been observed so far. As for sustainability, there has been no major change in the structure and personnel in the executing agency. Regular maintenance and periodic inspections are conducted by the executing agency and the technical level of the personnel in operation and maintenance has been maintained or even improved thanks to the provision of training and manuals. Accordingly, the conditions of the power facilities and spare parts are well-maintained. No particular problem has been found in the financial aspects of the executing agency. However, it is not practical to expect that the power plant itself will turn profitable. Hence, the executing agency has to continuously enhance the financial situation of its entire organization. In light of the above, this project is evaluated as unsatisfactory. <Recommendations to the executing agency> At the time of ex-post evaluation, the rate of appreciation in heavy fuel oil prices tended to be high. It is therefore preferable to take note of the combination of other power sources and to operate power facilities with low generating costs. < Recommendations to JICA> The importation of electricity from Vietnam and preferential purchasing from IPPs are recognized as the major elements of the low load factor of the generators. In the selection of equipment funded through Grant Aid, every environmental factor including external factors and the functions of the equipment will have to be carefully considered.

1 Relevance
(1) Relevance with the Development Plan of Cambodia At the time of planning, the National Poverty Reduction Strategy (2002) listed the reform and strengthening of the power sector as priorities to improve the electrification rate for poverty reduction. At the same time, the Cambodia Energy Sector Strategy indicated that Cambodia would start to import electricity from Vietnam and other countries, build base-load thermal power plants in coastal areas and peak-load thermal power plants in Phnom Penh, utilize small/medium-sized diesel engine power plants for base-load operation in rural areas or for peak-load operation, and extend the power grid to achieve lower costs for electricity supply in rural areas. At the time of ex-post evaluation, the National Strategic Development Plan (NSDP) Update 2009-2013 identified "further rehabilitation and construction of the physical infrastructure" as one of the six major achievements and challenges. In the NSDP Update, it is necessary to lower the high cost of electricity generation not only to support private sector development, but also to make it available to the poor at an affordable price. This project was implemented to reduce generation costs through fuel conversion of the existing generators. The project objective basically corresponds to the policy directions at both the time of planning and the ex-post evaluation. However, the Ministry of Industry, Mines and Energy (MIME) is intending to reduce dependence on petroleum-based fuel and increase the proportion of hydroelectric and coal-fired power generation due to the worldwide rise in fuel prices, and under such circumstance, it is expected that the generation facilities rehabilitated under this project will stop full operation at an appropriate time after 2015, after being used as a peak-time or backup power source. Thus, this project is consistent with Cambodia's development policy in terms of the aim of lower electricity supply costs. However, it is inconsistent with the future policy direction, under which petroleum-based fuel generators will be discontinued over time.

(2) Relevance with Development Needs of Cambodia

In Cambodia, small scale expensive-to-run diesel engine generator facilities were constructed in order to support vital economic growth and reconstruction after the civil war. In addition, electricity had been supplied by IPPs under purchase agreements that determined high unit prices for power. These forced the unit price of electricity in Cambodia to the highest level in Asia, which seems to have been one of the factors hindering the country's economic growth. In addition, rolling blackouts on a scale of 10 MW per day around Phnom Penh had been enforced as a result of the decreased level of power reserve capacity along with the more than 10% rate of increase in demand at the time of planning. Under these circumstances, the need for the C5 power station was high in order to attain a reduction in generation costs and a stabilized power supply. At the time of ex-post evaluation, the unit price of electricity in Cambodia was still higher than that of neighboring nations. Accordingly, it is necessary to lower the unit price of electricity through a reduction in generation costs in an environment of increasing purchasing prices for electricity from the surrounding nations and rising fuel prices, as well as for the purpose of investment promotion. The substantial need for the continued operation of the C5 power station was recognized in order to supply power at peak load, which was supported by 1) the need to secure reserve power especially in the Southern power supply area including Phnom Penh to meet the rapidly increasing sales volume of power in Cambodia, and 2) the policy of reducing the rate of dependence on power imports, which was 61.5% in 2010.

(3) Relevance with Japan's ODA Policy

At the time of preliminary survey, "Japan's country assistance program for Cambodia", which was released in 2002, stated that the significance of Cambodia in Asia should be emphasized. The policy targeted the development of the social and economic infrastructure as well as the improvement of basic social services for economic recovery, of which the power sector comprised a major part. In addition, JICA's project implementation policy for Cambodia assumed the need to cooperate on the development of the power supply system as one of the measures for "promotion of the economy and industry", and thus, the implementation of the project is consistent with these policies.

Considering all of the above factors, while being highly relevant to the country's development needs as well as Japan's ODA policy, this project was partly irrelevant with respect to the country's development policy at the time of ex-post evaluation. Therefore its relevance is fair.

2 Efficiency

(1) Project Outputs

The outputs of the Japanese side were completed mostly as planned.

(2) Project Period (Project Inputs)

The planned project period was 16 months and the actual period was 16 months. Thus, the project period was as planned (100% of the planned period).

(3) Project Cost (Project Inputs)

The planned project costs amounted to 359 million yen, whereas the actual costs were 359 million. Thus, the project costs were as planned (100% of the planned project costs).

Both the project period and project costs were within the plan, therefore the efficiency of the project is high.

3 Effectiveness / Impact

Due to 1) the tripling in the price of diesel oil and heavy fuel oil compared to the time of the preliminary survey and 2) the commencement of electric power importation, which reduced the annual plant load factor of the C5 power station from the rate of 50% calculated as the unit generation cost at the time of the preliminary survey[*1], the unit generation cost has risen considerably. Consequently, the effect of the project is not measurable by simply comparing the unit generation cost of US$305 at the time of the ex-post evaluation in 2010 and that of US$117 estimated at the time of the preliminary survey. Instead, the unit generation cost, without fuel conversion, was estimated using the price of diesel oil and the fuel consumption rate at the time of the ex-post evaluation, and was compared to the actual unit generation cost for the analysis.

As a result, the unit generation cost was estimated at US$401/MWh under the assumption that only diesel oil was used for electricity generation, and accordingly the fuel conversion probably has had the effect of reducing the generating cost by US$96/MWh (8.5 yen/kWh: converted using the 2010 annual average exchange rate), a 24% reduction. No particular problem has been observed thanks to the operation and maintenance techniques and manuals provided under the soft components of the project, although more advanced techniques are required compared to the operation of traditional power generating facilities using diesel oil. The implementation of the non-physical components is considered to have prevented a rise in the unit generation cost that would have resulted from an increase in repair costs and has therefore been effective in reducing the unit generation cost.

While the annual plant load factor of the C5 power station before the project implementation indicated about 24% in 2003 and 35% in 2004, at post-implementation, it stayed in the 25% range from 2007 to 2009 and eventually showed a substantial decline in 2010 due to the commencement of power importation of 135MW from Vietnam. As the plant load factor declined further by 17.4% in 2011, which was lower than the levels of 2009 and of the pre-project implementation, this project may only have a limited effect on the utilization of the power station.

(*1) The C5 power station was expected to be self-sustaining by achieving a surplus with 50% of the annual plant load factor utilizing in total four power generators (the two existing generators that are the objects of this project and two new generators that were planned to be added). But the plan for installation of two additional generators was cancelled because of the change in the function of the C5 power station. The two existing generators are operated as peak-load power sources.

As for the environmental aspect, it was confirmed that the smoke stack had been renovated (extension from 12 meters to 16 meters) as indicated by the Initial Environmental Impact Assessment, which was conducted in advance of the project implementation. There have been no negative impacts or complaints from neighborhood residents regarding noise or the discharge of NO_X, SO_X, and CO_2.

In case of an oil spill disaster, the fuel tanks have been placed in order to prevent further spillage of heavy oil and indirect impacts on the environment, although no such incident has occurred yet.

The direct effect has been achieved to a certain degree, by reducing generation costs due to the fuel conversion along with the implementation of the soft components under the current situation of the power generators. However, the overall effect of this project is considered to be limited since the annual plant load factor at the time of ex-post evaluation has not increased, indicating a lower level than the rate of pre-project implementation. Therefore the effectiveness of the project is low.

Under the current situation surrounding the generators as stated below, the Cambodian agency is assumed to be making efforts for the effective utilization of the generators.

The power generating facilities installed in this project have taken on the role of providing an ultimate peak-load power source due to various limitations such as the delay in building the power grid and the "take-or-pay contract" (the contract requires that EDC purchase and pay for power above a certain amount) with the IPPs, thus contributing to the stabilization of the electricity supply system in Phnom Penh. In this regard, the executing agency has maximized the limited use of the C5 power station despite the changes in the preconditions.

In the future, the demand for power supply from the C5 power station is expected to increase at least until the proper expansion of the power generating capacity of the country on or after mid-2010 since (i) the value of electricity sales is continuously growing, (ii) according to the executing agency, the grid system from Phnom Penh will be extended under the rural electrification project currently underway. The generation units will be operated continuously as a peak-load power source by this time.

Additionally, Cambodia has been required by its major power import trading partners such as Vietnam and Thailand to raise prices under power purchase agreements along with soaring world oil prices. To lower its dependence on imports from the neighboring countries, Cambodia has been making efforts to build power stations and also has a policy that emphasizes hydroelectric power generation utilizing domestic resources. However, according to the executing agency, the government faces a problem of unstable power supply from the existing hydroelectric power facilities due to the insufficient water volume in the dry season, which is also a period of the year of peak demand for electricity. Cambodia's economic development and the widespread use of electrical equipment such as air conditioners have also led to rapidly growing power needs during business hours, which is the period of peak demand of the day. Therefore, the C5 power station actually operated 24 days in June, the highest level, and 5 days in January, the lowest level in 12 months, and has thus continuously played an important role as a final power source at peak load. In addition, the C5 power station functions as a power source to restart the power stations of IPPs after blackouts (the power supply in Phnom Penh from IPP power stations accounted for 40.5% in 2010). The C5 power station has an important role in the stable operation of the electricity supply systems in the Phnom Penh area.

4 Sustainability

(1) Structural Aspects of Operation and Maintenance

The C5 power station continuously has more than forty staff members and it is therefore possible to assign sufficient personnel to implement operation and maintenance by itself except for large-scale overhauls and repairs. In the event of extensive overhauls and repairs, including the overhaul carried out every 7,500 operating hours, technicians are dispatched by the contractor. A post-project liaison system has become well-established between the executing agency and the contractor: for example, the reports prepared by the technicians dispatched from the contractor have been utilized for follow-up operation and maintenance.

Although EDC, the executing agency, separated the Transmission and Distribution Department from the Generation Department, this did not affect the organizational structure in the Generation Department in charge of power stations. The EDC, MIME (Ministry of Industry, Mines, and Energy), and EAC (Electricity Authority of Cambodia) have no plans to change their organizational structures in future.

(2) Technical Aspects of Operation and Maintenance

The executing agency has sufficient technical capacity to implement daily operation and maintenance, including minor inspections carried out every 2,500 operating hours, on their own. In order to maintain or improve their technical level, more than ten staff members annually receive training at the EDC training center, which has excellent training facilities and was accredited as an university in 2011. The manuals, prepared at the time of the construction of the power station or provided by the project, are kept in the power station and are available for reference.

The retention rate of the staff is very high and it is rare for anyone to resign their positions other than due to retirement.

(3) Financial Aspects of Operation and Maintenance

EDC has been operated under an independent accounting system and has not received financial support from the Government. However, there seems no particular concern regarding the financial aspects for the following reasons; 1) the management of EDC acknowledges the importance of operation maintenance, and they try to secure the budget for this every year, 2) the volume of retained earnings is sufficient, 3) a sound tariff structure is employed, which realizes stable profits from commercial-scale utility customers, and the management practice of the EDC is quite stable under the situation of consistent economic growth in Cambodia. EDC management practice is considered generally stable for the long term due to EDC's ceaseless efforts to remain in surplus and the high demand for power with Cambodia's economic growth. However, the executing agency will need to make further efforts to establish and maintain a stable financial structure due to the prospect of a nationwide cut in electricity rates.

The C5 power station was converted to another fuel in this project and has clearly demonstrated its role as a peak-load power source, which results in difficulties in the C5 power station being able to turn a profit and achieve self-sustained operation by itself. In the future, these difficulties are expected to continue due to high costs along with the rising cost of fuel compared to the imported power supplies. EDC therefore needs to support the C5 power station at an entire organizational level.

(4) Current Status of Operation and Maintenance

The power station has been operated after the one year warranty inspection up to the present date without any accidents. Both the management and staff of EDC fully recognize the importance of the operation and maintenance of the generation facilities and associated elements, such as spare parts. Consequently, the power station is well-maintained: the stock yard is well-organized and the entering and dispatching of the parts from the warehouse is conducted properly. In addition, they are willing to use expensive proper spare parts in order to keep the power station in good condition.

No major problems have been observed in the structural and technical aspects of operation and maintenance, and the financial condition of EDC is basically healthy. Therefore sustainability of the project effects is high.