

0. Summary

This project has been highly relevant to the development plan and development needs of Vietnam, as well as to Japan’s ODA policy. The implementation of this project required more time than planned because of several reasons including a delay in the selection of consulting services and the careful preparation and examination of the detail design. Since the Gross Electricity Energy Production, a key performance indicator for a power station, fully met its target, the Da Nhim power station can be seen to have played a critical role under the conditions of tight supply and demand. Several mechanical troubles have occurred in the last few years but they had not prevented the operation of the Da Nhim power station at the time of the ex-post evaluation. In light of the above, this project is evaluated to be satisfactory.

1. Project Description



Project Site



Da Nhim Power Station Turbine and Generator

1.1 Background

The Da Nhim Power Station, the power station which was rehabilitated by this project, is a mid-sized hydropower station with a generation capacity of 160 MW in Ninh Thuan province in the southern part of Vietnam. The hydropower station, including the Dran Dam, was built with Japanese post-war compensation and its operation began in 1964. Deterioration of the power station facilities caused operational problems in the late-1990s as by then the power station had been run for more than thirty years. The transmission and transformation facilities from the Da Nhim Power Station to Ho Chi Ming City (HCMC), a major consumption centre of electricity, were damaged in the Vietnam War but only a makeshift repair was carried out.

As Vietnam experienced economic growth after the implementation of the Doi Moi reforms in the mid-1980s, electricity demand increased rapidly. In the 1990s, generation capacity did not sufficiently meet the increase in electricity demand and the lack of electricity became severe, especially in the southern part of Vietnam. After high-capacity transmission lines between the north and the south were completed in 1994, power interchange from the north was made possible and supply and demand of electricity temporarily eased. However, it was foreseen that economic growth in the north would stimulate electricity demand and that the shortage of electricity in the south would be significant in the near future.

As tight supply and demand in the south was expected, rehabilitation of the Da Nhim power station and the transmission lines to HCMC became an urgent task to maintain a stable supply of electricity. This project supported the executing agency (Electricity of Vietnam, EVN) in coping with this task through the provision of an ODA loan.

1.2 Project Outline

The objective of the Project is to recover a stable operation of the Da Nhim power station and transmission/transformation facilities by rehabilitation work on these facilities, thereby contributing to the reliability of the power supply and the development of the regional economy in the southern region of Vietnam.

Approved Amount/ Disbursed Amount	7,000 million yen / 3,935million yen
Exchange of Notes Date/ Loan Agreement Signing Date	January 1997 /March 1997
Terms and Conditions	Interest Rate: 2.3% Repayment Period:30 years (Grace Period: 10 years) Conditions for Procurement: General Untied
Borrower / Executing Agency	The Government of the Socialist Republic of Vietnam / Electricity of Vietnam
Final Disbursement Date	June 2007
Main Contractor (Over 1 billion yen)	Toshiba (Japan) • Nissho Iwai ¹ (Japan) (JV), Mitsubishi Electric (Japan) • Mitsubishi Corporation (Japan) (JV)
Main Consultant (Over 100 million yen)	Nippon Koei (Japan)
Feasibility Studies, etc.	“Feasibility Study on the Rehabilitation of the Da Nhim Power System” (JICA, June 1995)
Related Projects	—

2. Outline of the Evaluation Study

2.1 External Evaluator

Nobuyuki Kobayashi, OPMAC Corporation

2.2 Duration of Evaluation Study

Duration of the Study: November 2010 – September 2011

Duration of the Field Study: January 9, 2011 – January 20, 2011, April 17, 2011 – April 22, 2011

2.3 Constraints during the Evaluation Study

Water runners at the Da Nhim Power Station had deficiencies and repair works were being planned at the time of the ex-post evaluation. Further technical knowledge was required for assessment on the recurrence of these deficiencies. An additional assessment after a certain period of operation is recommended.

¹ At the time that the main contact was signed.

3. Results of the Evaluation (Overall Rating: B)

3.1 Relevance (Rating: ③)

3.1.1 Relevance with the Development Plan of Vietnam

The Socio-Economic Development Plan (SEDP) 1996-2000, the national development plan at the time of the appraisal, identified 12 development programmes in order to overcome social and economic issues in Vietnam. Out of these programmes, the Industrial Development Programme and the Infrastructure Development Programme saw the upgrading of both power resources and the grid network as important tasks in the plan period.

In order to achieve the development goals of the SEDP 1996-2000, the Master Plan on National Electric Power Development (Fourth Stage) first assessed investment needs. Based on the analysis of supply and demand up to 2010, it was planned that generation capacity would be increased from 4,435 MW (1994) to 19,000 MW (2010) and high voltage transmission lines constructed for 10,588 km in the same period.

In the SEDP 2011-2015, the national development plan at the time of the ex-post evaluation, it was considered that fiscal infrastructure was an obstacle to social and economic development. It was pointed out in the plan that, in the power sector, the power generation and transmission systems did not satisfy the demands of industries and households. Large and complex works for the development of energy sources such as hydropower plant was one of the priority investments.

Similar to the development strategy in the SEDP 2011-2015, the Master Plan on National Electric Power Development (Sixth Stage) planned an increase in generation capacity from 12,357 MW (2005) to 42,000 MW (2015). Hydropower will maintain an approximate 40% of the total capacity from 2005 to 2015 and remains one of the major sources of electricity during this period. In the Master Plan on National Electric Power Development (Seventh Stage) it is forecasted that hydropower (excluding small hydropower) will account for approximately 30% of the total generation capacity in 2015². This is next only to coal-fired thermal. A lack of funds has resulted in a slower development of generation capacity, especially for that of hydropower. However, an expansion of the generation capacity of hydropower is being planned.

This project was relevant to the national and sector policies in Vietnam at both the times of the appraisal and the ex-post evaluation. The Vietnamese government had been concerned that the lack of electricity supply might limit social and economic development since the mid-1990s. Given a rapid growth in electricity demand, upgrading power stations and transmission lines remained an urgent task. The development of hydropower will continue to be a priority investment until 2015. Hydropower is expected to be a major source of energy next only to coal-fired in terms of generation capacity. Investment in hydropower was still being planned at the time of the ex-post evaluation.

3.1.2 Relevance with the Development Needs of Vietnam

At the time of the appraisal, the Da Nhim power station, which commenced operation in 1964, had become obsolete and had had serious mechanical troubles for three months in 1996. For this period, power generation had to be reduced despite an increase in electricity demand. The Feasibility Study on the Rehabilitation of the Da Nhim Power System, which was prepared by JICA, assumed that maintenance would require a longer outage which was expected to reach a quarter of annual operation without a major rehabilitation in 2010. The Da Nhim power station, with its capacity of 160 MW, accounted for 3.6% of the installed capacity of Vietnam (4,480 MW, 1995) and 10.7% of that of the southern region (1,491 MW, 1995) It thus had a vital role in the stable supply of electricity in the southern region of Vietnam at that time. Similarly, the grid line between the Da Nhim power station and HCMC had been used without major

² Although the Mater Plan (Seventh Stage) was not approved at the time of ex-post evaluation, it contains notable changes in sector policy. For this reason, the report mentions the seventh stage as well as the sixth stage.

rehabilitation work for more than 30 years. Only makeshift repairs for damages caused by the Vietnam War had been implemented.

In 2009, the Da Nhim power station accounted for 0.9% of the installed capacity in Vietnam (18,481 MW) and 1.5% of that in the southern region (10,723 MW)³. The generation capacity in Vietnam had been expanded as the power consumption grew almost six fold from 1996 to 2009⁴. For the period 2006-2010, however, investment in power generation facilities lagged behind that planned. At the time of the ex-post evaluation, supply and demand of electricity still remained tight. Potential hydro energy in Vietnam was estimated to be 20.6 GW in terms of generation capacity⁵. At the end of 2009, approximately 30% of the potential hydro energy had been developed. There was still a substantial potential for the development of hydropower.



Photo 1: Da Nhim Power Station

Potential hydro energy in Vietnam was estimated to be 20.6 GW in terms of generation capacity⁵. At the end of 2009, approximately 30% of the potential hydro energy had been developed. There was still a substantial potential for the development of hydropower.

This project was relevant to the development needs of Vietnam at the both time of the appraisal and the ex-post evaluation. As the generation capacity in Vietnam expanded, the percentage of the Da Nhim in the total generation capacity became more marginal. Nevertheless, the Da Nhim power station still played a critical role under the tight supply and demand conditions. Vietnam had rich resources of hydro energy and hydropower was still underdeveloped. It can be concluded that fully utilizing this potential under the tight supply and demand conditions matched the development needs of Vietnam.

3.1.3 Relevance with Japan's ODA Policy

Japan's Official Development Assistance (ODA) Charter, the preceding charter, which was approved in 1992, referred to the close relationship between Japan and East Asia, including ASEAN, and placed a special emphasis on assistance to the Asian region. The charter prioritized assistance in infrastructure development. In the ODA Annual Report for FY 1996, the country assistance strategy for Vietnam set out four priorities including infrastructure development in both the power sector and the transport sector. In particular, ODA loans were expected to play a vital role in the infrastructure development of these sectors.

At the time of the appraisal, Japan's ODA Charter placed importance on both assistance to Asian countries and on infrastructure development. Furthermore, the country assistance strategy emphasized assistance specifically in the energy sector. The project has been consistent with Japan's ODA Policy as it assists with infrastructure development in a power sector in the Asian region.

This project has been highly relevant with the country's development plan, development needs, as well as Japan's ODA policy, therefore its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

At the time of the appraisal, the project scope was expected to be procured in 4 packages. As project implementation was delayed, the key assumptions such as electricity demand and commodity prices changed drastically and this resulted in the changes in project scope. The

³ Based on data provided by the Da Nhim-Ham Thuan -Da Mi Hydropower Company (DHD), a subsidiary of EVN.

⁴ Based on the appraisal document and EVN Corporate Profile 2009-2010.

⁵ JICA "The Study on the National Power Development Plan for the Period of 2006-2015, Perspective up to 2025" (2006)

entire project scope under the Lot 4 was excluded from the scope of the ODA loan. In March 2003, Thu Duc (Saigon) substation was excluded from the scope of the ODA loan. Electricity demand in HCMC increased more rapidly than the forecast in the Feasibility Study (F/S). EVN improved the substation with a larger transformer capacity. In January 2006, 230 kV Transmission from the Da Nhim power station to HCMC was excluded from the scope of the ODA loan. During the tender process, one bidder was chosen from two bidders. However, the contract negotiation did not reach an agreement due to a difficulty in price negotiation. The bid price was above cost estimate. In addition, this rehabilitation work became less urgent as an alternative transmission line (500 kV transmission line from Di Linh station) was completed.

Table 1: Project Output (Planned and Actual)

Planned (At the Time of Appraisal)	Actual (At the Time of Ex-post Evaluation)
1. Revaluation of Da Nhim Power Station	
Lot 1: Generator and ancillary facilities (4 units) and substation facilities for the Da Nhim power station	Almost as planned with minor modifications. Some parts required full replacement instead of repair works.
Lot 2: Water turbine and ancillary facilities (4 units) and waterway and ancillary facilities	Almost as planned with minor modifications. Some parts required full replacement instead of repair works.
Lot 3: Hydrological data acquisition system (6 rainfall gauging stations, 2 water level gauging stations, 2 repeater stations, 4 warning systems, data processing system, etc.)	7 rainfall gauging stations, 4 water level gauging stations, 1 repeater station, 4 warning systems, data processing system, etc.
2. Rehabilitation of Thu Duc (Saigon) Substation and 230 kV Transmission Line	
Lot 4: Saigon Substation and 230 kV Transmission Line (257 km from Da Nhim power station to HCMC)	Excluded from the scope of the ODA loan.
3. Consulting Services	
Scope of Service: detailed design, tender documents, assistance in tendering, construction supervision Input: International 106 M/M	Scope of Service: detailed design, tender documents, assistance in tendering, construction supervision Input: International 53.167 M/M and Domestic 77.8M/M

Source: DHD and the Project Completion Report

At the time of the ex-post evaluation, the status of the transmission line between Da Nhim hydropower plant and the Thu Duc (Saigon) substation, which was originally included in the project, was as following:

- (1) Thu Duc - Long Binh: improved in 2005
- (2) Long Binh - Bao Lock: to be improved by the end of 2011.
- (3) Bao Lock - Di Linh -Da Nhim: makeshift repairs

The section between Bao Loc and Di Linh faced a capacity constraint but an alternative transmission line (500 kV transmission line from Di Linh substation) allowed rerouting.

3.2.2 Project Inputs

3.2.2.1 Project Cost

Reflecting the exclusion of the rehabilitation works for the Thu Duc (Saigon) substation and the 230 kV transmission line, the cost estimate was adjusted to JPY 7,148 million. The actual project cost was JPY 4, 679 million. The project cost was lower than planned (65% of the cost estimate). For all procurement packages, in particular for the Lot 1, actual costs were lower than the cost estimate at the time of appraisal. According to the executing agency, competition resulted in a reduction of project costs.

3.2.2.2 Project Period

The project period was significantly longer than planned (192% of the original plan). Firstly, the additional study related to the F/S was carried out by the Vietnamese government, though the F/S was approved in November 1997. The prolonged approval process of the additional study delayed the selection of consultants. Secondly, the prolonged preparation and approval process of the detailed design (D/D) also affected the implementation period. As this project was the first large scale rehabilitation project in Vietnam and did not allow detailed inspection until the D/D, the technical specification of the rehabilitation work needed to be carried out within the scope of the D/D. After the preparation of the D/D, both EVN and the Ministry of Industry carefully reviewed the D/D, in particular the scope of rehabilitation work, in terms of the financial and technical aspects. Given these factors, it was presumable that the original schedule underestimated the time for the preparation and approval of the D/D. Lastly, a delay in the completion of other power plants indirectly affected the D/D and the rehabilitation works of the Da Nhim power station. The executing agency could not stop plant operation for a smooth implementation of the project due to the lack of generation capacity.

Table 2: Project Implementation Schedule (Planned and Actual)

	Planned (At the Time of Appraisal)	Actual (At the Time of Ex-post Evaluation)
L/A Signing	March 1997	March 1997
Selection of Consulting Services	December 1996 - April 1997	June 1998 - June. 1999
Detailed Design	May 1997 - October 1997	June 1999 - December 2000
Procurement of Main Contracts	November 1997 - July 1998	April 2002 - June 2004
Rehabilitation Works ⁶	August 1998 - May 2001	June 2003- August 2006
Project Completion	May 2001 (51 months)	August 2006 (98 months)

Source: DHD

Although the project cost was within the plan, the project period was exceeded, therefore the efficiency of the project is fair.

3.3 Effectiveness (Rating: ③)

3.3.1 Quantitative Effects

3.3.1.1 Results from Operation and Effect Indicators

(1) Energy Production

The Da Nhim-Ham Thuan - Da Mi Hydropower Company (DHD), a subsidiary of EVN, was operating the Da Nhim power station at the time of the ex-post evaluation. The Financial Rate of Return (FIRR) at the time of the appraisal assumed that Gross Electric Energy Production would reach 943.3GWh (1979-1993 Average) after the completion of rehabilitation works. This assumption was considered a target level for power generation at the ex-post evaluation. The rehabilitation works resulted in an reduction of Gross Electric Energy Production in 2005 and 2006. Gross Electric Energy Production had been above the target since the completion of the retaliation works in 2006. Time Utilization had reached pre-implementation level since 2008 and this shows stable operation of the power station.

⁶ The detail design and manufacturing the equipment of the main contract is included.

Table 3: Key Performance Indicators

	Gross Electric Energy Production (GWh)	Time Utilization* (%)	Water Inflow to Reservoir (million m ³)
1996	1,129.094	97	1,189
1997	1,083.889	93	630
1998	1,160.052	95	1,189
1999	1,325.704	95	1,471
2000	1,289.394	98	1,112
2001	1,052.571	92	570
2002	808.997	93	492
2003	945.715	95	599
2004	761.130	98	359
2005	539.434	69	667
2006	1,016.717	73	563
2007	1,163.593	88	676
2008	1,209.156	96	825
2009	1,239.611	95	750
2010	1,226.708	96	961

Source: DHD

Note: * Generators only.

(2) Planned and Unplanned Outages

The Da Nhim power station has experienced unplanned outages several times in the last three years, though these outages did not seriously affect Time Utilization of the power station. Mechanical troubles in 2008 were due to a malfunction of the control boards procured by this project. DHD learned from actual practice in the Dai Ninh power station and fixed this problem. The incident in 2010 was caused by water runners.

Table 4: Planned and Unplanned Outages

		2008	2009	2010
Unplanned: Human Error	Times		1	
	Hours		2h 54 min.	
Unplanned: Mechanical Troubles	Times	8		1
	Hours	9h 34min.		79h 27min.
Planned	Times	6	5	4
	Hours	1,416	1,920	1,032
Total	Times	14	6	5
	Hours	1,425	1,922	1,111

Source: DHD

3.3.1.2 Results of Calculations of Internal Rates of Return (IRR)

The FIRR for this project is 5.49% (for the rehabilitation of the power plant only) which is below the comparable forecast at the time of the appraisal (12.65%). As the FIRR is marginally higher than the Cost of Capital (5.03%)⁷, this project is financially viable. The assumptions for the FIRR are as follows:

⁷ Weighted Average of the ODA loan financial costs of this project and lending rate in Vietnam based on IMF “International Financial Statistics 2009”

Table 5: Assumptions for FIRR

	At the Time of Appraisal (1997)	At the Time of Ex-post Evaluation (2011)
Costs	Investment cost, O&M cost, Tax, Energy loss	Investment cost, O&M cost, Tax (The same data is used for Tax due to the lack of detailed calculation methods)
Returns	Additional Energy Sales, O&M benefits (an reduction in O&M Costs), Renewal benefits	Additional Energy Sales, O&M benefits, Renewal benefits (The same data is used for Renewal benefits due to the lack of detailed calculation methods)
Project Life	50 years (45 years after completion, up to 2046)	55 years (45 years after completion, up to 2051)

Source: JICA “Feasibility Study on the Rehabilitation of the Da Nhim Power System”, DHD

There are some notable changes from the forecast at appraisal. While smaller investment costs and increased energy production contribute to financial gains, lower unit prices for electricity and negligible gains from O&M benefits are negative for the profitability of this project.

3.3.2 Qualitative Effects

(1) Hydrological data acquisition system

The hydrological data acquisition system installed rainfall gauging stations (RS 1-7 on Figure 1) and water level gauging stations (WL 1-4 on Figure 1) across the water basin of the Da Nhim River. Data from these gauging stations are used for the forecast of water levels at the reservoir. With these forecasts, the dam operator can pre-emptively discharge water before the water level rises. DHD had a similar system before the implementation of this project but the number of gauging stations was fewer. According to DHD, forecasts from the new system are more reliable than before. This system improved the accuracy of forecasts and prevented sudden discharges of water, which may have affected residents near the Da Nhim River.

(2) Warning System

The hydrological data acquisition system included the installation of a warning system. Warning stations (WS 1-4 on Figure 1) were installed along the Da Nhim River. At the warning stations, a siren blows before a water discharge. The warning system supplements a conventional warning system based on phone calls to local residents. The effective range of the siren is a radius of 2 km under fair weather conditions and a radius of 300-500m in rainy weather. WS covers the major residential areas along the Da Nhim River in the Don Duong district, Lam Dong province. Different types of siren are assigned to certain levels of water discharge. Interviews with residents along the Da Nhim revealed that the siren could be heard 2-3 hours before water discharge⁸.

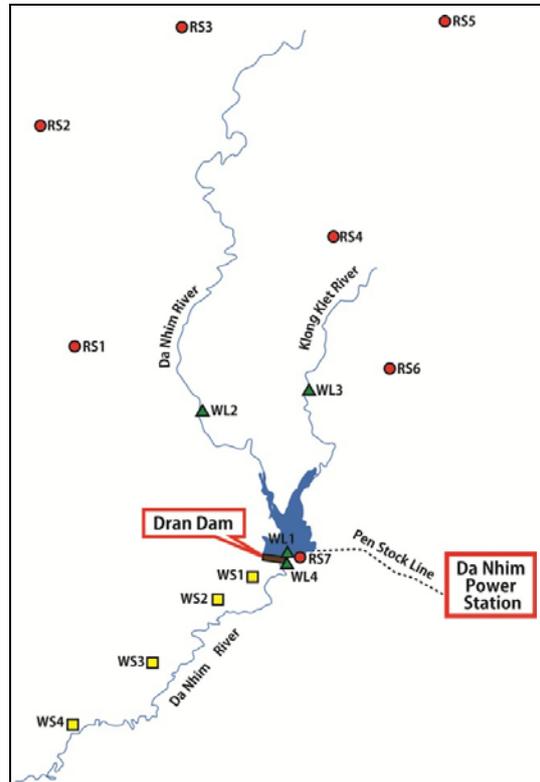


Figure 1: Map of Hydrological Data Acquisition System

⁸ Interviewed with 5 residents (male 2 persons, female 3 persons) near the warning stations

Example use of the warning system - Flood in November 2010:

Heavy rain from October 30 to November 3, 2010 caused flooding in the downstream area of the Da Nhim River including in the Dong Duong district. In order to maintain the water level at the reservoir, DHD discharged water. DHD informed residents of water discharge by both telephone and siren.

DHD and the Dong Duong District Flood Control and Natural Disaster Mitigation Committee jointly carried out a damage assessment covering the area along the Da Nhim River in the Dong Duong district. This joint assessment found that the DHD operation followed proper discharge procedures and that residents were updated about the water discharge schedule in a timely way. An inundation affected vegetable crops in low areas including illegally cultivated land near the Da Nhim River⁹. No casualties were reported in the joint assessment by DHD and the committee.



Photo 2: Warning System

This project has largely achieved its objectives, therefore its effectiveness is high.

3.4 Impact

3.4.1 Intended Impacts

(1) Stable Supply of Electricity

The Da Nhim Hydropower station is considered an indispensable source of energy under the tight supply and demand conditions. In 2009, The Da Nhim power station accounted for 2.8% of power generation in the southern region. An interviewee at the Power Transmission Company No.4, which was engaged in power transmission in the southern part of Vietnam, mentioned that even a marginal supply, 1-2% of total generation, played a critical role in the stable supply of electricity.

Interviews with local residents in Ninh Tuang province where the Da Nhim power station is located confirmed that a lack of power supply had affected the ultimate customers¹⁰. According to residents, rotating blackouts had become more frequent for the last three years¹¹. In particular, rotating blackouts occurred frequently in the dry season in 2010, although they had been rare in the rainy seasons. Residents have more electrical appliances and consumed more electricity than 10 years ago. Refrigerators and electrical fans, some of which were used for family-run small businesses, were popular products among the interviewees. The quality of life among the local residents depended more than before on a stable supply of electricity.

(2) Economic Development of the Southern Region

In Ninh Tuang province and Khan Hoa province, the Da Nhim hydropower is a major source of electricity. Both provinces also have experienced a population growth and economic expansion since the mid-1990s. The Gross Output of the industrial sector shows a boom in the manufacturing sector. Enterprises have started manufacturing operations along NH1 in Ninh Tuan province during the last decade and have partially contributed to this boom. As other factors also affect production in the manufacturing sector, growth is not only attributed to the implementation of this project. Nevertheless, it can be said that the Da Nhim power station supports local manufacturers in stable operations through its supply of electricity.

⁹ According to DHD, farmers often cultivate shoals and riverbeds where farming is prohibited.

¹⁰ Interviewed with 9 residents including a commune leader (male 5 persons, female 4 persons)

¹¹ A planned blackout implemented by a power supplier in order to prevent a large-scale unplanned blackout

Table 6: Economic Statistics for Khan Hoa and Ninh Tuang

	Khan Hoa			Ninh Tuang		
	1996	2007	% change	1996	2007	% change
Population (1,000 persons)	979	1,147	17.2%	476	575	20.8%
GDP (1994 Price,VND bil)	2,931	9,047	208.6%	1,022	2,347	129.6%
Gross Output of Industry (1994 Price,VND bil)	1,895	9,269	389.2%	248	796	221.5%

Source: General Statistical Office (1998) “Socio –Economic Statistical Data of 61 Provinces and Cities in Vietnam”, General Statistical Office (2009) “Socio –Economic Statistical Data of 63 Provinces and Cities in Vietnam”

3.4.2 Other Impacts

(1) Impacts on the Natural Environment

No significant negative impact on natural environment was observed during the site visit. As this project rehabilitated existing facilities, its impact on the natural environment was small. According to DHD, DHD complied with the relevant environmental regulations and monitored some of the parameters such as noise, vibration, discharged water and surface water in accordance with the regulations. DHD outsourced the treatment of waste such as waste oil to a company with the appropriate license.

(2) Land Acquisition and Resettlement

As the project scope was reduced to the rehabilitation of Da Nhim power station only, land acquisition and resettlement were not required. No significant negative impact on the social environment of neighbouring communities was observed.

It is plausible that this project has contributed to production activities in the region. Any negative impact on the natural and social environment is negligible.

3.5 Sustainability (Rating: ②)

3.5.1 Structural Aspects of Operation and Maintenance

At the times of both the appraisal and the ex-post evaluation, EVN was a state-owned company, although the Vietnamese government no longer subsidized the operation of EVN at the time of the ex-post evaluation. The corporate splitting-up of EVN had progressed since the mid-1990s. There were several subsidiaries under EVN including DHD, the operator of the Da Nhim power station. At the time of the ex-post evaluation, EVN owned almost 100% of DHD’s equity. Ownership on the part of external investors is very marginal, at less than 1%. The responsibility for O&M activities is clearly defined. While DHD is responsible for the operation and maintenance of the Da Nhim power station, EVN is responsible for the review and approval of maintenance and repair plans.

Table 7: Number of Staff at the Da Nhim power station

	2008	2009	2010
All staff	54	54	50
- Engineers	25	25	25

Source: DHD

The number of engineers has remained the same for the last three years. Staffing was not a critical issue for the O&M activities at the time of the ex-post evaluation.

3.5.2 Technical Aspects of Operation and Maintenance

According to DHD, the number and qualifications of the staff are sufficient for most facilities rehabilitated by this project. As mentioned in “3.3.1.1 (2) Planned and Unplanned Outages”, DHD is able to cope with a malfunction of the control board by themselves. As water runners for turbines had trouble at the time of the ex-post evaluation, repair works were being planned. As for training, contractors held training classes when new equipment was installed. They were also able to reply to technical queries after completion and, if necessary, send personnel to the Da Nhim power station. DHD routinely assessed whether O&M staff had sufficient knowledge and maintained the technical capacity of staff by training. All O&M staff at the Da Nhim power station took following tests conducted by DHD every year:

- (1) Annual knowledge test: basic knowledge relevant to operational positions. Staff failing this test must take a training course.
- (2) Annual safety test: proper use of equipment for the prevention of accidents

3.5.3 Financial Aspects of Operation and Maintenance

O&M expenses increased during the last few years but stayed at 4-7 % of DHD revenue from power generation in 2007-2009. DHD power generation operation made a profit in the last three years (2007, 2008, and 2009) and O&M expenses are presumably at a bearable level for DHD. Wholesale price of electricity is currently set at the level which enables DHD to recovery generation costs and maintenance costs. On the other hand, a large-scale rehabilitation would require a financial support from the parent company EVN.

DHD obtains all debt financing via EVN. In addition, EVN owns almost 100% of DHD equity. EVN plays a vital role in the financial stability of DHD as DHD’s financing activities depend mainly on EVN.

As shown in Table 8, the Debt to Equity ratio¹², which is above 2.0 at the time of the ex-post evaluation, shows the EVN high dependency on debt. However, the liquid ratio¹³ is above 1.0 which shows that EVN is unlikely to face a liquidity problem in the foreseeable future. EBIT¹⁴ surpasses net financial expenses, which suggests that EVN has enough earnings to cover interest payments. For these reasons, EVN is not expected to have problems with debt payment in the foreseeable future.

¹² Total Liabilities divided by Owner’s Equity

¹³ Current Assets divided by Current Liabilities

¹⁴ Current Profit plus net interest payment

Table 8: Financial Data of EVN

Unit: million VND

	2007	2008	2009
Net Sales	58,105,693	64,715,085	79,955,153
Financial Income	1,378,720	2,031,528	1,521,225
Financial Expenses	3,477,119	5,572,631	5,136,479
Current Profit	3,354,359	1,076,604	2,803,506
EBIT	5,452,758	4,617,707	6,418,760
Net Income (after Tax)	3,335,853	1,496,443	3,116,141
Current Assets	49,813,704	50,170,544	61,935,158
Non-current assets	135,096,701	154,192,248	191,787,229
Total Asset	184,910,405	204,362,792	253,722,387
Current Liabilities	25,601,309	30,373,244	43,245,794
Non-current Liabilities	81,302,337	108,173,055	139,448,343
Total Liabilities	106,903,646	138,546,299	182,694,137
Net Worth	78,006,759	65,816,493	71,028,250
Owner's Equity	73,085,628	61,250,481	64,724,962
Liquid ratio	1.95	1.65	1.43
EBIT/Net Interest	2.60	1.30	1.78
D/E Ratio	1.46	2.26	2.82
ROE	4.6%	2.4%	4.8%
ROA	1.8%	0.7%	1.2%
Net Profit Margin	5.7%	2.3%	3.9%
Asset Turnover	0.31	0.32	0.32
Financial Leverage	2.53	3.34	3.92

Source: EVN Corporate Profile 2008/2009 and 2009/2010

Table 9: O&M budget for Da Nhim Hydropower Station

Unit: million VND

	2007	2008	2009	2010
O&M Budget	32,259	60,031	49,451	44,407
O&M Expenses	28,939	37,019	49,365	43,074

Source: DHD

3.5.4 Current Status of Operation and Maintenance

Several mechanical troubles have occurred since the completion of the rehabilitation works. Given the amount of Gross Electric Energy Production, it can be considered that they did not prevent the operation of the Da Nhim power station in the short run. However, there was a risk doing so in the long run.

(1) Water runners for turbines

Water runners for turbines experienced trouble twice after installation. The first incident was in 2006 and the second in 2010.

In 2006, a bucket in the water runner Unit 4 was broken and cracks were found in Unit 1. Since both Units 1 and 4 had enough design strength, it was concluded that inappropriate heat treatment in the post-welding process of their fabrication had caused this incident. Both units were replaced with newly-fabricated ones.

Similar incidents occurred again in 2010. Unit 3 was broken. Cracks were found in Units 1

and 4. At the time of the ex-post evaluation, Units 1 and 3 were shipped back to Japan for further inspection. The cause for the incident was considered material deterioration during the fabrication process. Based on this assessment, repair works were being planned. Units 1, 3 and 4 were replaced with old runners so that DHD could maintain normal operation.

(2) Rain fall stations and water level stations

At the time of the ex-post evaluation, all sensors at the rain fall and water level stations except WL 1 were taken away and stored during the dry season in 2011 in order to avoid theft. Underwater pressure sensors at the water level stations were often damaged by debris in the rivers. Before the flood season of 2011, sensors were to be replaced with ultrasound sensors which could be placed above river water.

(3) Others

After the completion of the rehabilitation work, bearings for power generators and seal rubbers in the pen stocks had defects. These were replaced with spare parts and this did not negatively affect the operation of the Da Nhim power station.

Some problems have been observed in terms of the technical aspects of operation and maintenance; therefore sustainability of the project is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project has been highly relevant to the development plan and development needs of Vietnam, as well as to Japan's ODA policy. The implementation of this project required more time than planned because of several reasons including a delay in the selection of consulting services and the careful preparation and examination of the detail design. Since the Gross Electricity Energy Production, a key performance indicator for a power station, fully met its target, the Da Nhim power station can be seen to have played a critical role under the conditions of tight supply and demand. Several mechanical troubles have occurred in the last few years but they had not prevented the operation of the Da Nhim power station at the time of the ex-post evaluation.

In light of the above, this project is evaluated to be satisfactory.

4.2 Recommendations

4.2.1 Recommendations for the Executing Agency

Repair works on water runners are being planned at the time of the ex-post evaluation. It will require a certain period of operation to conclude whether the repair works have been effective. It is recommended that EVN assess whether the contractor's countermeasures, including the warranty period after the repair works, are appropriate for the proper settlement of this engineering issue.

4.2.2 Recommendations for JICA

Mechanical troubles occurred for the water runners, though they did not negatively affect the smooth operation of the Da Nhim power station. As the cause of the incident was found, repair works were being planned. It will require a certain period of operation to conclude whether the repair works have been effective. It is recommended, as a precautionary measure, that JICA continue to monitor the plant operation after the repair works of the runners.

4.3 Lessons Learned

None

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs	<p>(1) Generator and ancillary facilities, substation facilities for the Da Nhim power station</p> <p>(2) Water turbine and ancillary facilities, waterway and ancillary facilities</p> <p>(3) Hydrological data acquisition system (6 rainfall gauging stations, 2 water level gauging stations, 2 repeater stations, 4 warning systems, data processing system, etc.)</p> <p>(4) Rehabilitation of Saigon Substation and 230 kV Transmission Line</p>	<p>(1)-(2) almost as planned with minor modifications</p> <p>(3) 7 rainfall gauging stations, 4 water level gauging stations, 1 repeater station, 4 warning systems, data processing system, etc</p> <p>(4) Canceled</p>
2. Project Period	March 1997 – May 2001 (51 months)	March 1997 – August 2006 (98 months)
3. Project Cost		
Amount paid in Foreign currency	7,000 million yen	4,558 million yen
Amount paid in Local currency	1,239 million yen (123,900 million dong)	121 million yen (30,250 million dong)
Total	8,239 million yen	4,679 million yen
Japanese ODA loan portion	7,000 million yen	3,935 million yen
Exchange rate	1 dong = 0.01 yen (As of October 1996)	1 dong = 0.004 yen (As of January 2011)