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Vietnam

Ham Thuan – Da Mi Hydropower Project (1)(2)(3)(4)

Evaluator: Vietnam-Japan Joint Evaluation Team 2008[1]

On-site Survey: November 2008

1. Project Profile and Japanese ODA Loan

Project Site

Ham Thuan power house

1.1 Background

In Vietnam, the demand for electricity has been increasing rapidly along with economic development since the introduction of the *doi moi* policy in 1986. At the time of the project appraisal (1994), power shortages had already become a serious problem, especially in central and southern Vietnam. In the south, it was estimated that the power supply (12kWh/day/customer) did not meet the potential demand (14-14.4kWh/day/customer). It was projected that during the period from 1995 to 2000, the power demand would increase by 15.5% p.a. in the entire country and by 17.3% p.a. in the south.

The installed generation capacity as of 1994 was 4,470MW in Vietnam as a whole, and 1,507MW in the south. To meet the demand mentioned above, a maximum output of 4,595-5,390MW in Vietnam and of 1,740-2,290MW in the south was required in 2000.

In 1994, a 500kV transmission line to connect the north and south was commissioned so that

[1] The Vietnam-Japan Joint Evaluation Team 2008 consisted of three Working Groups each of which evaluated different projects. This project was evaluated by the Hydropower Group joined by the following members: Cao Thanh Phu (Ministry of Planning and Investment), Vu Van Thai (Ministry of Industry and Trade: MOIT), Luong Thi An (Electricity of Vietnam: EVN), Nguyen Xuan Thang (EVN), Le Sy Hoi (EVN), Nguyen Thi Hong Thuy (Hydropower Project Management Unit No. 6: HPPMU6), Nguyen Thi Lan Dai (HPPMU6), Nguyen Hong Hai (HPPMU6), Nguyen Tan Vinh (Da Nhim-Ham Thuan-Da Nhim Hydropower Plant: DHD), Nguyen Duy Thinh (DHD), Nguyen Song Anh (National Consultant), Nghiem Ba Hung (National Consultant), Takako Haraguchi (Japanese Consultant).

power shortages in the south could be alleviated by supply from the north. Nevertheless, it was projected that northern Vietnam would also run short of power in the near future due to rapid economic development. In sum, even with power supply from other areas, the development of large-scale power resources was necessary in the south.

1.2 Objective

The objective of the project was to meet the increasing power demand in southern Vietnam and to enhance irrigation agriculture in Binh Thuan Province by the construction of two hydropower plants (Ham Thuan and Da Mi) and related facilities along the La Nga River and the Da Mi River of the Dong Nai River System, thereby contributing to the economic development of the region.

Logical Framework Applied for Ex-Post Evaluation

Goal	Economic development of the region
Purpose	1. To meet the increasing power demand in southern Vietnam 2. To enhance irrigation agriculture in Binh Thuan Province
Outcomes	1. Increase in power supply to the southern area 2. Supply irrigation water to Duc Linh and Tanh Linh districts, Binh Thuan province
Output	1. Ham Thuan Hydropower Plant (HP) 300MW 2. Da Mi Hydropower Plant (HP) 175MW 3. Transmission Lines (T/L) 110 kV and 220 kV 4. Substations (S/S) 110kV and 220kV 5. Consulting services
Input	Total cost: 70,145 million Yen (JBIC loan: 59.623 million Yen; GOV portion: 10,522 million Yen)

1.3 Borrower/ Executing Agency/ Implementing Agency

Borrower: The Government of the Socialist Republic of Vietnam (GOV)

Executing Agency: Power Company No. 2 (PC2) (Electricity of Vietnam (EVN) since 27 Jan. 1995)

Implementing Agency: Hydropower Project Management Unit No.6 (HPPMU6)

1.4 Outline of Loan Agreement

	Phase 1	Phase 2	Phase 3	Phase 4
Loan Amount / Disbursed Amount	17,092 Million Yen / 15,837 Million Yen	4,962 Million Yen / 4,796 Million Yen	4,664Million Yen / 4,273 Million Yen	24,893 Million Yen / 9,884 Million Yen

	Phase 1	Phase 2	Phase 3	Phase 4
Date of Exchange of Notes / Date of Loan Agreement	EN: April 18, 1995 LA: No. VNII-3 dated April 18, 1995	EN: March 29, 1996 LA: No. VNIII-3 dated March 29, 1996	EN: January, 1997 LA: No. VNIV-3 dated March 26, 1997	EN: March 30, 1998 LA: No. VNV-3 dated March 30, 1998
Terms and Conditions - Interest Rate - Repayment Period (Grace Period) - Procurement	 1.8 % p.a. 30 years (10 years) General Untied	 2.3 % p.a. 30 years (10 years) General Untied	 2.3 % p.a. 30 years (10 years) General Untied	 1.8 % p.a. 30 years (10 years) General Untied
Final Disbursement Date	September 17, 2002	March 26, 2003	September12, 2004	July 25, 2005
Main Contractors (over 1 billion JPY)	Tomen Corporation (Japan), Ansaldo Energia SPA (Italy), Fuji Electric Co. Ltd. (Japan). Hitachi Zosen Corporation (Japan). Ssangyong Corp. (Korea). Hyundai Corporation (Korea). Tomen Corporation (Japan), Hydraulic Construction Company No.46 (Vietnam), Ssangyong Engineering & Construction Co Ltd (Korea), Maeda Corporation (Japan). Kumagai Gumi Co., Ltd. (Japan), Astaldi SPA. (Italy), Kukdong Engineering & Construction Co Ltd (Korea). Nissho Iwai Corporation (Japan).			
Consulting Services (over 100 million JPY)	Electric Power Development (Japan), Nippon Koei (Japan).			
Feasibility Study	1991 Government of Vietnam			

2. Results of Evaluation

2.1 Relevance (Rating: a)

This project has been highly relevant to Vietnam's national policies and development needs at the time of both the appraisal and the ex-post evaluation.

2.1.1 Consistency with Vietnamese Development Policies

A high priority on power sector development is continuously seen in the Socio-Economic Development Plans (SEDP) of both before and after the project. SEDP 1996-2000 (at the appraisal or ex-ante evaluation stage) emphasized adding to and upgrading power resources and networks in the Industrial Development Program and the Infrastructure Development Program. SEDP 2006-2010 (at the ex-post evaluation stage) gives an even higher priority to

power sector development than was the case in 1996-2000: electricity is the sector that is first mentioned in both industrial and infrastructure development plans. A priority on hydropower development, which can utilize Vietnam's natural resources and save generation costs, is also stressed.

As for power sector development plans, The Power Sector Master Plan IV (for 1996-2000 with perspective up to 2010) planned to increase generation capacity from 4,435MW (1994) to 19,000MW (2010). At the ex-post evaluation stage, Power Sector Master Plan VI 2006-2015 plans to increase generation capacity from 12,357MW to 42,000MW through the construction of power generation plants including 50 hydropower plants. As well as SEDP, hydropower development is given a high priority in the Power Sector Master Plans.

2.1.2 Consistency with Needs

Table 1 shows basic indicators of power demand and supply at the ex-ante and ex-post evaluation stages. High demand for power both before and after the project can justify the necessity for the development of power resources in the south.

On the other hand, given the development of a high-voltage national transmission network, electricity generated by the project is now supplied not only to the south but to the whole country. Therefore, the need for the project is also shared nationwide.

Table 1: Basic power indicators

Indicator	Ex-ante evaluation stage	Ex-post evaluation stage
Power consumption and growth rate		
Vietnam	9,198GWh (1994)	51,325GWh (2007) 14.7% p.a. (2000-2007)
South	4,248GWh (1994)	26,646GWh 17-20% p.a. (2000-2007)
Installed generation capacity		
Vietnam	4,470MW (1994)	13,512MW (2007)
South	1,507MW (1994)	3,920MW (2007)
Demand forecast		
Vietnam	15.5% p.a. (1995-2000) 14,640GWh → 30,105GWh	17-20% p.a. (2006-2015)
South	17.3% p.a. (1995-2000) 7,000GWh → 15,560GWh	

Source: EVN

2.2 Efficiency (Rating: b)

While the actual project cost was lower than planned, the project duration was slightly longer the planned. Therefore, the evaluation for efficiency is moderate.

2.2.1 Output

The project output was produced mostly as planned (see "Comparison of Original and Actual Scope" on the last page of this report). This consisted of five main components: (i) construction of the Ham Thuan hydropower plant with reservoir and dam; (ii) construction of the Da Mi hydropower plant with reservoir and dam; (iii) construction of transmission lines; (iv) expansion or construction of substations; (v) consulting services; and (vi) development of resettlement sites. The summary of the output produced is as follows:

Specification of major project output:

- Two hydropower plants with a designed capacity of 475MW: Ham Thuan plant with 300MW (150MW x 2 units); Da Mi plant with 175MW (87.5MW x 2 units)
- Two reservoirs with a total volume of 836 million $m^{3:}$ Ham Thuan reservoir with 695 million m^3; Da Mi reservoir with 141 million m^3
- Two main dams (rockfill dams): Ham Thuan main dam with a height of 93.5m; Da Mi main dam with a height of 72m
- Transmission lines: total 282.2km (171.2km of 220kV lines and 111km of 110kV lines)
- Four substations (S/S) 110kV and 220kV with a total transformer capacity of 379MVA:
  - Expansion of Bao Loc S/S (220/110/35kv – 63MVA and 110/22kV – 25MVA)
  - Construction of Phan Thiet S/S (110/22kV – 2 x 25MVA)
  - Construction of Duc Linh S/S (110/22kV – 16MVA)
  - Construction of Long Thanh S/S (220/110kV – 250MVA)

Ham Thuan Reservoir

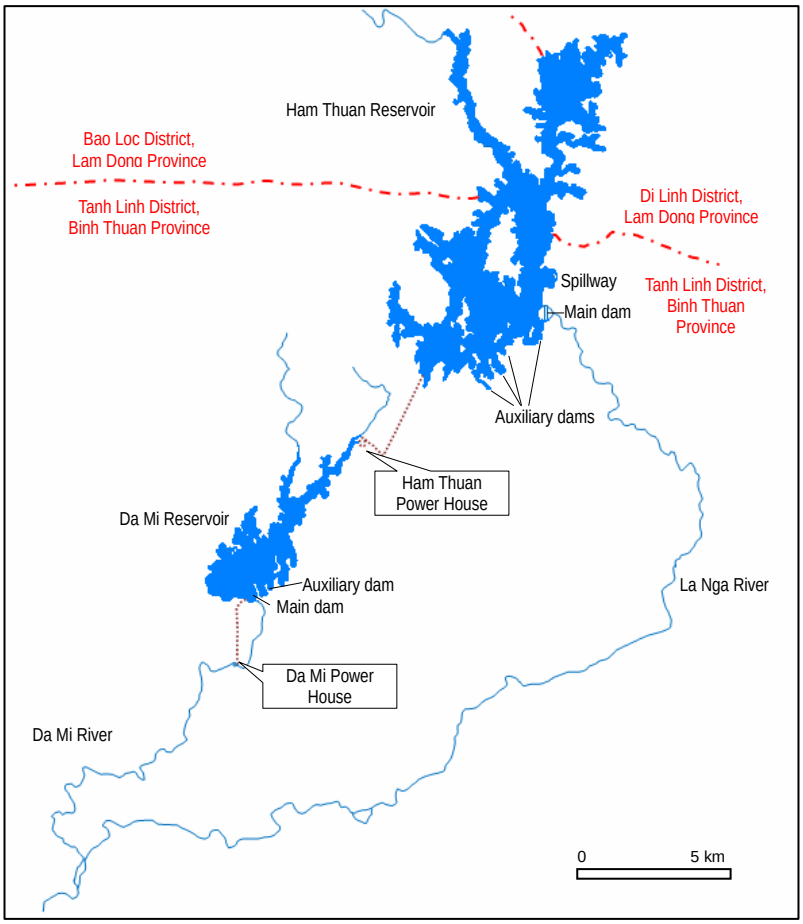
Da Mi main dam and water intake

Hàm Thuan power house

As for differences to the original plan (as of the appraisal of Phase 1), the total length of transmission line was shortened from 495km to 282.2km due to re-routing based on the

detailed design[2]. Also, among the four substations, the Long Thanh substation was not in the original plan but constructed as an additional output to transmit electricity from the Ham Thuan and Da Mi plants more effectively.

Figure 1: Map of the Project Site



After the completion of the facilities and equipment of the power plants, there were several problems found in the generators at both power plants. The problem in the generators at Da Mi plant has not yet been solved[3].

[2] The differences between planned and actual lengths are 198.8km (220kV) and 14km (110kV). The two 220kV sections, Ham Thuan-Phu My (155km) and Da Mi-Long Binh (165km) were cancelled as the construction of Long Tanh substation was added to the original scope. Instead, the Da Mi-Long Thanh 220kV lines (129km) was added.

[3] Major problems include following:

- Ham Thuan plant: (i) imbalanced roter pole, (ii) insufficient height of lubrication oil tank, and (iii) oil leakage of gus-insulated switchgear (GIS), all of which were repaired by the end of 2004.
- Da Mi plant: stators of Generator 1 and 2 of Da Mi plant burned during the testing performance and operation. The contractor replaced the generator's cooling system twice. Also, the contractor improved the break phase and stator winding end caps to ensure a gap of less than 9 mm. Work was undertaken from 2001to 2005. Up to now, however, the cracking of stater winding end caps remains unsolved. In May 2008 EVN and the contractor discussed the option of reducing the contract price and the provision of spare parts for back up for the next two years. EVN will repair the equipment by themselves. This option is being prepared for submission to EVN for approval in order to complete the contract.

The consulting services were provided mostly as planned. The major task was assistance in tender and construction supervision. No problem has been reported regarding the performance of the consultants.
The development of resettlement sites (related to the construction of reservoirs and transmission lines) is described in *2.4.3 Impact of Land Acquisition and Resettlement.*

2.2.2 Project Period

The project period originally planned was 69 months from April 1995 to December 2000[4]. The actual project period was 76 months from April 1995 to July 2001, which was 110% of the original plan.

Reasons for delays include: (i) the delayed start of construction works due to delays in tendering and a need for additional geological investigations and revisions in design accordingly; (ii) extra work arising during construction work due to several factors such as technical mismatches caused by the absence of the operator (i.e. DHD Hydropower Company) at the appraisal and tender stages and the overflow of the main dams and a partial collapse of Da Mi sub-tunnel; (iii) suspension of construction works due to natural disasters (i.e. floods in 1998 and 1999, the probability of which is once in 25 years); and (iv) delays in land acquisition for transmission lines. However, the overall duration of construction works was almost as planned.

It was originally planned that the first unit (Unit No. 1 of Ham Thuan) would start commercial operation in January 2000 and the last unit (Unit No. 2 of Da Mi) in April 2000. However, the actual starting dates of the Ham Thuan plant and the Da Mi plant were April 2001 and June 2001, respectively.

2.2.3 Project Cost

The total project cost originally estimated was 68,375 million yen of which a maximum 58,118 million yen was to be funded by Japan's ODA loans. The actual total project cost was 41,738 million yen, including 35,795 million yen of Japanese ODA loans.

The reasons for the cost under-run might include (i) competition in tender; (ii) exchange rate differences in 1995, 1996, and 1997; and (iii) cost saving by re-routing of transmission lines and the installation of uniform transformers in substations.

[4] The starting point is the date of signing of the loan agreement of Phase 1. The completion date was defined by the project as the date of passing the performance test.

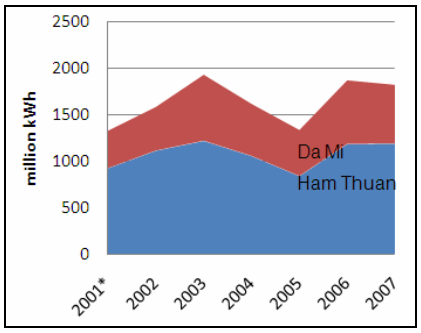
2.3 Effectiveness (Rating: a)

After the implementation process of the project, most of the expected outcome was completed as planned. Therefore, effectiveness of the project is high.

2.3.1 Increase in Power Supply

As shown in Figure 2 and Table 2, the annual energy output from the Ham Thuan and Da Mi hydropower plants has been above the guaranteed amount in all years and above the annual average in most years. The annual fluctuation of energy output is mostly due to the amount of rainfall (especially in 2005 with low water supply - hydrographic) and the problem of generators mentioned in *2.2 Efficiency*. Nevertheless, even in the year of minimum generation (year 2005), the total output was more than 85% of the annual average target. Unplanned outage hours were many in the early years because of the problems mentioned in *2.2 Efficiency*. The DHD Hydropower Company and HPPMU6 worked with the project consultant and contractor to solve these problems, and unplanned outage hours rapidly decreased over time (Table 3).

Figure 2: Annual energy output from Ham Thuan-Da Mi hydropower plants



Source: DHD Hydropower Company

Table 2: Target and actual annual energy output from the Ham Thuan-Da Mi hydropower plants

(Unit: million kWh)

	Target		**Actual**						
	Guaran - teed	*Annual Average*	2001*	2002	2003	2004	2005	2006	2007
Ham Thuan	*701*	*965*	923	1,112	1,217	1,054	838	1,183	1,188
Da Mi	*394*	*590*	401	468	708	558	494	682	629
Total	*1,095*	*1,555*	1,323	1,580	1,925	1,613	1,333	1,865	1,817

Source: Appraisal documents (target) and DHD Hydropower Company (actual)

Note: Figures of 2001 are for April-December (Ham Thuan) and June-December (Da Mi).

Table 3: Operation hours of the Ham Thuan and Da Mi generators

(Unit: hours)

	2001	2002	2003	2004	2005	2006	2007
Operation hours (Target: 3,500 hours/unit)							
Ham Thuan	6,196	7,958	9,164	8,224	6,476	8,636	9,419
- Unit 1	1,791	4,383	4,699	4,102	3,577	4,286	4,847
- Unit 2	4,405	3,575	4,465	4,122	2,899	4,350	4,572
Da Mi	5,218	5,513	8,459	6,673	5,895	8,163	7,539
- Unit 1	2,361	2,143	4,254	2,077	3,706	3,982	5,135
- Unit 2	2,857	3,370	4,205	4,596	2,189	4,181	2,404

	2001	2002	2003	2004	2005	2006	2007
Unplanned outage hours							
Ham Thuan	5,182	2,489	51	883	239	98	1
- Unit 1	3,237	1,924	10	368	126	28	0
- Unit 2	1,945	565	41	515	113	70	1
Da Mi	3,757	8,005	3,838	7,486	4,232	545	185
- Unit 1	2,360	4,818	1,939	4,941	840	262	150
- Unit 2	1,397	3,187	1,899	2,545	3,392	283	795

Source: DHD Hydropower Company

Table 4 shows a good use of water at the Ham Thuan and Da Mi plants. The annual water flow to reservoirs fluctuates depending on rainfall. There was only one year when the water level did not reach full capacity (year 2005). Water kept at the reservoirs is well utilized for generation: release through spillways is kept at a minimum. The measurement of the sedimentation of reservoirs has not yet been conducted, but is planned.

Table 4: Water flow to- and from- the Ham Thuan and Da Mi plants

(Unit: million m^3)

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Total volume of Inflow to the Reservoir							
Ham Thuan	1,880	1,786	1,964	1,627	1,358	1,760	1,933
Da Mi	1,054	1,792	1,966	1,651	1,341	1,876	1,928
Total volume of water release through spillway							
Ham Thuan	610	16	37	2	0	69	73
Da Mi	0	526	27	131	0	7	222
Volume of water used to run generators							
Ham Thuan	1,341	1,735	1,872	1,594	1,269	1,784	1,807
Da Mi	1,062	1,272	1,932	1,504	1,344	1,877	1,711

Source: DHD Hydropower Company

After the project, the Ham Thuan- Da Mi power plants also provided water to the Tri An hydropower plant (400MW) located downstream of the Da Mi plant along the Dong Nai river. Table 5 show, water flow to the Tri An reservoir, of which water from the Da Mi plant accounts for 30%, especially in the months of the dry season months from 2001,later increasing and higher than in 1998 (in 1999 and 2000, water flow to the Dong Nai river valley was abundant, and was below the 30% probability).

Table 5: Water flow to the Tri An reservoirs during dry season

(Unit: m^3/s)

Year	January	February	March	April	May	June
1998	83.26	45.39	29.09	43.20	155.70	188.77
1999	265.56	106.43	83.1	322.54	674.87	1,328.04
2000	146.46	101.15	94.93	158.30	230.50	509.25
2001	203.11	91.04	78.53	143.35	221.02	628.50
2002	107.55	64.70	71.45	88.73	127.20	375.36
2003	134.05	70.10	70.35	78.25	261.97	669.51
2004	122.94	69.36	58.09	103.78	198.56	623.59

Year	January	February	March	April	May	June
2005	64.46	48.89	123.04	72.13	160.02	269.86
2006	133.01	88.30	91.16	121.83	178.24	262.82
2007	222.05	56.37	80.74	114.75	263.04	327.03

Source: Tri An hydropower plant

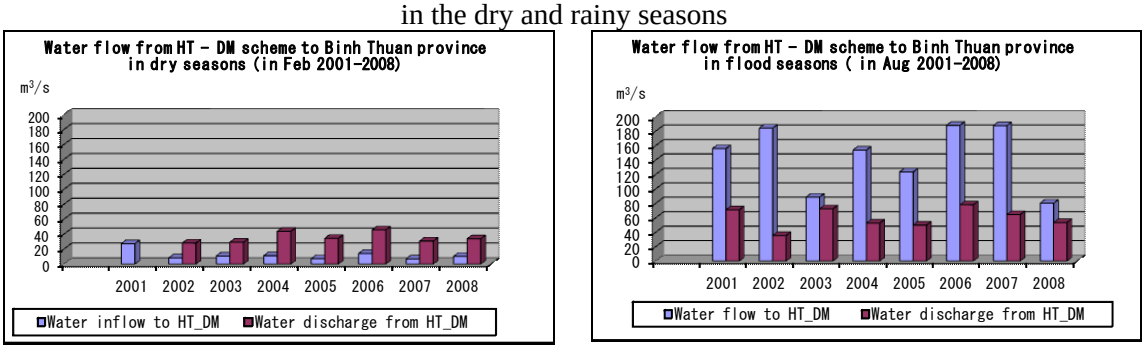
2.3.2 Internal Rate of Return (IRR)

At the appraisal stage, the financial internal rate of return (FIRR) of the project was calculated at 7.62%, taking investment cost, re-investment cost and operation and maintenance (O&M) cost as the cost, and revenue from electricity sales as the benefit. For the ex-post evaluation, FIRR was re-calculated using the actual figures of cost and benefit. The re-calculated FIRR was 3.52%. This decrease might be because of a lower tariff than estimated at appraisal[5]. The economic internal rate of return (EIRR) was not calculated at the appraisal stage.

2.3.3 Enhancing Irrigation Agriculture in Binh Thuan Province

The water used for generation at the Ham Thuan –Da Mi hydropower plants was supplied for irrigation to districts along the La Nga River in Binh Thuan province. According to the DHD Hydropower Company, the Ham Thuan-Da Mi reservoir scheme provides 1,500 million m^3/year or a maximum 136m^3/s of water to Binh Thuan province. Figure 3 shows that during the dry season, water is stored at the Ham Thuan and Da Mi reservoirs, and more water than flows into the scheme is discharged (after generation). The water supply from the scheme has been crucial to the Tanh Linh and Duc Linh districts (Binh Thuan province) especially during the dry season. For the impact of the water supply on agricultural production, see *2.4.1 (3) Improvement of Rice Production*.

Figure 3: Comparison of water flow from/to the Ham Thuan-Da Mi Scheme in the dry and rainy seasons



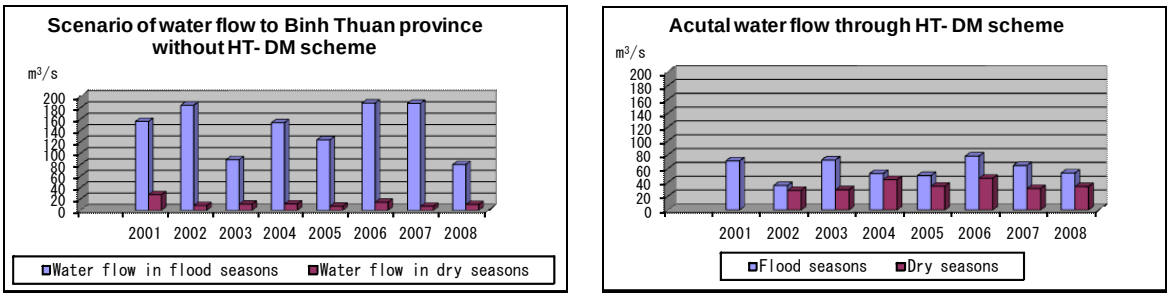
Source: DHD Hydropower Company

[5] At the appraisal stage (1993), tariff was assumed to be 0.06USD/kWh, which was equivalent to 1,193VND/kWh in the 2000 constant price (applying an exchange rate of 1USD=10,536VND as of 1993); current available figures show the selling prices were 128VND/kWh, 131VND/kWh and 156VND/kWh in 2006, 2007 and 2008, respectively (in 2000 constant prices); retail prices of high voltage electricity (110kV or higher) for producers range from 316VND/kWh (off-peak hours) to 1,183VND/kWh (peak hours) in 2000 constant prices. If the selling price estimated at the appraisal were applied, the recalculated FIRR would have been around 14%. It cannot be said that the appraisal overestimated the selling price because other similar studies also used similar rates. Electricity prices are under the control of EVN.

2.3.4 Stabilization of water supply to Binh Thuan province

With the Ham Thuan – Da Mi reservoirs in place, water resources from La Nga river to Binh Thuan province have very much stabilized. Figure 4 shows a comparison of the with- and without- project scenario to illustrate the amount of water supply to the province: the reservoirs help reduce the flood level (i.e. reduce water discharge) in the flood seasons and supply much more water during the dry seasons[6].

Figure 4: Comparison of water discharge during the dry/ rainy seasons with and without the project



Source: DHD Hydropower Company

2.4 Impact

The project has supplied power for socio-economic development, contributing to the implementation of the industrialization and modernization process in the southern provinces as well as in other regions of the country. In addition, a more direct impact on people has been seen in Binh Thuan province.

2.4.1 Impact on the Economic Development of the Region (Achievement of Goal)

(1) Economic Growth

The annual average GDP growth rate 1997-2007[7] of Vietnam was 7.2%. Sector growth rates during the same period were 11.4% in the manufacturing sector, 3.5% in the agricultural sector and 12.0% in the energy and water supply sector. Development in the industrial sector drove Vietnam's economic growth.

(2) Power Supply for Economic Development (Impact of Power Generation)

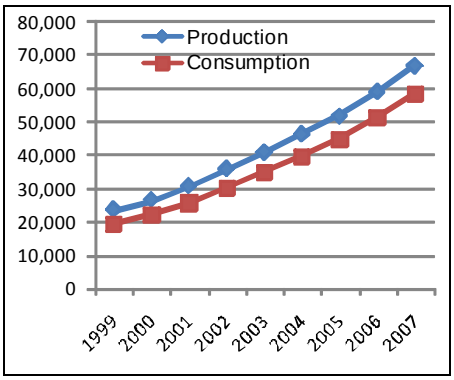
It is natural to assume that increased power supply has supported economic development. As Figures 5 and 6 show, both power production and consumption have been constantly increasing.

[6] The graphs in Figure 3 and Figure 4 were show the hydrography of the Ham Thuan and Da Mi Reservoirs from 2001 to 2008. In this data chain, February and August was selected to present dry and flood seasons respectively.

[7] At 1994 constant price.

Figure 5: Power production and consumption in Vietnam as a whole

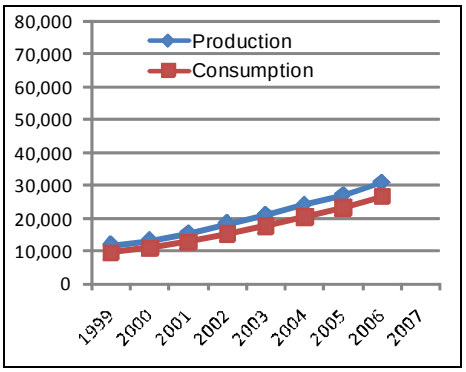
(Unit: million kWh)



Source: EVN

Figure 6: Power production and consumption in the south

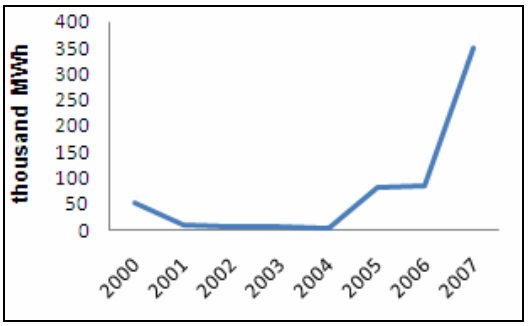
(Unit: million kWh)



Source: EVN

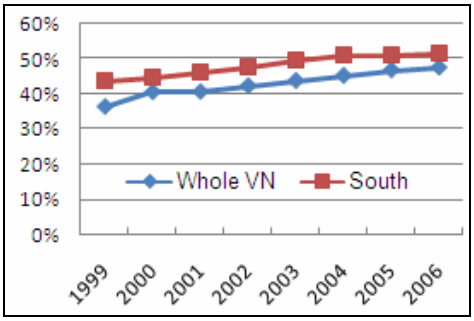
Thanks to the progress of power sector development including this project, the gap between power demand (as projected by EVN) and supply was reduced to nearly zero during the period from 2001 and 2004. However, due to a rapid increase in demand, the gap has again become wider (Figure 7).

Figure 7 Energy deficit
[gap between requirement and actual supply]



Source: EVN

Figure 8. Share of power consumption in the production sector



Source: EVN

The number of electricity consumers increased from 3,063 in 1999 to 10,390 in 2006. Also, the rate of households with access to the national grid increased from 60% to 92% during the same period. The share of power consumption in the production sector[8] is increasing as well: in 1999, it accounted for 36% of power consumption in Vietnam as a whole and 44% in the south; in 2006, the share increased to 48% and 52% respectively (Figure 8). Among the provinces in the south where industrial development is prominent, the share reaches 78% in Dong Nai Province, 30km north of Ho Chi Minh City, where a number of industrial parks are located.

[8] EVN classifies electricity consumers into: (i) residential and management; (ii) business and services; (iii) production; (iv) agriculture, forestry and fishery; and (v) others.

As power generated at the Ham Thuan-Da Mi hydropower plants is sent to the national grid through the 220kV transmission network, benefits of this project reach the entire country and contribute to the increase in power supply mentioned above. Using data on power production, it can be calculated that electricity output from the Ham Thuan-Da Mi hydropower plants accounted for 3.6% of the power generated in the whole country or 7.0% of the power generated in the south in 2006. Also, the population benefiting from this project can be calculated at approximately 3 million people by dividing the output from the Ham Thuan-Da Mi hydropower plants by per capita power consumption (609kWh in 2006).

(3) Improvement of Rice Production (Impact of Irrigation Water Supply)

In the Duc Linh district of Binh Thuan province, the biggest rice producer in the province, water supply from the Ham Thuan-Da Mi hydropower plants enabled the cultivation of an additional 900ha of irrigated area (out of a total 6,200ha irrigated area in the district), where farmers could produce rice three seasons a year. Provincial and district governments invested in construction of pump stations, dykes and reservoirs in the Duc Linh District and the Tanh Linh District using their own budget. Some farmers also constructed simple pump stations with their own funding. Rice production in the Duc Linh district has been steadily increasing reaching 75,300t in 2007.

Newly-cultivated rice fields

Pump stations invested in by local governments

(4) Improvement of Transportation (Impact of Road Construction)

To improve access to the project site, the project constructed and rehabilitated a total of 120km of local roads connecting National Highway No. 1 (around Phan Thiet city) and National Highway No. 20 (around Bao Loc town). The road was then designated as National Highway No. 55, and shortened travel time between Phan Thiet (capital of Binh Thuan province) and Da Lat from 6 ½ hours to 4 ½ hours.

(5) Opinions of Beneficiaries

Power companies. The direct beneficiary of the project is the Power Transmission Company

No.4 (PTC4) of the National Power Transmission Corporation (NPT)[9] which manages a power transmission of 220kV or higher voltage in the south. The ex-post evaluation team interviewed PTC4 and the power distribution companies operating in the south, namely Ho Chi Minh City Power Company (HCMC PC), Dong Nai Power Company (Dong Nai PC) and Power Company No. 2 (PC2)[10] , and several local distribution companies under these power companies. All of them mentioned that electricity from the Ham Thuan-Da Mi hydropower plants improved power supply and supported industrial development, while the supply was already not sufficient, especially after 2005.

Local governments. People's committees of Ho Chi Minh City, Dong Nai Province, Binh Thuan Province, Lam Dong Province were interviewed for the ex-post evaluation. According to all of them, power sector development in the south in general impacted on industrial development (especially through the development of industrial parks), on agricultural development (by powering irrigation pumps and breeding facilities), and on rural electrification.

As for a more direct impact of the project, Binh Thuan province stressed (i) benefits from the irrigation water supply during dry seasons, (ii) increased convenience through the construction of an inter-province road (After the completion of the project, the road was transferred to Lam Dong and Binh Thuan provinces for management. It was then named as National Highway No. 55), and (iii) big changes in the lives of people who were affected by land acquisition and resettlement (see *2.4.3 Impact of Land Acquisition and Development* below). On the other hand, Lam Dong province, where the Ham Thuan reservoir and part of the Ham Thuan hydropower plant are located, said that hydropower plants including the Ham Thuan plant had increased provincial income[11].

Electricity Consumers. 22 companies (mainly manufacturers and shops/hotels), who are customers of PC2 and HCMC PC, were surveyed using the same questionnaire as the one used in 2007 for the ex-post evaluation of the Phu My Thermal Power Plant Project (1)-(4) (Loan Agreements were concluded in 1994, 1995, 1997 and 1999 and the project was completed in 2005).

[9] Power transmission management was transferred from EVN to NPT upon the establishment of NPT in July 2008.

[10] HCMC PC is responsible for power distribution in Ho Chi Minh City, Dong Nai PC is responsible for Dong Nai Province, and PC2 for all other provinces in the south. Under each of these companies, there are a number of local (i.e. lower level) distribution companies.

[11] According to the People's Committee of Lam Dong province, accumulated revenues from the Da Nhim-Ham Thuan-Da Mi Hydropower Company (operator of this project) during 2005-2007 reached 10 million USD including VAT, water resources tax and business tax.

The results of the survey were consistent with the 2007 survey, showing the respondent companies' common perception that the power supply amount and its reliability have improved since the early 2000s. At the same time, many comments mentioned recent power shortages and a need for more improvement. Although the number of the samples of this survey was very small, such a consistent trend might show some extent of credibility of the results. Box 1 shows more details of the customer survey.

Farmers. The ex-post evaluation team conducted a focus group discussion with 24 farmers in Vo Xu town, Duc Linh district, Binh Thuan province. Many participants said the project supported agricultural production, while stressing negative aspects such as unregulated water release. The box shows the outline of the focus group discussion.

Interview with a power company

Interview with a provincial government

Box 1. Overview of the EVN Customer Survey in the South

1. Objective of the survey: to collect information on the effects of power sector development in the south in the 2000s.

2. Survey period: November 2008

3. Survey methods:

1) Written questionnaire, the same as the one used in 2007 for the ex-post evaluation of the Phu My Thermal Power Plant Project (1)-(4) ("the 2007 survey").
2) Semi-structured interviews with three of the questionnaire respondents.

4. Profile of respondents: total 22 responses from PC2 and HCMC PC customers

1) PC2 customers: total 10 responses (3 stores and 7 manufacturers)
2) HCMC PC customers: total 12 responses (1 store, 6 manufacturers, 2 hotels, 3 other services)

	No. of employees	Annual power consumption (MWh)	Annual electricity charge paid (million VND)
Maximum	2,000	19,000	181,000
Minimum	15	650	220
Average	482	5,838	7,610

* The 2007 survey collected a total of 30 responses.

5. Major survey results in comparison to the 2007 survey

1) Amount of power supply (unit: number of answers)

The most frequent answer category (highlighted) shifted from “Low” to “Fair” after 2002.

2007 survey (n=30)

	High	Fair	Low	Very low	N.A.
Before 2002	1 (3%)	8 (27%)	18 (60%)	2 (7%)	1 (3%)
After 2002	1 (3%)	25 (83%)	4 (13%)	0	0

2008 survey (n=22)

	High	Fair	Low	Very low	N.A.
Before 2002	1 (5%)	3 (14%)	10 (46%)	1 (5%)	7 (32%)
After 2002	0	14 (64%)	7 (32%)	0	1 (5%)

2) Reliability of power supply (unit: number of answers)

The most frequent answer category (highlighted) shifted from “Poor” to “Fair” after 2002.

2007 survey (n=30)

	Exce-llent	Fair	Poor	Very poor	N.A.
Before 2002	1 (3%)	6 (20%)	20 (67%)	2 (7%)	1 (3%)
After 2002	1 (3%)	24 (80%)	4 (13%)	1 (3%)	0

2008 survey (n=22)

	Exce-llent	Fair	Poor	Very poor	N.A.
Before 2002	2 (9%)	4 (18%)	8 (36%)	0	8 (36%)
After 2002	6 (27%)	14 (64%)	1 (5%)	0	1 (5%)

3) Positive effects of power supply on business operations (2008 survey)

- Power supply better meets requirements for manufacturing and business
- Power supply enabled a larger amount of production and improved quality
- Interruption of production due to unstable power supply and outages was reduced
- Outages still occur, but warning is given in advance (before it was not), so we can prepare for them.
- Good cooperation of power companies during the past period is appreciated.

4) Other comments (2008 survey)

- The outage situation should be improved and the power supply should be more stabilized
- Power sector should invest more in generators
- Underground medium voltage grid should be improved
- After 2002, the power supply was much better, but after 2008 it became very limited again

6. Comparison between responses from HCMC PC customers and PC2 customers

The score for each answer category was calculated in the following way:

- For each answer to the questions about the power supply amount, reliability, outages, voltage fluctuation and voltage level, the following points were given:
  4 points for “High” or “Excellent”;
  3 points for “Fair”;
  2 points for “Low” or “Poor”;
  1 point for “Very Low” or “Very Poor”; and
  0 point for “N.A.”
- The Score for each answer category was calculated by multiplying the above-mentioned points by frequency.

- Scores were standardized for comparison between HCMC PC customers and PC2 customers (so that they would range from 0 points to 100 points)

Differences between "Before 2002" and "After 2002" are generally higher with PC2 customers than HCMC PC customers.

HCMC PC customers (located in HCMC)

	Amount	Reliability	Outages	Voltage fluctuation	Voltage level
Before 2002	1	8	18	2	1
After 2002	1	25	4	0	0
Difference	11	16	25	11	(7)

PC2 customers (located in other areas)

	Amount	Reliability	Outages	Voltage fluctuation	Voltage level
Before 2002	1	3	10	1	0
After 2002	0	14	7	0	0
Difference	43	63	55	60	55

Box 2. Results of theFocus Group Discussion with Farmers in Binh Thuan Province

1. Time and place

11 November 2008 at Vo Xu town, Duc Linh district, Binh Thuan province

2. Participants

Total 23 participants (15 male and 8 female)

3. Discussion on the question: "How did the project change your life?"

The number after each comment is the number of votes given by participants (each participant had three votes and were asked to allocate their votes to the "changes" that they thought most important).

Top five "changes" that participants consider most important:

1) Support for production by more cultivated areas and diversified cultivation – 20;
2) Unregulated water release caused a negative impact to production – 14;
3) Change in the life of rural areas, people are happy – 10;
4) Less floods – 5;
4) Reduction in environmental pollution – 5.

2.4.2 Environmental Impact

The environmental impact assessment (EIA) for this project was approved by GOV in April 1994. According to EIA, the project site was not located in a protected area and no endangered species existed in the area. During construction, the Departments of Science, Technology and Environment (DOSTE) of Lam Dong province and Binh Thuan province monitored water

quality, air quality, noise level and vibration level once a month. After the hand-over, the DHD Hydropower Company has been monitoring water, air, noise and vibration once a year. According to the results of monitoring and interviews with the provincial governments and the DHD Hydropower Company, no environmental problem has been detected.

2.4.3 Impact of Land Acquisition and Resettlement

(1) Affected Areas and Population

A total of 6,827ha of land was acquired for the project: 3,144ha for reservoirs, 3,175ha for the power plants, 64ha for roads and 444ha for transmission lines and substations[12]. Accordingly, a total of 3,209 households were affected and thus compensated/assisted by the project:

- 823 households moved out of the reservoir areas. Among them, 150 households moved to the resettlement site in the La Da commune, Ham Thuan Bac district, Binh Thuan province, which was developed by the project, and others moved to nearby districts in the same province such as Bao Lam district and Di Linh district. Most of these had already moved out of the reservoir areas when the project appraisal was conducted[13].
- 345 households removed their houses from land acquired for transmission lines and substations.
- Some part of the land, trees and crops of the remaining 2,041 households was affected.

(2) Compensation and Support by the Project

The project provided the following compensation and/or support to people affected, with close consultation with the local authority:

- For 150 households in La Da commune: the building of (i) 150 houses (main house, kitchen and poultry house) and 3ha of cultivation area next to each house, (ii) 1 clinic, (iii) 1 primary school, (iv) a commune road, and (v) irrigation schemes. Cash payment was not made.
- For people who moved to the Loc Nam commune, the Bao Lam commune and the Hoa Bac commune, Di Linh district: 30.4 billion VND for the building of irrigation schemes (including 1 reservoir/dam for the irrigation of 100-140ha for each district) and a total 12.9 billion VND for support in moving and agriculture.
- For people affected by land acquisition for transmission lines and substations: 44.5 billion VND in cash as compensation.

[12] No planned figures are mentioned in appraisal documents.

[13] Residents around the reservoir areas belong to the *K'ho* tribe, an ethnic minority group, who had traditionally practiced shifting cultivation. Among the affected people, 66 households had already been resettled in the La Da commune, where their relatives had lived, and 84 households were identified as additional subjects for resettlement. As those 84 households wanted to move to the La Da commune, the project prepared 150 houses, including ones for people who had moved in earlier to avoid conflicts between new and old settlers.

HPPMU6 still has close communication with the commune, district and provincial governments to follow-up on the above-mentioned infrastructure.

(3) Impact of Land Acquisition and Resettlement

Basic indicators. Statistics from the La Da commune show significant changes in many aspects of people's lives after the project developed the commune as the resettlement site (Table 5).

Table 5: Basic statistics of the La Da commune (resettlement site)

	Before the project (1995)	After the project (2007)
Total area		11,212ha
Population		600 households (K'ho tribe)
Household electrification rate	0%	100%
Access to clean water	0%	100%
Household motorcycle ownership rate	13%	70%
Household TV ownership rate	12%	90%
Per capita food consumption	89kg/year	320kg/year
Cultivated area	7,673ha	1,700ha
Cropping season per year	1	2-3
Livestock head	200 head	Over 1,000 head
Number of children per family	Sometimes 13	4
Number of primary schools	2	3 (*)
Number of secondary schools	1	1
Number of health clinics	0	1(*)

Source: La Da commune People' Committee

Note: Additional primary schools and health clinics are the ones constructed by the project.

Focus group discussion with resettled people. On 12 November 2008, the ex-post evaluation team conducted a focus group discussion with 20 settlers in the La Da commune. In response to the discussion question "How did the project change your life?", participants emphasized negative comments such as "concern about high voltage transmission lines", "unclear land use rights", "greater distance to their fields" and "degradation of houses" rather than a few positive comments such as improved houses and roads.

Houses and road built by the project (La Da)

Focus group with resettled people (La Da)

Primary school built by the project (La Da)

Questionnaire survey. In 2007, the Research Center of Social Development and Poverty Eradication conducted an impact study on people affected by this project in the La Da commune, the Loc Nam commune and the Hoa Bac commune[14]. A total of 350 residents were surveyed. In contrast to the above-mentioned focus group results, the survey results show a high satisfaction of respondents: 87.7% of respondents said they were satisfied with their current accommodation while 12.3% said they were not; 57.0% of respondents said the resettlement program was good, 13.4% said not, and 25.3% said there was no change. Also, survey results about changes in lives (production, health, education, culture, etc) were consistent with the trend of statistics shown in Table 5.

2.5 Sustainability

No major problem has been observed in the capacity of the executing agency, operation nor the maintenance system. Therefore, sustainability of this project is high.

2.5.1 Executing Agency and O&M Agencies

2.5.1.1 O&M System

No problem is detected in the organizational settings for O&M of the project facilities. The Da Nhim - Ham Thuan - Da Mi (DHD) Hydropower Company under EVN is responsible for O&M of the Ham Thuan - Da Mi hydropower plants including reservoirs and dams. Upon project completion, an interim operation management board (established by EVN, under the management of HPPMU6) was re-organized into the DHD Hydropower Company. Operation is carried out by Operation Department No. 2, and maintenance is carried out by Maintenance Department No. 2 with support from the Technology Department and the Planning & Materials Department.

Currently, Lam Dong Province and Binh Thuan Province have not provided the DHD Hydropower Company with land-use right certificates. Therefore, there is a possibility that people in the surrounding areas may invade the territory of the hydropower plants (mainly for cultivation) causing difficulties in the protection, monitoring and maintenance of the plants.

O&M of transmission lines and substations developed by the project is the under responsibility of the local power transmission companies of PTC4 (for 220kV system) and the local power distribution companies of PC2 and HCMC PC (for 110kV system).

[14] Research Center of Social Development and Poverty Eradication (Vietnam National University and University of Social Sciences and Humanities), *Estimation on Economical and Social Effects of the Ham Thuan-Da Mi Hydroelectricity Project*, July 2007.

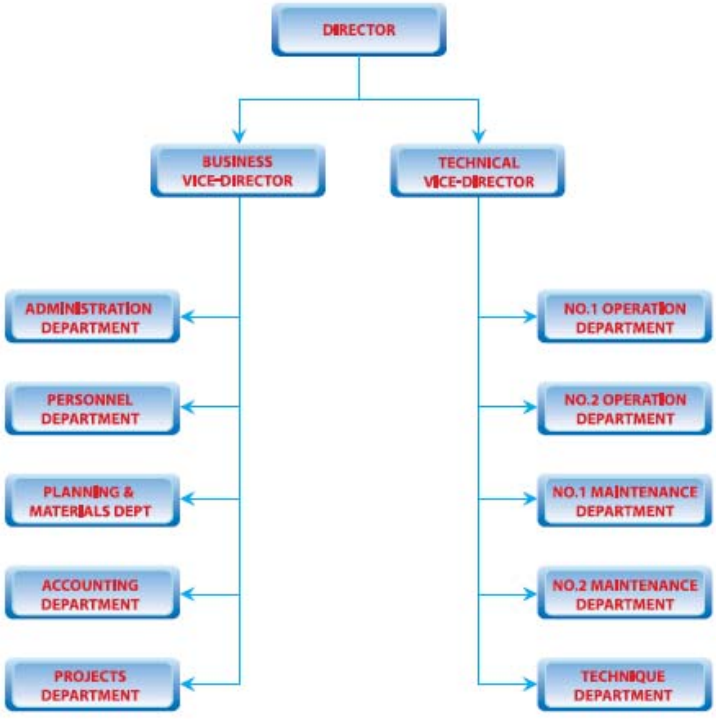
2.5.1.2 O&M Technical Capacity

The technical capacity of O&M staff is basically sufficient, although there are some areas where they need to rely on suppliers for repair.

The Operation Department of the DHD Hydropower Company has 48 staff including 12 Engineers. The Maintenance Department has 42 staff including 20 Engineers. According to DHD, the number and qualifications of the staff are sufficient for the O&M of most project facilities. As for training, 30 staff members of the Hydropower Company were trained by manufacturers and suppliers during the project. After completion, the Hydropower Company has continuously provided in-service training for its O&M staff. O&M activities are carried out according to the established procedures based upon O&M documents or equipment suppliers.

Most of the maintenance works are carried out by the DHD Hydropower Company themselves, but some must still be outsourced to a manufacturer who sells genuine equipment and services (e.g., Governor systems, excitation control systems from suppliers), which might affect timely maintenance and repair.

Figure 9: Organization chart of theDa Nhim-Ham Thuan-Da Mi Hydropower Company



Source: DHD

2.5.1.3 Financial Status of O&M

Table 6 shows that O&M cost for this project is covered by revenue. It is planned to increase the O&M budget by 10 million VND every year (Table 7). However, the electricity selling price is almost at the same level as the unit production cost. Currently, the DHD Hydropower Company is under the process of equitization.

As for transmission lines and substations, separate budget information on O&M of the project facilities was not available because power transmission companies and power distribution companies manage the O&M costs of the system as a whole. At least it can be said that the recent financial performance of the EVN group is quite good (Tables 8 and 9).

Table 6: Cost and revenues of the Da Nhim-Ham Thuan-Da Mi Hydropower Company

	2001	2002	2003	2004	2005	2006	2007	2008
Fuel	0	0	0	0	0	0	0	0
Material	2,614	3,307	3,496	3,079	5,257	5,387	8,958	6,070
Personnel	9,794	12,200	13,980	16,048	18,144	25,185	27,489	32,392
Asset depreciation	157,455	324,710	316,916	276,566	278,949	297,149	308,505	326,857
Outsourcing	622	889	1,052	986	871	1,452	1,465	1,682
Overhaul	7,501	9,849	13,625	12,416	21,989	16,474	15,187	31,278
Natural resources tax	-	-	-	-	4,102	40,385	44,801	38,126
Land lease	99	116	141	141	148	255	740	907
Interest on long-term debts	2,689	90,297	89,984	103,672	100,011	84,143	133,887	140,211
Meals allowance	752	825	1,300	1,339	1,431	1,572	1,793	1,681
Other expenses	4,168	5,967	7,784	7,302	7,555	8,245	8,676	8,255
Total cost	**185,694**	**448,160**	**448,278**	**421,550**	**438,457**	**480,247**	**551,501**	**587,459**
Unit cost of production (VND/kWh)	77.01	185.68	154.55	175.98	236.62	166.5	184.7	231.2
Electricity selling price (VND/kWh)						172.20	172.7	278.8
Revenue						**496,625**	**791,978**	**708,431**
Profit before tax						**16,378**	**240,477**	**120,972**
Profit after tax						**14,085**	**23,841**	**49,571**

Source: DHD Hydropower Company

Table 7: O&M cost and budget

(unit: Million VND)

	Actual O&M cost						O&M budget			
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Amount	16,943	7,470	78,817	86,990	95,705	109,859	120,000	130,000	140,000	150,000

Source: PCR Note: O&M cost excludes fixed asset depreciation and interest on long-term debts.

Table 8. Consolidated balance sheet of EVN group

	2005	2006	2007
Current asset-to-current liabilities ratio	186%	203%	195%
Cash-to-current liabilities ratio	125%	144%	137%
Capital-to-asset ratio	42%	38%	41%
Fixed asset-to-equity capital ratio	175%	188%	177%

Source: EVN

Table 9. Consolidated income statement of EVN group

(unit: million VND)

	2005	2006	2007
Total revenue	38,818,688	44,920,047	58,133,397
Gross profit	5,731,131	7,660,987	9,777,833
Profit after tax	2,327,253	2,256,201	3,335,853

Source: EVN

2.5.2 O&M Status

Maintenance of the hydropower plants is carried out in the following manner, which is in compliance with national s and the O&M manuals of manufacturers.

- Overhaul (every 4 year);
- Routine maintenance (every 2 years); and
- Regular checking (every year)

Currently, the conditions of the Ham Thuan hydropower plant are normal. However, as mentioned in *2.2 Efficiency*, some problems of the Da Mi generators have not been fully solved. Also, some equipment of the control system, the governance system and the excitation system is not produced any more, thus making it difficult to get replacements. Moreover, the price of such equipment is very high. Measures to bring the Da Mi hydropower plant back to normal conditions are still going-on. Meanwhile, the generators receive more frequent maintenance than regulated.

Maintenance works at Long Thanh substation

3. Conclusion, Lessons Learned and Recommendations

3.1 Conclusion

From the findings described above, this project can be evaluated at highly satisfactory.

3.2 Lessons Learned

(1) Project preparation

- Land acquisition and compensation were carried out well due to the support of local authorities and related agencies. Especially, the provision of land use rights, crops and forestry products for the protection of forests was timely, with the assistance of GOV and local authorities. The following considerations taken by the project could become good practices for future projects:
  - Encouraging people to understand government policies on hydropower construction;
  - Creation of favorable conditions in land acquisition as follows:
    + After the land inventory is finalized with local people, local authorities allowed the contractors/sub-contractors to start construction.
    + A task force was established to handle the forest tree issue in acquiring land in a timely manner for construction.
    + The compensation and support scheme was quickly appraised and approve to speed-up disbursement to tlocal people.
    + All obstacles were solved in a timely manner by the local authorities.
  - Maintenance of a regular good relationship with the province, district and commune People Committees, in a spirit of cooperation and collaboration to fulfill the tasks.
  - All obstacles should be discussed and solved with mutual understanding and concerns based upon the government's policies and regulations.
  - Minimization of the use of official letters and report (if not necessary). The use of these management tools is always time consuming and ineffective.
- Geology conditions were different from the survey & investigation even according to procedure – random sampling. Surveys should have been done in better way (i.e. by increasing the number of investigation drills) to avoid delays due to re-investigation and re-design at the construction stage.

(2) Implementation

- With the participation of operation agencies in the construction stage (i.e. as a member of the interim operation management board), experience was enriched for O&M. Future projects could follow this good practice as a means to improve sustainability.

(3) Operation and maintenance

- Incorporate technical transfer. In the construction of hydropower plant projects, if

financial conditions allow, the investor could consider buying technology and know-how of manufacturing as well as copy rights (technology transfer) for key equipment such as: the governor system, excitation system, control system and protection control system. Technology transfer would help a project be less dependent on the original equipment supplier and minimize operation stoppages.

3.3 Recommendations

(1) Completion of all project components

- The DHD Hydropower Company should continue measures to solve the problems of the Da Mi generators seeking advice from HPPMU6.

(2) Improvement of the operation system

- Lam Dong and Binh Thuan should quickly provide land use rights to the Ham Thuan-Da Mi hydropower plant so that the power plants and related facilities can be properly operated and maintained without encroachment by people in the surrounding areas.

Comparison of Original and Actual Scope

Item	Plan	Actual
1. Output 1) Ham Thuan hydropower plant	a) Installed capacity: 300MW (150MW x 2 units) b) Total volume of reservoir: 695 million m3 c) Main dam: rock fill; H=91m	a) Same as planned b) 695.23 million m3 c) Rock fill; H=93m
2) Da Mi hydropower plant	a) Installed capacity: 175MW (87.5MW x 2 units) b) Total volume of reservoir: 141 million m3 c) Main dam: rock fill dam; H=69m	a) Same as planned b) Same as planned c) Rock fill dam; H=72m
3) Transmission lines 110kV and 220kV	6 sections total 495m	6 sections total 282.2km
4) Substations (S/S)	a) Expansion of Bao Loc S/S: 220/110/35kV–63MVA and 110/22kV-25 MVA b) Construction of Phan Thiet S/S: 110/22kV-2x25MVA c) Construction of Duc Linh S/S: 110/22kV-16MVA	a) Additional: spare bay 110/22kV-25 MVA b) Same as planned c) Same as planned d) Construction of Long Thanh S/S: 220/110kV–250MVA
4) Consulting services	Foreign: 763MM Local: 1,300MM	Foreign: 696.5MM Local: 1,252.5MM
5) Development of resettlement sites	150 houses and other necessary infrastructure	150 houses, road, utilities, school, clinic, irrigation scheme
2. Project Period	April 1995 – December 2000	April 1995 – July 2001
3. Project Cost Foreign Currency Local Currency Total ODA Loan Portion Exchange Rate	 42,756 Million Yen 25,619 Million Yen (2,561,900 Million VND) 68,375 Million Yen 58,118 Million Yen VND= 0.01Yen (As of August 1994)	 35,795 Million Yen 5,943 Million Yen (258,000 Million VND) 41,738 Million Yen 35,795 Million Yen 1 VND = 0.0082Yen (Average during period from 1996 to 2007)