Malaysia

Rehabilitation of The Tenom Pangi Hydropower Project

Field Survey: August 2003

1. Project Profile and Japan's ODA Loan

Site location map

Entrance to Tenom Pangi Hydroelectric Power Plant

1.1. Background

Tenom Pangi Hydroelectric Power Plant went into operation in 1984 as the core power plant supplying electricity to western coastal regions of Sabah state, Malaysia (an area centered round Kota Kinabalu that accounts for 40% of the state's electricity consumption), and is the only large-scale hydroelectric power plant in the state. It is situated on the banks of the Padas river on the outskirts of Tenom city some 120 kilometers to the south of the state capital, Kota Kinabalu.

The plant has a generation capacity of 66 MW (3 × 22 MW generators) and covered a little over 50 percent of peak demand (123.1 MW) in the west coast region when the operation started. However, the Padas river flooded as the result of heavy rains throughout September 1988 (250.1mm of rain was recorded for the month) causing damage to the water intake gate and other facilities (trash protection, vertical gates, etc.) and hindering the operation of the power plant. This resulted in the suspension of power supplies due to the unplanned suspension of operations at the plant, leading to the loss of stable power supplies. In order to put an end to this problem and restore the plant to its original state, the implementation of urgent and appropriate rehabilitation work was a pressing issue.

1.2. Objectives

To eliminate problems relating to the operation and maintenance of the Tenom Pangi Hydroelectric Power Plant through the rehabilitation of those existing facilities and equipment that had sustained damage due to flooding and thereby, to contribute to efficient supply of power.

1.3. Outputs

The project comprised the following four scope components:

(1) Trash control system

- Installation of a movable protection rack, installation of a trash boom, reinstallation of a trash

screens, installation of strainer and sand separator, etc.

(2) Civil engineering works

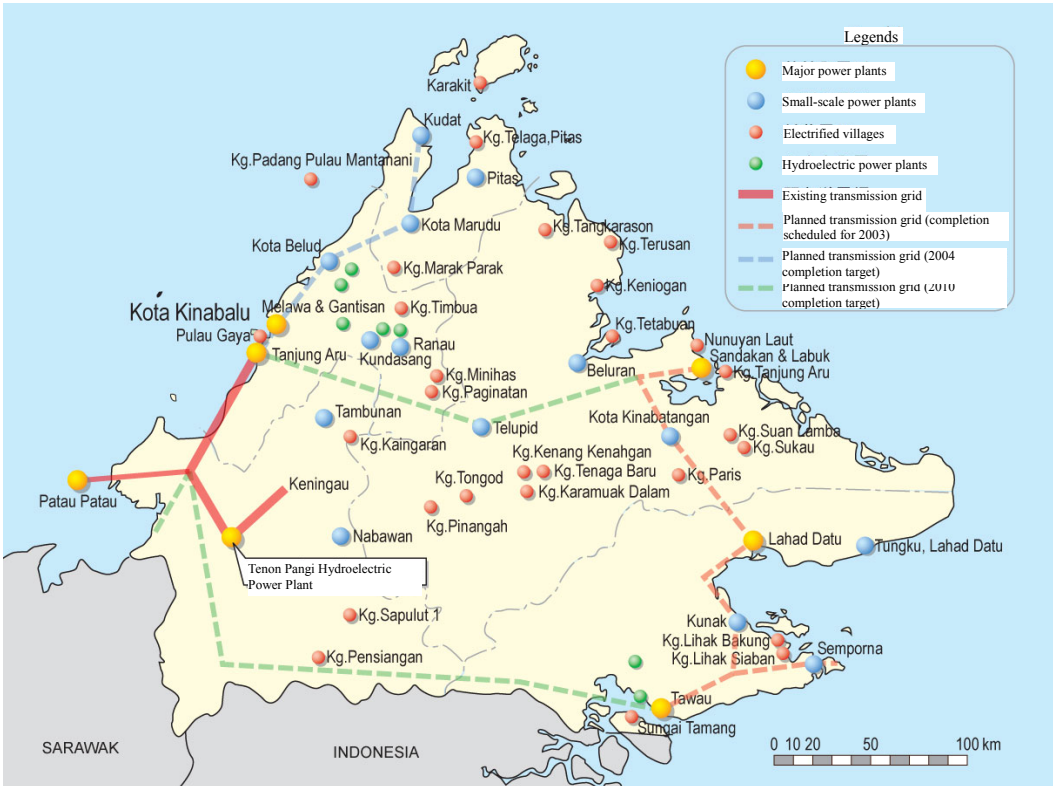
- Protection of the riverbed and access roads, etc.

(3) River flow rate prediction system

(4) Consulting services

- Bid / contract assistance, supervision of the construction works listed in (1) to (3) in the above.

Figure 1: Sabah Power Supply System (power stations and core transmission grid) and the location of Tenom Pangi Hydroelectric Power Plant



Peak demand in Sabah was 447 MW (for the entire state) in 2002, and according to the forecast of SESB (the executing agency), it is expected to grow at a rate of 7.9 percent annually (median forecast). SESB is pushing ahead with the development of generation facilities and the transmission grid in order to respond to this growth in demand. It has set 2008 as the target for power generation infrastructure development and is promoting the switch away from oil-fired capacity to a system that is dependent on natural gas and coal (in eastern regions), and to a system that is capable of receiving power from the large-scale hydroelectric electricity generation plants (the Bakun Dam Hydro Project being implemented by SESCO) that are envisioned for Sarawak state.

In terms of transmission grid infrastructure, the eastern grid (Sandakan-Lahad Datu-Tawan-Semporna) is scheduled to start operating in August 2003. Meanwhile, the northern grid (Kudat- Kota Belud-Kota Kinabalu) is scheduled to be completed by 2004. Added to which, there are plans to connect an east-west grid (Kota Kinabalu-Liwagu-Sandakan) by 2010. Note that if the

aforementioned plans to receive supplies from Sarawak are to be realized it will be necessary to construct transmission facilities linking Sarawak to the western grid.

1.4. Borrower / Executing Agency

Malaysia / Sabah Electricity Board (SEB: currently known as Sabah Electricity Sdn. Bhd.: SESB)

1.5. Outline of Loan Agreement

Loan Amount	543 million yen
Loan Disbursed Amount	299 million yen
Exchange of Notes	May 1992
Loan Agreement	May 1992
Terms & Conditions	
Interest Rate	3.0%
Repayment Date	25 years
(Grace Period)	(7 years)
Procurement	General untied
Final Disbursement Date	September 1999

2. Results and Evaluation

2.1. Relevance

Since its completion in 1984, the Tenom Pangi Hydroelectric Power Plant has covered a little over 50 percent of peak demand in the west coast region of Sapah state. However, flooding in 1998 caused damage to equipment near the water intake gate, which resulted in an unplanned suspension of operations (and the destabilization of power supplies). This rehabilitation project was implemented with the aim of addressing these circumstances.

At the appraisal, the Sabah state power supply expansion plan (1986-2000) called for the stabilization of power supplies, which was consistent with the objectives of this project. At the evaluation, the state's long-term plan (Outline Perspective Plan Sabah 1995-2010) states that power supplies are to be restored / stabilized in order to support economic activity in the west coast of Sabah state, as the center of economic development, thus the project is considered to have been highly relevant both at appraisal and evaluation.

2.2. Efficiency

2.2.1 Outputs

Project outputs comprised a trash control system, civil engineering works, and a flow rate prediction system. This project was implemented with two packages. Package 1 involved the construction / installation of a movable protection rack, trash boom, and trash screens

(reinstallation), etc. designed to protect power generation water intake function and generation equipment, in addition to civil engineering works, including bank protection work near sediment / intake gates, riverbed protection work, etc. Package 2 involved the installation of the flow rate prediction system (at three upstream locations with different water levels). All outputs were executed in line with the original plans.

2.2.2 Project Period

The project was completed in January 1998, approximately three years behind the original schedule (December 1994). Completion was delayed for two reasons firstly because the consultant selection process took just under two years longer than planned and secondly because procurement and construction processes were held back by several months due to torrential rain. In connection with the delays in consultant selection, the appraisal documents indicate that it was not possible to reach consensus on the Malaysian government's policy of utilizing local resources, including for consulting services, and the terms for consultant procurement that were in place at appraisal. Ultimately, a global standard consultant was recruited.

2.2.3 Project Cost

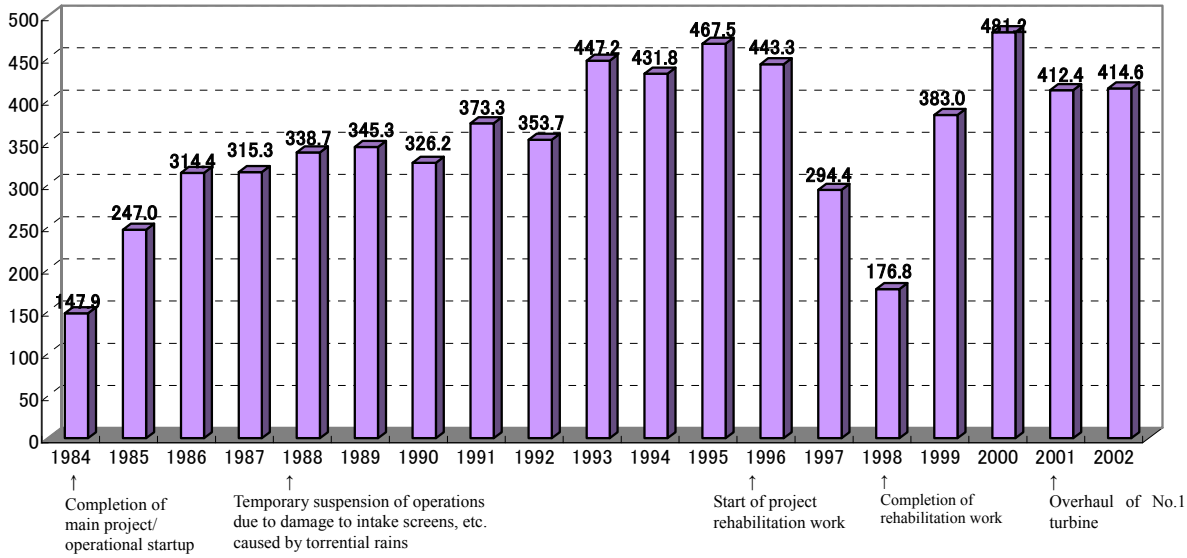
Total project costs amounted to 485 million yen (on a construction order price base) against the original budget of 725 million, in consequence of efficient ordering achieved through competitive bidding etc. The final disbursement was around 60 percent (299 million yen) of the originally budgeted loan amount (543 million yen).

2.3. Effectiveness

(1) Stable Power Supplies

Figure 2 shows electricity generation from 1984 (project completion) to 2002. The power plant started operating in 1984 with electricity production increasing steadily thereafter; however, flood damage caused by heavy rains in 1988 made it necessary to regulate output until 1992. In consequence, actual generation has hit the ceiling (average electricity generation for 1988-1992: 347 GWh/year; equipment utilization rate: 60%) at less than the planned volume of 475 GWh/year (an equipment utilization rate of 82%). In 1993 the executing agency implemented various emergency measures, including the installation of trash screens, resulting in electricity generation averaging 449GWh/year until 1995: the year this project was initiated. However, these emergency measures were not sufficient to withstand additional flood damage and permanent rehabilitation work (this project) was thus executed between 1996 and 1998. It was necessary to regulate operations at the power plant whilst the work was in progress, thus average output was 305GWh/year during the implementation phase.

Figure 2: Electricity Generation at Tenom Pangi Hydroelectric Power Plant (GWh/year)



Source: SESB

Post-completion output averaged 423GWh/year between 1999 and 2002, with the Tenom Pangi Hydroelectric Power Plant accounting for one seventh – up from one sixth – of total state output (2,700 GWh in 2002). The output target of 475GWh/year was exceeded in 2000, when the plant generated 481GWh/year but dropped again in 2001 and 2002; however, this is attributed to the overhaul of the No. 1 turbine. In view of the fact that the turbine has now been refurbished, the plant is expected to generate stable, high-volume supplies of electricity from 2003.

(2) Recalculation of Financial Internal Rate of Return (FIRR)

Following the calculation methods used at appraisal, the FIRR of this rehabilitation project was recalculated as 9.2 percent, which is slightly lower than the initial figure of 9.4 percent. Project benefits were assumed to be the output lost by the suspension of generation operations (opportunity losses covered by the project), which is now avoidable thanks to the implementation / completion of this project (assumed to be generated over a 50-year period from project completion through 2033), whilst costs were taken as actual project costs, maintenance costs, and opportunity losses consequent upon the suspension of operations during the implementation phase. The recalculated FIRR is on a par with the initial figure, despite a slight delay in the onset of benefits due to the holdup in project completion, because project costs were kept well within budget.

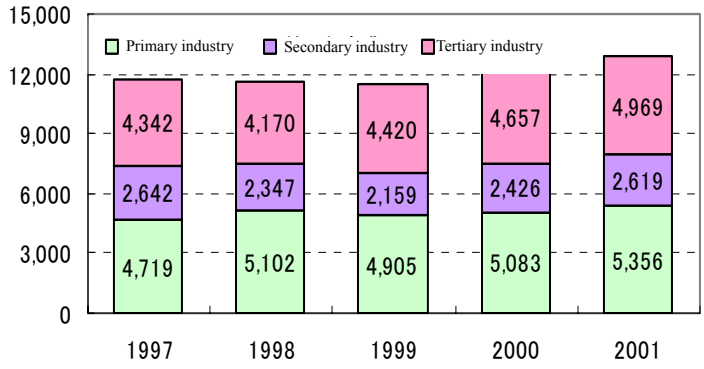
2.4. Impact

(1) Contributions to stable livelihoods and the regional economy

Gross regional production (GRP) for Sabah stagnated until 1999 as a result of the Asian currency crisis at the end of the 1990s, but it began recovering in 2000 and has been back on track for growth since (Figure 3). Since project completion, economic growth has averaged 6.2 percent

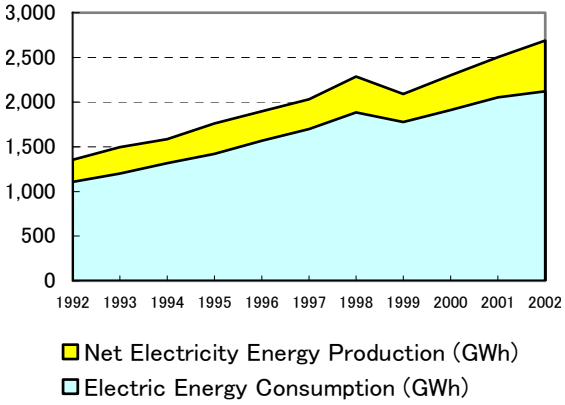
in Sabah state (1999-2001) (national average: 4.2%), and as a key power plant generating approximately 15% of state output, Tenom Pangi is believed to be supporting economic growth and the stable livelihoods of state citizens (population: approx. 2.4 million). Looking at the trends in state electricity consumption and output shown in Figure 4, it is clear that economic recovery bring an tendency to increase in both parameters and that stable supplies are thus necessary to support economic growth in Sabah.

Figure 3: Industry-specific GRP in Sabah (million MYR at 1987 prices)

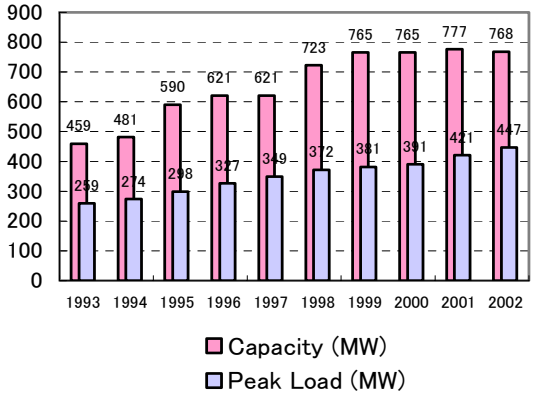


Source: Sabah State Statistics Bureau

Figure 4: Electricity generation & consumption (left: GWh/year) and total generation capacity (right: GWh)



Source: as above



Source: as above

(2) Environmental and Social Impacts

According to the project's executing agency, SESB, there has been no evidence of any issues or problems of particular concern from an environmental perspective. On the contrary, the project is expected to have positive impacts in curbing bank and riverbed erosion in areas downstream of the power plant's water intake gates. The project did not involve any land acquisition or relocation of local residents.

2.5. Sustainability

2.5.1 Executing Agency

(1) Technical Capacity

Tenom Pangi Power Plant has a full-time payroll of 76 employees, and according to the plant's manager staff numbers are adequate at this time. Furthermore, the plant manager reports that it was possible to achieve appropriate technical transfer during the implementation phase, and technical levels are evaluated as being appropriate.

(2) Operation and Maintenance System

Tenom Pangi Power Plant is operated and maintained by SESB (Sabah Electricity Sdn. Bhd.). SESB was established in 1963 as the government owned Sabah Electricity Board (SEB) and was responsible for all generation, transmission and distribution of power within the state. It was privatized in 1988 when the national power utility (TNB: Tenaga Nasional Berhad), which controls the Peninsular's power supply system, took a stake in the company.

2.5.2. Operation and Maintenance Status

The generator capacity of Tenom Pangi Hydroelectric Power Plant was 66 MW at the evaluation time point, thus maintaining the original level (problems with the No. 1 turbine in 2000 were properly repaired), and the various generation equipment is in favorable condition. Of the facilities and equipment rehabilitated / provided in this project, the movable protection rack, and trash screens in front of the water intake gates, and the civil engineering facilities on the river are all in good working order. Although the plant failed to provide various financial data pertaining to maintenance when this survey was undertaken, in view of the aforementioned fact that the plant has been in favorable operating condition since project completion, it is assumed that there are no notable problems in terms of securing the maintenance budget. However, some equipment (the trash boom, strainers and sand separator, and the flow rate prediction system) are not fully functional. The condition of these facilities after project completion is detailed below.

1) The float belonging to the trash boom that was set up under Package 1 was washed away during flooding a few weeks after the completion (1998) and currently only wires and winch remain in position. Since then, the water intake gate has sustained no damage even without the trash boom; however, SESB is currently investigating measures to repair the facility with support from the research and development section of its parent company TNB (the company that supplies power to the Peninsula).

Figure 5: The Trash Boom

The trash boom was attached to the front of the water intake gate to trap driftwood and large debris. During flooding that occurred after the work was completed the float that was attached using wires / cables was washed away and only the wires and winch now remain in position.

2) Also installed under Package 1, the strainer and sand separator for turbine coolers became dysfunctional a few weeks after the completion / handover. The plant has responded by switching back to the old system that was formerly in use.

Figure 6: Silt Separation Equipment

The strainer and sand separator installed in this project; it became dysfunctional shortly after the installation.

3) The flow rate prediction system that was set up at three upstream locations on the Padas river (Kemabong、Ansip、Biah) under Package 2 has not been functioning since sometime in 1999. Silt incursion has caused equipment to become clogged and solar panels attached to the equipment have been stolen. SESB has given up repairing the system and is currently investigating the purchase of a new flow rate prediction system in conjunction with the State Drainage and Irrigation Bureau.

Figure 7: The Flow Rate Prediction System

The water level monitoring system in the upstream Kemabong district. It is not currently functional. Two small huts are visible in the photo on the right: the smaller of the two (back right) is the well for measuring water levels, the hut on the right-hand side of the road stores records with solar-powered generator.

3. Feedback

3.1. Lessons Learned

None.

3.2. Recommendations

(To the executing agency)

To ensure the sustainability of project effects, it is necessary to rehabilitate / replace equipments (trash boom, strainer and sand separator, and flow rate prediction system) as appropriate.

Some of the equipments procured using project funds (trash boom, flow rate prediction system) has been damaged due to flooding or stolen, and is thus not functioning as planned. Should floods such as those experienced in 1988 and 1998 (when the flow rate exceeded 300m^3/second) recur, there were the risk of unplanned operational suspensions similar to those already occurred, and thus appropriate, immediate rehabilitation / replacement (purchase) of equipment is deemed necessary.

Comparison of Original and Actual Scope

Item	Planned	Actual
1. Outputs		
Trash control		
1) Trash boom	1 set	As planned
2) Movable protection rack	1 set	
3) Reinstallation of trash screen	1 set	
4) Strainer and sand separator	1 set	
5) Water level differential detection system	1 set	
Rehabilitation of civil engineering facilities		
1) Front footholds of side walls / apron foot protectors	1 set	
2) Gabion retaining wall	1 set	
3) Gradient protection on access roads	1 set	
Upgrade of flow rate prediction system		
1) Flow rate prediction system	1 set	
Consulting services	International consultant: 20.90 M/M Local consultant: 25.50 M/M	International: 21.24 M/M Local: 25.70 M/M
2. Project period		
L/A	May 1992	As left
Consultant selection	January 1993 – March 1993	January 1995
Consulting services		
Preparation of bid documents	April 1993 – May 1993	April 1995
Bid	June 1993 – July 1993	
Evaluation and approval of bid	August 1993 – September 1993	June 1996
Negotiations / conclusion of contract	October 1993	
Construction work		
1) Trash control	July 1994 – November 1994	September 1996 – January 1998
2) Rehabilitation of buildings	July 1994 – December 1994	September 1996 – January 1998
3) Upgrade of flow rate prediction system	July 1994 – October 1994	September 1996 – July 1997
3. Project costs		
Foreign currency	482 million yen	Unknown
Local currency	243 million yen	Unknown
Total	725 million yen	485 million yen * contract order base
- ODA loan portion	543 million yen	299 million yen
Exchange rate	1 Malaysia Ringgit = 46.6 yen (1994 rate)	Unknown

Third Party Evaluator's Opinion on
Tenom Pangi Hydroelectric Power Plant Rehabilitation Project

Tan Sri Datuk Mohamed Khatib Abdul Hamid
Former Ambassador
Chairman
National Heart of Institute

Relevance

In terms of reference, it cannot be denied that the hydroelectric project is indeed very relevant as the supply of electric power is vital to socio-economic development of the state of Sabah, Malaysia.

The damage to the facilities in 1998 was regrettable and entirely attributed to unexpected heavy flooding. However, rehabilitation work was necessary and appropriate.

It is noted that the utmost care has been taken in the conception, planning and execution of the project and the execution of the said project has not resulted in any adverse impact on the population as well as the environment.

From my observation, in the process of the implementation of the project, especially at the construction phase, one of the spillover/ancillary benefits of such a huge project are the inherent contribution to the development of skills in the industry.

Sabah Electricity Sdn Bhd has deemed the project successful in providing reliable and cheapest (cost-effective) provision of power supply and is now conducting a feasibility study with a view to upgrade the power plant capacity.

Efficiency, effectiveness, impacts and sustainability

The efficiency, effectiveness, impact and sustainability of the project depends on the efficiency and professionalism of the Management as well as the full utilization of power generated for the socio-economic activities which contribute to increase in income and well being of the population covered by the project.

Another indicator of the socio-economic impact of this project has been the effective hand-over of the project and the fact that there was adequate local expertise able to facilitate the transfer.

Local involvement is also assumed at the construction stage. Thus a further positive impact on the local community.

From the report, I do not see any cost over run from the implementation of the project. The project has been constructed based on international standards and specifications. Therefore, introducing these high standards into the local construction industry.

By most standards, this project is a success. Most importantly it has directly contributed to the development of the local economy and the improvement of the quality of life for the people.

It is imperative that rural communities have proper, modern utilities that serve as a cost efficient, reliable source of energy.

Cost efficient and reliable production of such energy is essential for the sustainability of local industry and subsequently the improvement of the community's standard of living.

Therefore, this project is a success as it directly contributes to the development of the local economy and the improvement of the quality of life for the people.