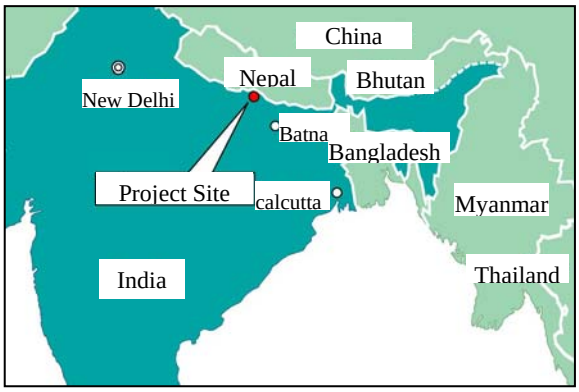
India

Eastern Gandak Canal Hydroelectric Project

Field Survey: July 2003

1. Project Profile and Japan's ODA Loan



Project Site

Power plant viewed from the lower reaches of the purpose-built channel

1.1 Background

Bihar is one of the poorest states in India. Its poverty derives from a quite inadequate industrial base, and the electric power sector is no exception. Annual power consumption per person in FY1982 was 83.2 kWh, approximately 60% of the national average. The electrification rate in rural areas was as low as 44%. The main power source was thermal power generation. There existed a huge gap between supply and demand of electricity and power supply was unstable. For example, the power shortage rate in FY1982 was 22.0%, over twice as high as the national average of India (9.4%), indicating the seriousness of the power shortage in Bihar State. In fact, the state had to purchase electricity from other states.

The 7th Five Year Plan (FY1985-1989) set forth a goal of increasing the electric power sector's power generation capacity and annual power generation to 1,669MW and 8,200GWh, respectively. However, the Central Electric Authority estimated the peak time demand in Bihar in FY1990 at 2,200 MW（requiring an installed generation capacity of 3,666 MW）and predicted that annual demand for power generation would reach 12,485 GWh. In this case, the power shortage rate was estimated at 48% in terms of installed generation capacity and 34% in terms of volume of electricity. In Bihar State, which suffered from total power shortages, scheduled outages often took place and this situation was expected to continue.

In order to reduce the supply-demand gap for electricity and make power supply more stable, the Bihar State Government was committed to promoting development of hydropower. In particular, small-scale hydroelectric power generation using idle heads of irrigation canals was promoted as it was expected to contribute to regional development.

1.2 Objectives

The project's objectives were to ease power shortage in Bihar State by constructing a bypass channel for power generation along the Eastern Gandak Irrigation Canal in the northwestern part of Bihar,

and conducting low-head power generation[*1], and thereby contribute to the economic development of the region.

1.3 Output

The planned outputs of the project were as follows:

(1) Power generation and transformation equipment

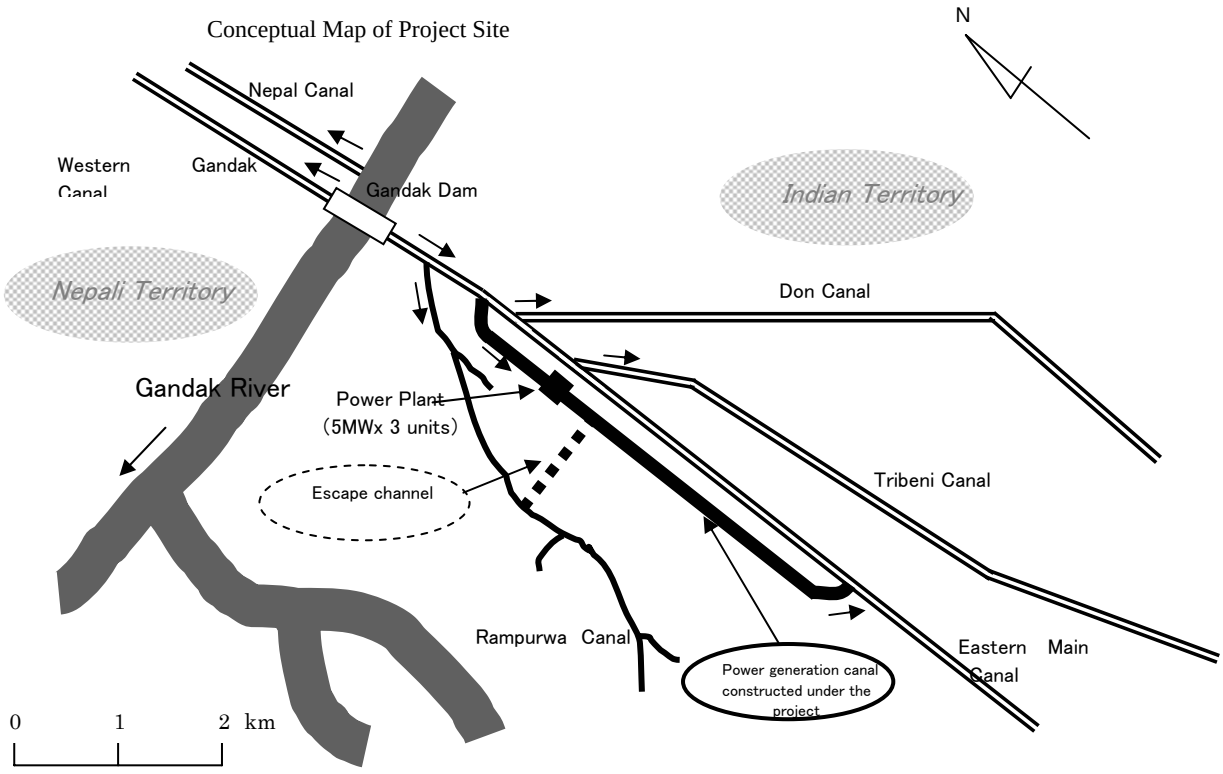
- Hydraulic turbine (valve-regulated tubular) rated output: 5,155 kw×3 units
- Generator rated output: 5,000 kw × 3 units
- Transformer capacity: 10,000 kVA × 2 units
- Other equipment switches, cranes, etc.

(2) Canal built for power generation total length: 4,300m (headrace channel: 1,067m; tailrace channel: 3,230m)

(3) Transmission line (132 kV) 2km

(4) Others lodgings, etc.

Among the estimated total project cost of 5,260 million yen, the entire foreign currency portion (1,630 million yen) was to be covered by the ODA loan. The local currency portion was to be financed by the Indian side (executing agency).



[*1] Hydroelectric power generation at a low-height dam.

1.4 Borrower/Executing Agency

Borrower: President of the Republic of India

Executing Agency: Bihar State Hydro Electric Power Corporation Ltd (BHPC)

1.5 Outline of Loan Agreement

Loan Amount / Loan Disbursed Amount	1,630 million yen / 1,628 million yen
Exchange of Notes / Loan Agreement	August 1984 / December 1984
Terms and Conditions -Interest Rate -Repayment Period (Grace Period)	 3.25% 30 years (10 years) Partially untied
Final Disbursement Date	July 1996

2. Results and Evaluation

2.1 Relevance

As stated above, there was a strong need to reduce the gap between power supply and demand in Bihar State at the time of appraisal (1984). The project was also highly necessary to develop the economy in the Eastern Gandak Region, where the power plant was constructed.

The project began to generate good results during the 9th Five Year Plan (FY1997-2001) and was consistent with the plan's policies such as "promotion of hydroelectric power generation" and "promotion of regional electrification." The necessity for hydroelectric power generation is also emphasized in the "9th Plan" (FY1997-2001), a Bihar State development plan. Therefore, the project was and is considered to be sufficiently relevant under government policy both at the time of the appraisal and today.

2.2 Efficiency

2.2.1 Output

Project outputs are composed of 3 elements: 1) power generation and transformation equipment, 2) a canal built for power generation, and 3) transmission lines. While 1) was implemented as initially planned, some changes were made to 2) and 3) as explained below.

Canal for power generation

The length of the headrace channel and the tailrace channel were extended from the planned 1,067m and 3,230m to 1,432m and 4,282m, respectively. According to the executing agency, the canal route was changed because it required long time to obtain permission to construct the originally planned route through the forest.

Transmission lines

The total length was extended from the planned 2km to 15km. The transmission line was extended to the neighboring substation in Nepal because the voltage of the originally planned terminal substation was too low. BHPC funded the original 2km and the Bihar State Electricity Board (BSEB) bore the additional costs.

2.2.2 Project Period

At the time of the completion and the start of operations of the No.3 unit, which was the final stage, the project was almost 10 years behind schedule. The planned and actual implementation period of each process is shown below.

Planned and Actual Implementation Period

	Plan (month/year)	Actual (year)
Preparatory work	Nov. 1983 - Oct. 1984	Not known
Site acquisition	Nov. 1983 - May 1984	1985 - 1990
Construction of headrace and tailrace	Oct. 1984 - 1987	1986 - 1993
Construction of power plant	Oct. 1984 - Nov. 1986	1988 - 1992
Procurement of equipment and materials	Dec. 1983 - Oct. 1986	1984 - 1994
Construction of switch yard	Feb. 1985 – May 1987	- 1994
Installation and start-up of power generators	Aug. 1986 – Oct. 1987	- 1997

It seems that many factors combined to cause project delays. As a long period of time had passed since the start of the project, it was difficult to analyze the causes of the delays in detail. The followings are the main causes of the delays according to the interim monitoring survey conducted by JBIC in March 1993.

Shortage of local currency funds

The Bihar state government had difficulty securing funds for the local currency portion.

Delay in government procedures

In this project, obtaining forest clearance took so long that the route of the power generation canal had to be changed, causing delay.

Other causes of delay were shortage of electricity for construction, difficulty in local procurement of necessary materials (especially fuel), and unusually heavy rainfall.

Those delays on the entire project affected the construction procedure of the escape channel and it remained incomplete.

Currently, however, the Executing Agency has been implementing the construction of the escape channel on their own budget.

2.2.3 Project Cost

The initially estimated and actual project costs are compared below.

Item	Estimate (in yen terms)	Actual Cost	Percentage Compared to Estimate
Electric engineering	3,014 million yen	2,817 million yen	93.5%
Civil engineering	2,244 million yen	1,409 million yen	62.8%
Total	5,260 million yen	4,226 million yen	80.3%

*Exchange rate at the time of the appraisal: 1 rupee ＝ 22 yen. As for the actual cost, the average annual rate during the implementation period (1 rupee = 9.85 yen) was applied because the implementation period extended over a long time and foreign exchange rates fluctuated.

In terms of local currency, the project cost was initially estimated at 239.1 million rupees, while the actual cost came to 429 million rupees (179.5% of the estimate). Details are unknown because the actual costs by item are not available. The executing agency mentioned the increase in the amount of construction materials and extension of the construction period as the main causes. The executing agency received financial support from the state government and financial institutions for the shortfall. In terms of foreign currency, actual project cost turned out to be 80.3% (4,226 million yen) of the estimate (5,260 million yen) due to depreciation of the local currency at a greater rate than the inflation rate.

2.3 Effectiveness

2.3.1 Operation of power plant

The operational data on the power plant provided by the executing agency are shown below.

Operation of Eastern Gandak Canal Hydroelectric Power Plant

FY	1995 (Construction completion)	1996	1997	1998	1999	2000	2001	2002
Total Power Generation (GWh/Year)	-	7.61	22.27	27.35	20.22	25.02	25.76	26.46
Net Electric Energy Production (GWh/Year)	-	-	21.43	26.44	19.37	24.01	24.78	25.37

Note) “Construction completion” in 1995 means that the construction was practically completed.

Annual total power generation

Annual total power generation is maintained at less than one-third of the initially planned amount (90-103 GWh/Year). This is because the maximum output is 6-7 MW against the planned 15 MW. Of the output, 2-3 MW (initially planned to be 5MW) of electricity is supplied to the local region and the rest is distributed all over Bihar State via the state’s power transmission network (grid).

Unplanned outage hours

Unplanned outage hours have been maintained at a reasonable level for a hydroelectric power plant except for FY2001[*2].

[*2] According to “Manual on Planning Criteria” by the Central Electricity Board in 1994, below 4.5% is considered as the standard.

According to the report by the engineers of the supplier of the generator (a Japanese company) who were sent to the project site in January this year, the main cause of the low output is not defective power generation equipment but the low head of 4.2-4.8 meters against the planned 5.3 meters when more than one generator is working. In other words, under the present tailrace structure, too much water is discharged when more than one generator is operated and the water level does not drop sufficiently at the lower reach, preventing them from generating a sufficient amount of electricity. The executing agency explained that they will be able to solve this problem by completing the escape channel connecting the existing tailrace to Rampurwa Canal (see the map in 1.3 for the location of the auxiliary escape channel)[*3].

2.3.2 Financial Internal Rate of Return (FIRR)

FIRR was recalculated using the executing agency's cost-benefit data for 2 scenarios: 1) the escape channel is constructed as planned; and 2) the escape channel is not constructed (see the table below)[*4].

The recalculated FIRR is lower than the initial estimate (13.4%) in both cases. It is higher in the case in which the escape channel is constructed (10.3%) than not constructed (5.4%).

Comparison of Assumptions for the Calculation of FIRR

Assumptions		Initial Estimate (at appraisal)	Recalculation (at evaluation)	
			Escape channel is constructed	Escape channel is not constructed
Costs	Investment cost	227 million rupees	125 million rupees is accounted for as the escape channel construction cost for FY2004 in addition to 475.3 million rupees, the actually incurred cost up to FY1996	Actually incurred cost up to FY1996: 475.3 million rupees
	Operation and maintenance cost	1% of the total investment amount	Actually incurred cost for FY2002: 14.7 million rupees (approx. 3% of the above initial investment cost)	
Benefits	Total power generation	90.8 GWh/year	To be increased to 60.0 GWh in FY2005 and remain at the same level	To be maintained at 26.5 GWh, which was achieved in FY2002
	Electricity price per unit	0.4 rupees/kWh	To be maintained at FY2002 level, 2.0 rupees/kWh	
Project Life		35 years		
FIRR		13.4%	10.3%	5.4%

2.4 Impact

2.4.1 Impact on Social Environment

The project has had only a limited impact because the planned amount of power generation was

*3 The local expert accompanied to the survey pointed out that the simulation at the planning stage was not sufficient.

*4 Although the project cost increased by the local portion, a certain amount of the profit has been secured by the reasonable pricing.

small and the planned power generation has not been achieved mainly due to external factors. Here are some examples of the project's impact according to the interviews with local residents[*5].

The largest effect for the local residents was the availability of electricity (the electricity rate is fixed at 68 rupees a year). As a result, they can use electric appliances such as TVs. Also, some farm work such as water pumping and wheat processing has become mechanized. No accident such as electric shock has occurred.

Those who owned land on the site of the constructed canal and farmers affected by the construction of the transmission lines were compensated for land and agricultural production in accordance with domestic laws and regulations[*6].

Relocation of local residents was not necessary because there was no residence on the project site.

It was reported that some farmland along the canal has been permeated by water because of the earth lining of the canal bank. It is advisable to take necessary measures, such as conducting detailed survey.

2.4.2 Impact on Natural Environment

In this project, deforestation was planned for the construction of the canal for power generation. However, as it took time to obtain permission, the plan was changed and deforestation did not take place (see 2.2.1). No environmental impact has been reported.

2.5 Sustainability

2.5.1 Executing Agency

(1) Operation and Maintenance System

The power plant has 16 employees in total. The technical staff is composed of one Assistant Chief Engineer, 2 Superintending Engineers, 4 Executive Engineers and 8 Assistant Engineers. Operation and maintenance is partially outsourced by the power plant, and the staff of the outsourcing company carries out daily operation and maintenance under the supervision of the power plant employees.

(2) Technical Capacity

Most daily operation and maintenance is conducted by the outsourcing company as mentioned above. Its 25 staff members include 1-2 engineers (bachelors of engineering) and 6-7 diploma holders. They are considered capable of conducting daily operation and maintenance.

(3) Financial Status

The summary of the unconsolidated profit-and-loss statement of Eastern Gandak Power Plant obtained from the executing agency is shown below.

[*5] On Tuesday, July 8, 2003, we asked the executing agency to call up the residents living in the neighborhood of the power plant and interviewed 8 residents in the presence of the power plant staff. The local consultant we accompanied interpreted for us.

[*6] It includes the purchase of the land as well as acquisition of the right of way from the farmers (in case of the state owned land). The total compensation cost is summed up to approximately 3 million rupees based on the Land Acquisition Law (1984 revision).

Profit and Loss Statement of Eastern Gandak Power Plant (million rupees)

Fiscal Year		1997	1998	1999	2000
Total Income	Income from sales of electricity	47.6	38.8	48.0	49.6
	Other income	0.1	0.4	0.2	0.2
	Total	**47.7**	**39.2**	**48.2**	**49.8**
Total Expenditure	Personnel expenses (salaries)	1.5	1.8	1.6	1.6
	Operation and maintenance expenses	3.5	4.0	4.6	5.3
	Interest expenditure (on the debt to the state government)	29.9	31.8	32.4	31.3
	General administrative expenses	3.3	3.4	4.1	4.6
	Depreciation expenses	53.9	43.0	34.3	20.0
	Others total	0.3	0.3	0.4	0.6
	Total	**92.4**	**84.3**	**77.4**	**63.4**
Current Profit/Loss		-44.7	-45.1	-29.2	-13.6

Source: Executing agency

The power plant has posted losses up to FY2000, although the figure has been declining. Given that depreciation expenses are on the decrease, the financial status is expected to improve in the future. However, as the latest financial information is not available and we could not obtain information on the financial status of the executing agency BHPC as a whole, a further evaluation and comprehensive analysis is impossible.

2.5.2 Operation and Maintenance Status

The power plant constructed under the project has not achieved the initially planned power generation. The main problem is currently thought to be the overall design of the tailrace, not the generator. As mentioned earlier, this problem is expected to be relieved substantially by constructing the escape channel connected to another tailrace.

3. Feedback

3.1 Lessons Learned

None

3.2 Recommendations

（To the executing agency）As the construction of the escape channel is expected to help lower the water level and increase power generation, the construction of the escape channel which is currently underway should be completed steadily and early.

Comparison of Original and Actual Scope

Item	Planned	Actual
(1) Output		
1) Headrace		
Length	1,067m	1,432m
Designed water depth	4.88m	As planned
2) Power plant		
Installed capacity	5MW×3 units＝15MW	As planned
Type of hydraulic turbine	valve-regulated tubular	As planned
Head (rated)	5.3m	5.1m (when only one generator is operated)
3) Drainage canal		
Length	3,230m	4,282m
Depth	3.2m	3.2m
(2) Project Period		
Preparatory work	Nov. 1983 - Oct. 1984	Not known
Site acquisition	Nov. 1983 - May 1984	1985 -1990
Construction of headrace and tailrace	Oct. 1984 – 1987	1986 - 1993
Construction of power plant	Oct. 1984 - Nov. 1986	1988 - 1992
Procurement of Equipment and materials	Dec. 1983 - Oct. 1986	1984 -1994
Construction of switchyard	Feb. 1985 – May 1987	Completed in 1994
Installation and start-up of power generators	Aug. 1986 – Oct. 1987	Completed in 1997
(3) Project Cost		
Foreign Currency	1,630 million yen	1,628 million yen
Local Currency	3,630 million yen (165 million rupees)	2,192.6 million yen (222.6 million rupees)
Total	5,260 million yen	4,225.7 million yen
ODA Loan Portion	1,630 million yen	1,628 million yen
Exchange Rate	1rupee ＝ 22yen	1rupee＝9.85yen

Third Party Evaluator's opinion on
Eastern Gandak Canal Hydroelectric Project

Dr.Basanta Kumar Pradhan
Chief Economist
National Council of Applied Economic Research

Relevance

The project objective met the goals of the 7th plan (Fy 1985-89) during the period when the project was initiated. The necessity of Hydroelectricity is emphasized in the 9th plan (FY 1997-2001) when the project started giving results. Even the ongoing 10th plan (FY 2002-7) emphasizes the importance of hydroelectricity in no uncertain terms. India is trying to expand electric power generation capacity, as current generation is seriously below peak demand. The unreliability of electricity supplies is severe enough to constitute a constraint on the country's overall economic development. For the poor state of Bihar, this can not be overemphasized. The division of Bihar into two states created further recourse problems including the accentuation of electricity shortage for Bihar. Bihar purchases substantial amount of power from Central sector. Average annual consumption in Bihar, after the formation of Jharkhand, is only 60 units against national average of 320 units. In north Bihar it goes down to 20 units. Hence, the project was very relevant under government policy when it was appraised and its relevance to Bihar is more now than when it was conceived.

With the formation of the Jharkhand State, the total installed capacity in Bihar now is only 474.90 MW. Further, the hydro-thermal-mix is 10:90 against ideal requirement of 40:60.

Efficiency

The ten year gap of implementation between plan and implementation is very high. However it is a common feature in India specially for very large projects which get delayed in getting regulatory approvals and failing to secure adequate financing. It appears the cost in rupee terms went up of due to delay in implementation.

Effectiveness

The effectiveness of the project is not fully realized due to the non-implementation of the escape canal yet.
That would increase both the physical and financial performance. And, if the delay in implementation of the project would have been less, the FIRR would have been higher.

Impact

The electricity is helpful to the local residents for their household consumption as well as for their farm work. Since the electricity generation is much less in comparison to demand, especially since the creation of Jharkhand, the benefits to the other parts of the state also needs appreciation.

The small hydroelectric projects are environment friendly in comparison to the other sources. Further, in this project no forest land was used.

The compensation for loss of land and agricultural production is always a contentious issue in India. It is generally perceived to be much less than the long term loss in livelihood.

Sustainability

The financial status would likely to improve as the depreciation expenses goes down and the escape channel is constructed improving production levels and hence profits.

Recommendations

The planned escape channels need to be completed as soon as possible.