Pakistan

Second 220KV Guddu-Sibbi-Quetta Transmission Project

Report date: February 2001
Field survey: August 2000

1. Project Profile and Japan's ODA Loan

Project Area Location Map: Eastern Balochistan

Photo: Industrial II Substation

1.1. Background

The state of Balochistan, which occupies 40% of Pakistan in terms of area, is the most underdeveloped state in the country due to its natural environment characterized by mountainous terrain and a dry climate. The average power consumption per person in Balochistan at the time of appraisal was 131kWh/year, only 60% of the national average. Transmission lines in the state accounted for only 8% of the total length (in the catchment area of the executing agency, WAPDA), an extremely low percentage given the state's area. Power consumption in Balochistan had increased sharply in the preceding 5 years (1982/83 – 1986/87) by an average 17.1%. According to an estimate for power supply and demand made at the time, it was predicted that demand would exceed the supply capacity of existing facilities in 1994.

1.2. Objectives

The objective of the project was to construct transmission lines in Balochistan, the least electrified state in Pakistan, in order to meet the demand for electric power which has been rapidly increasing particularly in that state and to enhance the reliability of power supply facilities, thus contributing to the development of the local economy and the stabilization of the people's livelihood.

1.3. Project Scope

The project covered the following items: 1) construction of 220kV transmission lines (single circuit between Guddu and Sibbi and double circuit between Sibbi and Industrial II), 2) construction of 132kV transmission lines (double circuit between Industrial II and Q.S. Manda), 3) expansion of the Guddu and Sibbi 220kV substations, 4) establishment of the Industrial II 220kV substation, and 5) extension of the Q.S.

Manda 132kV substation. The Japan's ODA loan (the "ODA loan") covered the entire foreign currency portion of the project and part of the local currency portion.

1.4. Borrower/Executing Agency

The President of Islamic Republic of Pakistan/ Water and Power Development Authority (WAPDA)

1.5. Outline of Loan Agreement

Loan amount/Loan disbursed amount	¥4.915 billion/¥3.705 billion
Exchange of notes/Loan agreement	March 1989/ March 1989
Terms and conditions	Interest Rate: 2.5%, Repayment period (grace period): 30 years (10 years), Partially untied
Final disbursement date	August 1998

2. Results and Evaluation

2.1. Relevance

This project aimed to meet the rapidly increasing demand for electric power in the State of Blaluchistan. Operation of hydraulic power plants in Balochistan is difficult due to low level rain fall. Moreover, thermal power generation is not a realistic option considering the difficulty in transporting fuel and securing coolant. Plans were to construct and extend a 220kV transmission network and substations in order to increase capacity to supply electric power from the trunk transmission network.

The 220 kV transmission lines and their distribution network constructed under the project cover almost 80% of the state, benefiting 75% of the population. It was expected that after completion the necessity for planned outage ('load shedding') caused by capacity shortfalls on 220kV transmission lines would be eliminated, thus improving the reliability of the power supply in the region. The project plan was therefore considered relevant.

2.2. Efficiency

(2.2.1.) Implementation Schedule

The project was completed 7 years behind schedule owing to WAPDA's inability to control procurement and construction management, lack of experience of the contractor and discord with WAPDA. Steel tower components and wires were frequently stolen from the Guddu-Sibbi transmission line construction site, in particular, where patrol was difficult because the route was 10 to 20 km away from the trunk road. In one case, a steel tower fell down as a result of stealing. Stealing was one of the factors that delayed the implementation schedule.

(2.2.2.) Project Cost

Because of the long delay in the implementation schedule, the construction of 132kV transmission lines between Industrial II and Q.S. Manda and the extension of Guddu and Q.S. Manda substations were implemented at WAPDA's own cost. As a result, the actual ODA loan disbursement was ¥3.705 billion, 24.6% less than the approved amount of ¥4.915 billion. However, total project costs overran initial levels by 15.5% (¥7.270 billion→¥8.396 billion). This overrun is attributed to the need to re-procure materials and equipment due to the above-mentioned collapse of a steel tower and stealing of transmission lines (steel towers and transmission lines were not covered by the ODA loan).

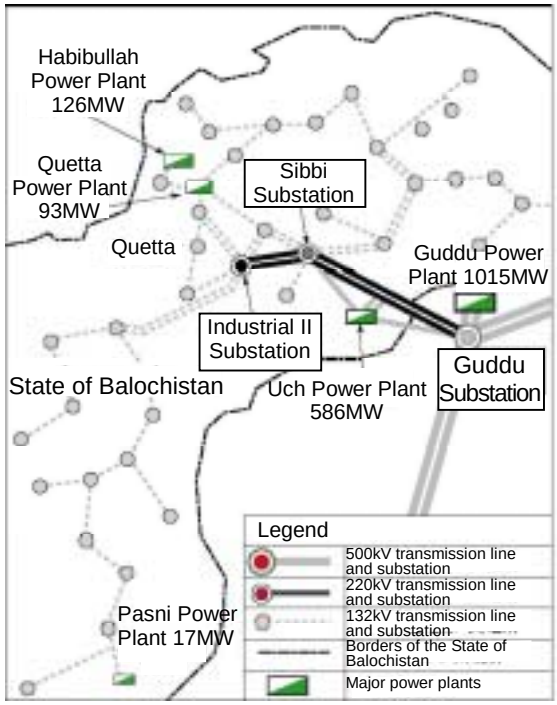

Figure 1 Power Transmission Network in Balochistan

2.3. Effectiveness

(2.3.1.) Stable Power Supply

Following the completion of the Guddu-Sibbi transmission line and its connection to the trunk network in June 1998, there was a jump in the amount of electric power transmitted along 220kV lines in 1999.

The power transmission and distribution network extending from the transmission lines constructed under the project covers 80% of the total area of Balochistan, supplying electric power to 75% of the state's population. Until recently, there was no large capacity power plant in Balochistan[*1] and electric power was supplied from the trunk network to the local network. Before the implementation of the project, the existing Guddu-Sibbi 220 kV transmission line was the only line connected to the trunk network. Therefore, power supply from the trunk line stopped every time trouble occurred on the line.

[*1] As of project completion in June 1998, Balochistan had only two power plants with relatively large capacity: 96MW Quetta Thermal Power Plant and 17MW Pasni Power Plant.

Table 1 Electric Supply Reliability between Guddu-Sibbi-Industrial II

Indicator	1994	1995	1996	1997	1998	1999	2000
Transmitted power[*A] (GWh)	Unknown	Unknown	953.0	874.3	856.9	1,884.0	1,036.0[*B]
Number of outages lasting more than 20 minutes[*C]	0	3	2	1	4	1	9
Number of outages lasting up to 20 minutes[*C]	1	3	0	0	0	0	6
Annual load shedding (hours)	0	Unknown	81	1	276	2	199[*B]

*A: Including the amount transmitted along the existing 220kV line
*B: Total for January-June, 2000
Source: QESCO data
Note: The Sibbi-Industrial II line was completed in December 1994 and the Guddu-Sibbi line in June 1998.

Table 1 shows the number and annual duration of outages caused by accidents, etc. for the two 220kV transmission lines constructed between Guddu, Sibbi and Industrial II under the project. The annual outage for 1998 and 2000[*2], in excess of 100 hours, is the total of single line outage. There were no incidents in which the two lines were out concurrently, indicating that the whole system including the existing transmission line has been functioning well. Since the completion of the project, electric supply from the trunk network has not been stopped and stable electric supply has been maintained.

[*2] Problems with the maintenance of transmission lines will be mentioned later.

(2.3.2.) Reduction of Load Shedding

In Balochistan, planned load shedding was frequently necessary due to the sharp drops in voltage on 132kV and 11kV transmission lines (132kV→125kV, 11kV→10kV) caused by capacity shortfalls on the main transmission line connecting Guddu and Sibbi, and insufficient power generation capacity. This situation had a serious impact on the local economy particularly in the summer when load shedding of 50-70 MWh was necessary in Quetta. Moreover, sharp voltage increases/decreases resulted from the lack of appropriate protective devices at substations rendered the voltage at the customers' supply point unstable.

Since project completion, no load shedding has been necessary and sharp changes in voltage caused by capacity shortfalls on 220kV transmission line have not occurred; a stable power supply has thus been realized.

Table 2 is a comparison of the average power consumption per customer in Balochistan and the entire country. Average power consumption in Balochistan, which was only 60% of the national average at the time of appraisal, has increased every year to reach 76% of the national average in 1998 when the project was completed. If the project had not been implemented, the existing transmission lines

could not have met the demand for power in the state and a number of rotational outages would have been necessary.

Table 2 Power Consumption per Person

(Unit: kWh)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
① Balochistan	135	160	174	180	204	230	237	238	243	256	262	262
② National average	222	250	258	275	289	311	324	324	336	346	347	343
①/②	61%	64%	67%	65%	71%	74%	73%	73%	72%	74%	76%	76%

Source: WAPDA data

Load shedding remains necessary in some parts of Balochistan for the following reasons: 1) power supplied from power plants is not sufficient to meet peak demand; and 2) planned load shedding is necessary due to overloading of 132kV transmission lines between Quetta and Mastung, which is not covered by the project. However, given that the Uch Thermal Power Plant was constructed by an independent power producer (IPP) and started supplying power (as of October 2000, generating 586MW of electricity), and that the National Transmission and Dispatch Company (NTDC) is pushing ahead with plans to convert the 132kV single-circuit transmission line connecting the Industrial Substation to the Mastung Substation to a double-circuit line as a measure to solve the problem of transmission capacity shortage between Quetta and Mastung, it is likely that the problem of load shedding in Balochistan will be solved in the near future and that the power supply will be stabilized.

(2.3.3.) Financial Internal Rate of Return (FIRR)

The FIRR recalculated based on the increased portion of power sales generated by the project (benefits) and project costs and operation and maintenance costs (costs) was 4.8%, 7.8 percent lower than the initial projection of 12.6%. The main causes of the low FIRR were: 1) overrun of project costs, 2) long delays in project implementation, 3) the Pakistani government's policy to control increases in electricity prices at a lower level than other prices escalation, which resulted in electricity being priced at 48% lower than the initial projection, and 4) the increase in distribution losses due to increased power theft (see Table 3).

Table 3 Difference in Cost and Benefit Calculation Bases

	Increased transmission	Wholesale unit price of electricity	Distribution losses
Initial calculation	945,730GWh	1.827Rp/kWh*2	18.00%*4
Recalculation	970,342GWh*1	0.954Rp/kWh*3	25.79%*5

*1: The amount transmitted after the completion of the project (1999) less the average of the amount transmitted during the preceding 2 years (1996-1997).

*2: 1998 equivalent of the initially calculated average wholesale unit price 100.74 Paisa/kWh (1992) adjusted using the Consumer Price Index (CPI) for convenience of comparison with the actual result.

*3: WAPDA's average wholesale price unit in 1998. The actual unit price may be lower where power demand in the industrial and commercial sectors is low (1.23Rp/kWh, 2.47Rp/kWh) while that in the agricultural sector is high (0.44Rp/kWh).

*4: Calculated in the following manner using the data at the time of appraisal for convenience of comparison with the actual result: 1- increase in transmission/increased transmission volume.

*5: Using the QESCO distribution loss rate in 2000

2.4. Impact

(2.4.1.) Promotion of Agricultural Development

Figure 2 is the breakdown of 1998-1999 electricity sales in Balochistan by type of customers. It shows that power demand in the commercial and industrial sectors accounts for less than 10% of the total while power consumption in the agricultural sector accounts for 67.1% of the total consumption in the state.

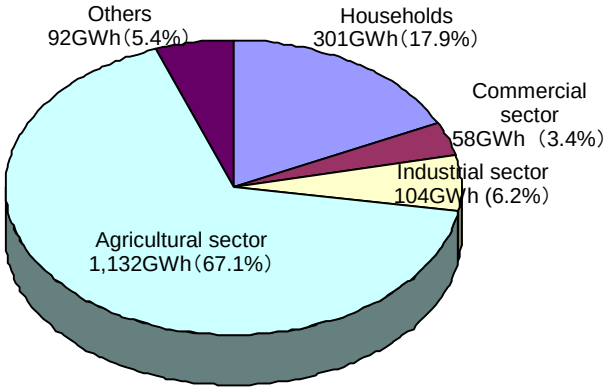

Figure 2 is the breakdown of 1998-1999 electricity sales

Table 4 is the comparison of the national and provincial average of power consumption per customer. The average power consumption in the commercial and industrial sectors in Balochistan is only half that for Pakistan as a whole, whereas that in the agricultural sector is more than double the national average. This indicates that in Balochistan, where annual rainfall is less than 120mm and little surface water is available, agriculture requires large volumes of electric power to pump up underground water. In other words, a stable power supply is indispensable for agricultural development.

Table 4 Comparison of Power Consumption per Customer

	Households	Commercial sector	Industrial sector	Agricultural sector
①National average (1998)	1,936 kWh	1,265 kWh	54,884 kWh	40,783 kWh
②Balochistan (1998-1999)	1,995 kWh	635 kWh	27,587 kWh	88,706 kWh
②/①	103.0 %	50.2 %	50.2 %	217.5 %

Source: WAPDA data

Balochistan sustained serious drought damage to agricultural products for 3 consecutive years. These external factors make it difficult to assess the impact of the project in quantitative terms. In the long run, however, the agricultural sector stands to benefit most from the stable power supply achieved by the project through expected increases in agricultural production.

According to the data obtained in the field survey, the rural electrification rate in Balochistan is as shown below. The electrification rate, which was 18.1% in 1987, increased only 2 percent during the 10 years up to 1996. However, it recorded a 5 percent increase in the 4 years from 1996 to 1999. Although the direct cause of this increase is the effect of power distribution projects, construction and improvement of transmission lines and substation facilities under the project are also essential factors in that they facilitate rural electrification. Therefore, the project is expected to continue making a contribution in the future.

Table 5 Rural Electrification Rate in Balochistan

Indicator	1996	1997	1998	1999
Electrification rate (based on number of communities)	20%	22%	24%	25%

Source: WSPDA data

(2.4.2.) Environmental Impact

The transmission lines covered by the project were routed through soil desert and rocky areas mostly devoid of human habitation. Therefore, displacement of residents was not necessary for site acquisition. No particular environmental problems have been noted.

2.5. Sustainability

(2.5.1.) Operation and Maintenance

The operation and maintenance of facilities constructed under the project are performed by the Quetta branch office of Grid System Operation (GSO) of NTDC, which was separated from the transmission department of WAPDA and incorporated.

GSO Quetta has 1,036 employees including 199 technical staff. Among them, 199 employees are engaged in the operation and maintenance of the project. A total of 107 employees are stationed full time at Sibbi and Guddu substations. 220kV transmission lines including the existing line are operated and maintained by a staff of 92, who are ready to cooperate with Grid System Construction (GSC) in repair work in the event of accidents such as breakdown of a steel tower. GSO Quetta has been engaged in the operation and maintenance of the existing 220kV transmission line, and its workforce is adequate both in terms of number and quality. Therefore, there do not appear to be any problems with the operation and maintenance system.

Table 6 Personnel Engaged in Operation and Maintenance of Facilities

	Transmission lines	Substations	Total
Technical	76	55	131
Non-Technical	16	52	68
Total	92	107	199

(2.5.2.) Technical Problems in Operation and Maintenance

Construction of the Guddu-Sibbi transmission line was initially planned along the route of the existing 220kV transmission line. However, the high voltage transmission department in charge of project planning at WAPDA gave the highest priority to curtailing construction costs and thus selected the shortest route between substations. As a result, the transmission line is 10 to 20km away from the trunk road at some points.

As a result, extensive patrols were not conducted during implementation, allowing construction materials to be stolen. Even now, periodic visual inspection and prompt repair work in the event of accident are prevented by the inaccessibility of the site. During the dry season when temperatures around the transmission route exceeds 50^{o}C, it is practically impossible to work in the heat of the day. In low and marshy places, the transmission lines become almost inaccessible in the rainy season.

Under these circumstances, repairs to transmission lines and steel towers in the event of an accident are very time-consuming (see Table 1). In order to improve this situation, NTDC and GSO Quetta are planning to adopt the following two measures:

① Clear a path along the transmission line to provide access to the site and connect it with the trunk road at 10km intervals; and

② Establish maintenance stations serving as observation posts at 50km intervals

(2.5.3.) Effects of the Privatization of WAPDA

The executing agency WAPDA is a 100% government-financed special corporation engaging in construction, operation and maintenance of the power supply sector and

power transmission and distribution system covering all parts of Pakistan except for the Karachi area (served by Karachi Electric Supply Corporation Ltd. (KESC)). WAPDA is currently in the process of dividing and privatizing its organization with cooperation from the World Bank. The thermal and nuclear power generation department, transmission department and distribution department have already been incorporated as of October 1999.

NTDC, which was separated from WAPDA and is executing the operation and maintenance work of the project, does not supply electric power directly to customers. Instead, it collects revenue from electric power sold to Quetta Electricity Power Supply Company (QUESCO), a distribution company serving most of Balochistan. However, QUESCO collects only 50 to 60% of the amount due. The low collection rate is attributable to nonpayment by end users, rampant power theft and delays in payment by public institutions.

Financial problems including those related to revenue collection are common not only to QUESCO and NTDC but also to WAPDA and KESC. Therefore, there is a great concern over the soundness of public enterprises in the electric power sector in Pakistan. Considering the public nature of NTDC's services, which is a disadvantage in terms of profitability, the Pakistani government intends to continue to support it as a government-owned enterprise, and the organization will not be privatized. The Pakistani government has expressed its commitment to structural reform of the electric power sector ((1) dividing three functions: policy planning, regulation of the industry concerned and the operation of public enterprises, (2) liberalizing the electricity market, (3) and promoting structural and organizational reform of public enterprises aimed at gradual privatization).

3. Lessons Learned

Nothing particular

4. Recommendations (not for publication)

There are major concerns about the business conditions of all Pakistan's government-owned corporations including WAPDA. Since the collective proposals of the World Bank and ADB will play a vital role in the Pakistani government's implementation of structural reforms in the power sector, it will also be necessary for JBIC to follow such movements.

Comparison of Original and Actual Results

Item	Plan	Actual
1. Project scope	Construction of 220kV transmission lines	
	· Guddu-Sibbi: 280km (single circuit)	· 259.2km (single-circuit line)
	· Sibbi-Industrial II: 107km (double circuit)	· 128.0km (double-circuit line)
	Construction of 132kV transmission line	
	· Industrial II-Q.S. Manda: 13km (double circuit)	· Separately implemented at expense of the executing agency
	Extension of 220kV substations	
	· Guddu (220kV transmission line bay, single circuit)	· Separately implemented at expense of the executing agency
	· Sibbi (220kV transmission line bay, single circuit)	· 4 line bays
	· Sibbi (1 transformer 160MVA)	As planned
	Establishment of 220kV substation (Industrial II)	
	· 2 transformers 160MVA	As planned
	· 220kV transmission line bay, double circuit	As planned
	· 220kV transmission line bay, double circuit	As planned
	Extension of 132kV substation	
	· Q.S. Manda (132kV transmission line bay, double circuit)	· Separately implemented at expense of the executing agency
2. Implementation schedule	Transmission lines: August 1989 to June 1991 (23 months) Substations: October 1989 to May 1991 (21 months)	Transmission lines: 1991 to June 1998 (commencement month unknown) Substations: 1993 to September 1995 (commencement month unknown)
3. Project cost		
Foreign currency	¥3.612 billion	¥3.705 billion
Local currency	Rp 504 million	Rp 1.155 billion
Total	¥7.270 billion	¥8.396 billion
ODA loan portion	¥4.915 billion	¥3.705 billion
Exchange rate	Rp 1.00=¥7.25 (March 1988)	Rp 1.00=¥4.11 (average from July 1989 to July 1998)