Pakistan

500kV Transmission Line Boosting Project

Report Date: November 2002
Field Survey: Not conducted*[1]

1. Project Profile and Japan's ODA Loan

Site map: Transmission Line

Site Photo: Multan Substation

1.1 Background

Electric Power Supply in Pakistan was provided by the Water and Power Development Authority (WAPDA), which served all areas of the country but Karachi region. About 80 percent of total installed capacity for electric power generation in Pakistan, including 1,874MW of hydropower in Northern region and 1,389MW of thermal power (677MW in Northern region, 480MW in Central region, 58MW in Quetta region, and 174MW in Southern region), was owned by WAPDA in 1981. In the dry season, between December and June, when hydropower generation lost about 40 percent of its supply capacity, power was transmitted from the Central region to the Northern region, and was transmitted from the North to Central and Southern regions in high water season between July and November.

The trunk transmission line connecting Tarbela, Faisalabad (Gatti), Multan, and Guddu was designed for 500kV operation, but the line between Faisalabad (Gatti), Multan, and Guddu had been operated at 220kV since there was no need for 500kV service in that section.

WAPDA planned to expand its power generation to 1,050MW at the Tarbela Hydro Power Station in the Northern region by June 1985, and to 510MW at the Guddu Thermal Power Station by June 1985. As a result, it was necessary to upgrade the voltage of the existing transmission line between Faisalabad (Gatti), Multan, and Guddu from 220kV to 500kV by June 1985 in order to serve the expanded power generation capacity.

Table 1: Power Demand and Supply Estimates

	1981		1982		1983		1984		1985		1988	
	Dry	H. Water	Dry	H. Water	Dry	H. Water	Dry	H. Water	Dry	H. Water	Dry	H. Water
Northern Region												
Demand	2,063	2,318	2,249	2,527	2,446	2,748	2,665	2,994	2,910	3,270	3,561	4,001
Generation Cap.	1,740	2,635	1,740	2,635	2,160	3,435	2,160	3,435	2,265	3,825	2,365	4,995
Supply Cap.	1,740	2,435	1,740	2,435	2,160	3,135	2,160	3,135	2,265	3,525	2,365	4,695
Gap	-323	+117	-509	-92	-286	+387	-505	+141	-645	+255	-1,196	+694
Central and Southern Region												
Demand	491	551	569	640	654	735	743	834	861	968	1,152	1,295
Generation Cap.	640	640	640	640	640	658	943	943	943	1,143	1,613	1,993
Supply Cap.	640	435	640	435	640	443	943	623	943	753	1,613	1,348
Gap	+149	-116	+71	-205	-14	-292	+200	-211	+82	-215	+461	+53

[1] The field survey was cancelled due to security uncertainty of Pakistan in Autumn 2001, when JBIC was planning to dispatch an ex-post evaluation survey mission.

Demand Total	2,554	2,869	2,818	3,167	3,100	3,483	3,408	3,828	3,771	4,238	4,713	5,296

Source: JBIC appraisal document.
Note: Dry=Dry Season (from December to June), H. Water=High Water Season (from July to November)

1.2 Objectives

To construct 500/220kV Substations at both Multan and Guddu, and to expand the Faisalabad (Gatti) Substation in order to upgrade transmission voltage from 220kV to 500kV between Faisalabad (Gatti) and Guddu.

1.3 Project Scope

The project scope includes:

a) Construction of 500kV substations at Multan and Guddu
b) Expansion of 500kV substation at Faisalabad (Gatti)
c) Procurement of spare parts, O&M and testing equipment and tools; and
d) Consultancy services.

1.4 Borrower / Executing Agency

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

1.5 Outline of Loan Agreement

Loan Amount Loan Disbursed Amount	12,200 million yen 9,354 million yen
Exchange of Notes Loan Agreement	January 1982 March 1982
Terms and Conditions Interest Rate Repayment Period (Grace Period) Procurement	 2.75 % 30 years (10 years) Partially Untied
Final Disbursement Date	March 1989

2. Results and Evaluation

2.1 Relevance

WAPDA has steadily developed its power generation capacity as planned. The capacity of both Tarbela Hydro Power and Guddu Thermal Power Stations has been expanded. The present installed capacity of the two power generations is 3,478MW at Tarbela Hydro Power and 1,655MW at Guddu Thermal Power Station. However, the existing 220kV transmission line between the Tarbela and Guddu was thought insufficient to transmit the increased power smoothly. Therefore, upgrading the existing transmission line between Faisalabad (Gatti), Multan, and Guddu from 220kV to 500kV was enough reasonable in that it sustains present power demand and consumption (increased power transmission) in Pakistan, more precisely, in the Northern region and the Central and Southern region. At national level, on the other hand, the Ten Year Perspective Development Plan & Three Year Development Plan (2001-2004) is forecasting electricity demand growth of 6%. When considering this forecast, the objective of the project is still relevant in that it would support future augmenting power consumption and transmission.

At the time of appraisal, seasonal imbalance in supplying electricity had been reported. In the Northern region, where hydroelectric plants are predominant, there had been excess supply of energy in high water season thanks to enough raining. By contrast, there had been constant insufficient energy supply in dry season due to the lack of enough rain to generate electricity. To alleviate this gap, the Government of Pakistan had planned to boost the transmission line, from 220 kV to 500 kV, between the Northern region and the Southern central region. More precisely, it was planned that extra energy generated in the North

would be transmitted to the Southern central region in high water season and energy deficit in the North in dry season would be complemented by transmitting energy from the Southern central region. In this regard, in terms of assuring the stability of the transmission line between the two regions, this project was relevant, too.

According to the WAPDA power system statistics, the Southern Central region had 1,355 MW of extra energy supply while the Northern region had 2,892 MW of energy deficit in the dry season of 1994, 7 years after the completion of this project. The statistics also shows a certain amount of energy transmission (approximately 1,350 MW to 1,550 MW) in the same year between Multan and Guddu substations. This fact means that, as articulated in the appraisal, boosting the transmission line from 220 kV to 500 kV has significantly contributed to the alleviation of energy deficit in the Northern region especially in dry season. It is clear that this project meets the objectives of the project and hence, is relevant at present.

2.2 Efficiency

2.2.1 Project Scope

There was no major revision or modification of the project scope. Repair of the breaker in the Gatti Substation, which was affected by a rainstorm in October 1986, was included in the scope utilizing the unused loan amount. For this reason, the period of loan disbursement was extended.

2.2.2 Implementation Schedule

The original project implementation schedule was 38 months, from May 1982 (selection and contract of consultant) to June 1985 (Commissioning), while the actual schedule was 48 months, from March 1983 to February 1987. The main reason for the delay was the fact that it took extra time to finish the contracting process between WAPDA and the contractors, since a high tender price was offered by the contractors. Consequently, the project was completed with a 20-month delay.

2.2.3 Project Cost

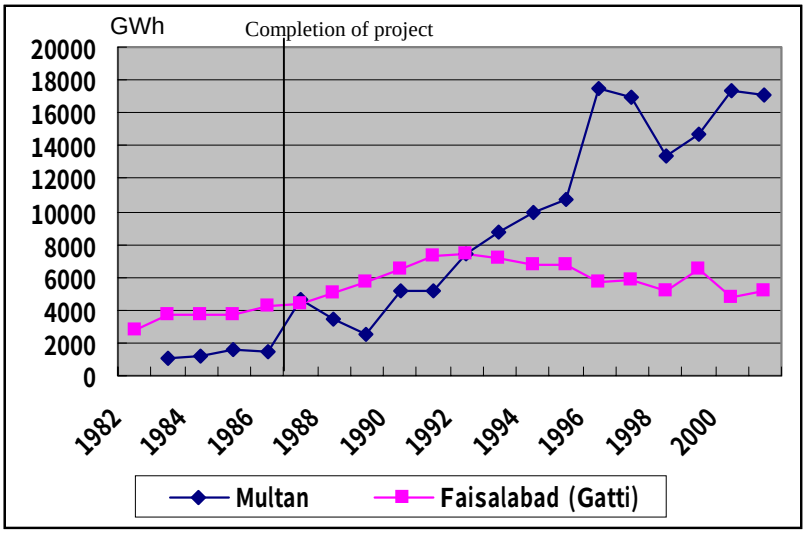
The original total project cost was 22,678 million Yen (foreign currency portion: 12,200 million Yen; local currency portion: 451 million Rs.), while the actual total project cost was 14,927 million Yen (foreign currency portion: 9,354 million Yen; local currency portion: 525 million Rs.). The foreign cost decreased 23% (2,846 million Yen), and the local cost increased 16% (74 million Rs.). The main factor contributing to the cost overrun in the local portion is thought to be inflation, but the reason for the cost under run in the foreign portion has not been identified. The cost for procurement of consulting services was to be covered by the ODA loan, but in fact it was procured with WAPDA's own funds and therefore excluded from the scope of the ODA loan.

2.3 Effectiveness

2.3.1 Electricity Supply

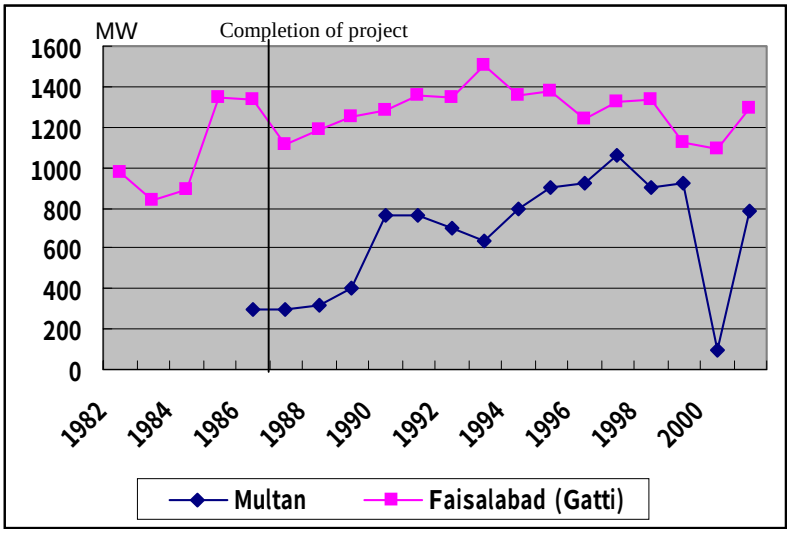
Since project completion in 1987, the electricity supply at Multan substation has increased dramatically. Electricity supply at Faisalabad (Gatti) substation has not shown a noticeable improvement (The situation at Guddu substation is unknown due to lack of data and information). The positive effect of the project on the improvement of electricity supply is clearly demonstrated at Multan substation.

Figure 1: Electric Supply at Multan and Faisalablad (Gatti) Substations



Source: WAPDA

Figure 2: Peak Load at Multan and Faisalablad (Gatti) Substations



Source: WAPDA

2.3.2 Transmission Loss

The project was expected to contribute to the improvement of transmission loss between Multan, Guddu, and Faisalabad (Gatti) substations. Due to a lack of data and information, the precise effect on the loss between the targeted substations is uncertain; however, there has been a notable decline in transmission and distribution loss in the WAPDA system as a whole. Comparing values in 1982 (27.7%) and 1988 (23.0%), it can be concluded that this project has contributed to the decline to some extent.

Table 2: Transmission and Distribution Loss in WAPDA electricity transmission lines (%)

1978	1980	**1982**	1984	1986	**1988**	1990	1992	1994
33.5	30.5	**27.7**	27.1	24.5	**23.0**	21.3	20.7	21.6

Source: WAPDA Power System Statistics, 1995

2.3.3 Maximum Load

According to the data provided by WAPDA, maximum load of major transmission lines and substations shows effective use of related facilities installed by the project. The figures at Multan and Guddu substations indicate the total inflow/outflow of energy. WAPDA has reported that max load on voltage transformers (electrical transformers) is always under the carrying capacity (1,000A), which means that the facilities are utilized properly without overloading.

Table 3: Max load at transmission lines and substations (AMP)

	Transmission Lines*[2]		Substations	
	Multan - Lahole	Guddu - Multan	Multan	Guddu
1992-1993	1,100A	900A	560A	1,940A
1993-1994	1,150A	960A	760A	1,830A
1994-1995	1,109A	850A	1,070A	1,830A
1995-1996	1,075A	800A	1,076A	1,860A

Source: WAPDA

2.3.4 Other Operational Indicators

According to the data provided by Multan and Faisalabad (Gatti) substations, after project completion in 1987, the availability factor at the two substations has been both high and stable. The availability factor at Multan substation in particular has improved considerably.

Table 4: Other Operational Indicators

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. Availability Factor (%)																				
Multan	-	-	-	-	37	37	39	49	93	82	86	79	98	111	113	130	111	113	123	96
Faisalabad	81	69	73	111	110	92	98	103	105	112	111	124	112	114	102	107	110	92	89	107
2. Planned Outrage Hour (hour)																				
Multan	9	55	61	233	223	70	71	42	71	86	1067	157	128	54	62	350	107	273	2120	1772
Faisalabad	96	90	53	88	64	113	69	79	190	61	160	282	299	360	214	202	144	113	211	251
3. Forced Outrage Hour (hour)																				
Multan	5	99	14	57	25	22	31	107	148	134	276	50	253	562	112	2499	45	75	432	841
Faisalabad	n.a.	n.a.	n.a.	2	1	-	-	5	11	7	7	3	5	-	-	11	-	-	25	-

Source: WAPDA

It was reported in a JBIC's survey conducted in 1999 that Multan substation was experiencing frequent breakdowns of its circuit breaker (seven accidents occurred from 1994 to 1998). These accidents increased the duration of planned and forced outages at Multan. The operational status of Faisalabad (Gutti), which has operated without major difficulties, is generally stable.

2.4 Impact

According to the Multan substation of WAPDA, business activity at mills and small hotels along the road linking the main highway to the Grid Station was stimulated as a result of the service expansion.

The project did not involve any land acquisition or involuntary relocation/resettlement of local residents since the sites for the project had been prepared by the executing agency prior to the commencement of the project.

2.5 Sustainability

2.5.1 Operation and Maintenance

[2] The capacity of one transmission line is approximately 2,380A to 2,450A.

WAPDA is a state-owned enterprise responsible for the following activities in all areas, with the exception of electricity supply service in the Karachi region: (i) generation, transmission, and distribution of power, (ii) irrigation, water supply, and drainage, (iii) prevention of waterlogging and saline land, (iv) flood control, and (v) inland navigation. In cooperation with the World Bank, WAPDA has gone through an institutional reform and privatization process, in which the generation, transmission and distribution division of WAPDA was to be restructured into twelve public companies, as follows: three Thermal Power Generation Companies (GENCOs), one National Transmission & Dispatch Company (NTDC), and eight Distribution Companies (DISCOs). The restructuring process is underway.

The operation and maintenance of the project facilities, including transmission lines and substations, are handled by the Grid System Operation (GSO) Department of WAPDA. The transmission lines are patrolled every 3-4 months by about 200 staff members at GSO.

2.5.2 Technical Capacity

The operation and maintenance of substations in Multan, Guddu, and Faisalabad (Gatti) are carried out by the GSO staff at each substation in accordance with both technical manuals provided by the supplier and instructions from WAPDA. Multan substation has a staff of 18 for operation and 23 for maintenance duties (the situation at the other substations, in Guddu and Faisalablad (Gatti), is unknown due to the lack of data and information).

According to officials at Multan substation, of the main problem with the project facilities are the frequent damage to/fault in the circuit breakers, which are caused by the internal and external faults. As far as internal faults are concerned, it has been difficult to arrange for spare parts through various purchase orders to foreign suppliers. In order to cope with such difficulties, O&M staff has made efforts to purchase materials locally, and have fixed most of the faults. However, as mentioned in Table 4, the frequent maintenance required has led to the long outage hours at Multan substation.

2.5.3 Financial Status

NTDC, a part of WAPDA, is executing the operation and maintenance work of the project. It does not supply electric power directly to customers. Instead, it collects revenue from sales of electric power to distribution companies. The low collection rate (50 to 60% of the amount due) is attributable to nonpayment by end users, rampant power theft and delays in payment from public institutions.

Financial problems, including those related to revenue collection, are common in Pakistan’s power sector. Therefore, there is a great concern over the soundness of public enterprises in this sector. To cope with these problems, the government of Pakistan (GOP) has expressed its further commitment to power sector reform in Pakistan, including the following measures: (a) separation of policy-making, regulation, and provision of power service , (b) liberalization of the power market, and (c) organizational reform and gradual privatization of public enterprises.

Comparison of Original and Actual Scope

Item	Plan	Actual
(1) Project Scope		
a) Substation	- Construction of 500kV substations with 500/220 kV 450MVA ×2 transformers and shunt reactors at Multan	Same as Plan
	- Construction of 500kV substations with 500/220 kV 450MVA ×2 transformers and shunt reactors at Guddu	Same as Plan
	- Expansion of 500kV substations with one bay and shunt reactors at Gatti (Faisalabad)	Same as Plan
b) Power Line Carrier (PLC)	Construction of PLC telecommunication system between above substations and upgrade of existing PLC communication from present 220kV system to 500kV between Guddu, NGPS Multan, 500kV Multan, Gatti, Tarbela and Load Dispatch Centre.	Same as Plan
c) Others	Procurement of spare parts, O&M and testing equipment and tools.	Same as Plan
d) Consulting Services - Design - Tender document review - Supervision	Total: 257.5 M/M	
(2) Implementation Schedule		
a) Selection and Contract for Consultant	May 1982	Mar 1983
b) Tendering	Dec. 1982 – Feb. 1983 (3M)	Nov. 1983
c) Evaluation of Tender	Mar. 1983 – May. 1983 (3M)	Nov. 1983 – Jan. 1984 (3M)
d) Contract for Contractor	Jun. 1983	Apr. 1985
e) Design	Jul. 1983 – Oct. 1983 (4M)	Apr. 1985 – May 1986 (2M)
f) Manufacture, shipment and transportation	Sep. 1983 – Feb. 1985 (18M)	Jun. 1985 – Aug. 1986 (15M)
g) Civil Work	Feb. 1984 – Nov. 1984 (10M)	Aug. 1985 – Dec. 1986 (17M)
h) Erection and Construction	Mar. 1984 – May 1985 (15M)	Dec. 1985 – Dec. 1986 (12M)
i) Commissioning	June 1985	Feb. 1987
Total implementation Period	May 1982 - June 1985 (38M)	Mar 1983 – Feb. 1987 (48M)
(3) Project Cost		
Foreign Currency	12,200 million yen	9,354 million yen
Local Currency	10,478 million yen (=451 million Rs.)	5,573 million yen (=525 million Rs.)
Total	22,678 million yen	14,927 million yen
ODA Loan Portion	12,200 million yen	9,354 million yen
Exchange Rate	1 Rs = 23.2 yen	1 Rs = 10.6 yen