



Completion Report

Project Number: 32107
Loan Number: 1764
November 2008

IND: Power Transmission Improvement (Sector) Project

CURRENCY EQUIVALENTS

Currency Unit – Indian rupee/s (Re/Rs)

		At Appraisal (25 August 2000)	At Project Completion (as of 10 August 2007)
Re1.00	=	\$0.0217	\$0.0246
\$1.00	=	Rs45.890	Rs40.57

ABBREVIATIONS

AC	–	alternating current
ABT	–	availability-based tariff
ADB	–	Asian Development Bank
CEA	–	Central Electricity Authority
CERC	–	Central Electricity Regulatory Commission
EHV	–	extra-high voltage
ESPP	–	environment and social policy and procedures
EIRR	–	economic internal rate of return
FIRR	–	financial internal rate of return
HVDC	–	high voltage direct current
IDC	–	interest during construction
IEE	–	initial environmental examination
IPP	–	independent power producer
LC	–	letter of credit
LIBOR	–	London inter-bank offer rate
MOEF	–	Ministry of Environment and Forests
NTPC	–	National Thermal Power Corporation
O&M	–	operation and maintenance
POWERGRID	–	Power Grid Corporation of India Limited
PCB	–	polychlorinated biphenyl
PLF	–	plant load factor
PAP	–	project affected person
PPA	–	power purchase agreement
RAP	–	rehabilitation action plan
ROE	–	return on equity
SEB	–	state electricity board
SERC	–	state electricity regulatory commission
SFR	–	self financing ratio
WACC	–	weighted average cost of capital
WTP	–	willingness to pay

WEIGHTS AND MEASURES

V (volt)	–	unit of voltage
kV (kilovolt)	–	1,000 volts
W (watt)	–	unit of active power
kW (kilowatt)	–	1,000 W
MVA	–	1,000,000 VA
MW (megawatt)	–	1,000 kW
VA (volt-ampere)	–	units of power/capacity
kVA (kilo volt-ampere)	–	1,000 VA
kWh (kilowatt-hour)	–	unit of energy
km (kilometer)	–	unit of length
ha (hectare)	–	unit of area
ckt-km (circuit kilometer)	–	unit of transmission line length

NOTES

- (i) The fiscal year (FY) of the Government and POWERGRID ends on 31 March. FY before a calendar year denotes the year in which fiscal year ends, e.g., FY2000 ends on 31 March 2000.
- (ii) In this report, '\$' refers to US dollars.

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BASIC DATA

A. Loan Identification

1.	Country	India
2.	Loan Number	1764-IND
3.	Project Title	Power Transmission Improvement (Sector) Project
4.	Borrower	Power Grid Corporation of India Limited
5.	Executing Agency	Power Grid Corporation of India Limited
6.	Amount of Loan	\$250 million
7.	Project Completion Report Number	IND 1079

B. Loan Data

1.	Appraisal	
	– Date Started	5 September 1998
	– Date Completed	19 September 1998
2.	Loan Negotiations	
	– Date Started	20 August 2000
	– Date Completed	21 August 2000
3.	Date of Board Approval	6 October 2000
4.	Date of Initial Loan Agreement	4 December 2000
	Date of Amended and Restated Loan Agreement ¹	17 July 2002
5.	Date of Loan Effectiveness	
	– In Loan Agreement	10 January 2001
	– Actual	10 January 2001
	– Number of Extensions	None
6.	Closing Date	
	– In Loan Agreement	31 March 2006
	– Actual	10 August 2007
	– Number of extensions	Two
7.	Terms of Loan	
	– Interest Rate	Pool-based variable lending
	– Maturity	20 years
	– Grace Period	5 years
	Amended and Restated Loan	
	– Interest Rate	London interbank offered rate (LIBOR) based
	– Maturity	20 years
	– Grace Period	5 years

¹ An amount of \$223,877,445.12 was transformed into loan based on the London interbank offered rate (LIBOR).

8. Disbursements

a. Dates

Initial Disbursements^a	Final Disbursements	Time Interval
8 March 2001	10 Aug 2007	77 months
Effective Date	Original Closing Date	Time Interval
10 January 2001	31 March 2006	62 months

^a Front-end fee, amounting to \$2.5 million, was capitalized on 10 January 2001.

b. Amount (\$ million)

Category	Original Allocation	Last Revised Allocation^b	Amount (Canceled)/ Increased	Amount Disbursed	Undisbursed Balance
01 : Cost Project Expenditure	210.30	244.41	34.11	244.41	0.00
02 : Interest During Construction	37.20	3.09	(34.11)	3.09	0.00
03 : Front End Fee	2.50	2.50	0.00	2.50	0.00
	250.00	250.00	0.00	250.00	0.00

^b Reallocation as of 26 May 2003. Based on POWERGRID's request, ADB reallocated the balance under the Interest During Construction category, amounting to \$34.11 million, to the Cost Project Expenditure category.

C. Project Data

1. Project Cost (\$ million)

Cost	Appraisal Estimate	Revised Estimate^c	Actual
Foreign Currency	394.2	379.82	250.00
Local Currency	97.3	98.63	140.94
Total	491.5	478.45	390.94

^c Revised estimate as of 26 May 2003. The revised estimate includes only the candidate subprojects that were finally financed under ADB loan proceeds.

2. Project Financing Plan (\$ million)

Source	Appraisal Estimate			Revised Estimate^d			Actual		
	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total
ADB	250.0	0.0	250.0	250.0	0.00	250.0	250.0	0.0	250.0
International Commercial Borrowing	120.0	0.0	120.0	0.0	0.0	0.0	0.0	0.0	0.0
Domestic Borrowing	0.0	16.3	16.3	0.0	0.0	0.0	0.0	0.0	0.0
POWERGRID	24.2	81.0	105.2	129.8	98.6	228.4	0.0	140.94	140.94
Total	394.2	97.3	491.5	379.8	98.6	478.4	250.0	140.94	390.94

^d Revised estimate as of 26 May 2003. The revised estimate includes only the candidate subprojects that were finally financed under ADB loan proceeds.

3. Cost Breakdown by Project Component (\$ million)

Item	Appraisal Estimate			Revised Estimate ^e			Actual			
	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	
A. Project Expenditure										
1. Interregional Link Strengthening Between East and West Regions	51.15	15.77	66.92	51.15	15.77	66.92	36.09	6.58	42.67	
2. Grid Strengthening for Goa	34.38	13.67	48.05	34.38	13.67	48.05	18.51	4.63	23.14	
3. Kawas-II (650 MW) Transmission System ^f	20.65	10.37	31.02	0.00	0.00	0.00	0.00	0.00	0.00	
4. Gandhar-II (650 MW) Transmission System ^f	12.16	3.34	15.5	0.00	0.00	0.00	0.00	0.00	0.00	
5. Anta-II (650 MW) Transmission System ^f	35.27	12.44	47.71	0.00	0.00	0.00	0.00	0.00	0.00	
6. Reinforcement of Central Grid in Southern Region	0.00	0.00	0.00	38.72	14.51	53.23	29.27	13.38	42.65	
7. Ramagundam-III Transmission System	0.00	0.00	0.00	15.85	5.84	21.69	18.73	0.23	18.96	
8. Tala Transmission System ^f	176.79	30.41	207.20	0.00	0.00	0.00	0.00	0.00	0.00	
9. Sipat Transmission System				186.03	27.49	213.5	141.81	85.56	227.36	
Subtotal (A)	330.40	86.00	416.40	326.13	77.28	403.41	244.42	110.38	354.79	
B. Interest During Construction	63.80	11.30	75.10	53.69	21.35	75.04	3.09	30.56	33.65	
C. Front End Fees	0.00	0.00	0.00	0.00	0.00	0.00	2.50	0.00	2.50	
Total (A+B+C)	394.20	97.30	491.50	379.82	98.63	478.45	250.00	140.94	390.94	

^e Revised estimate as of 26 May 2003. The revised estimate includes only the candidate subprojects that were finally financed under the ADB loan.

^f These candidate subprojects were dropped from ADB financing.

Source: Power Grid Corporation of India Limited and Asian Development Bank's loan financial information system.

4. Project Schedule

Item	Appraisal Estimate		Actual	
	Start	End	Start	End
A1: Interregional Link Strengthening Between East and West Regions				
Tendering and Award of Contract	Jun 1999	Jan 2001	June 1999	May 2001
Supply, Erection, and Commissioning	Feb 2001	Jan 2004	Feb 2001	Mar 2003
A2: Grid Strengthening of Goa				
Tendering and Award of Contract	May 2000	Dec 2000	May 2000	Mar 2001
Supply, Erection, and Commissioning	Apr 2001	Jul 2003	Dec 2000	Dec 2002
A3: Reinforcement of Central Grid in Southern Region				
Tendering and Award of Contract	July 2000	Mar 2001	Jul 2000	Sep 2002
Supply, Erection, and Commissioning	Apr 2001	Aug 2005	Jan 2002	Mar 2005
B1: Ramagundam-III Transmission System				
Tendering and Award of Contract	Dec 2000	Oct 2001	Dec 2000	Sep 2002
Supply, Erection, and Commissioning	Nov 2001	Nov 2004	Aug 2002	Nov 2004
B2: Sipat Transmission System				
Tendering and Award of Contract	May 2002	Jan 2003	May 2002	Apr 2005
Supply, Erection and Commissioning	Feb 2003	Feb 2007	May 2004	Apr 2008

Source: Power Grid Corporation of India Limited

5. Project Performance Report Ratings

Implementation Period	Ratings	
	Development Objectives	Implementation Progress
From 1 December 2000 to 31 January 2004	S	S
From 1 February 2004 to 30 April 2004	S	PS
From 1 May 2004 to 31 July 2007	S	S

S = Satisfactory, PS = Partly Satisfactory.

Source: Project Performance Reports of the Asian Development Bank.

D. Data on Asian Development Bank Mission

Name of Mission	Date	Number of Persons	Number of Person-days	Specialization of members ^a
Consultation	16-31 January 1998	4	64	a,q
Consultation	9-12 March 1998	1	4	r
Fact Finding	11-22 May 1998	12	108	a,b,d,g,h,i,o,q
Project Specific Contact	10-11 August 1998	1	2	a
Appraisal	7-19 September 1998	11	143	a,b,c,d,g,h,o,s,q
Consultation	17-25 February 2000	2	18	a,b
Inception	30 April-2 May 2001	3	9	a,k,q
Special Loan Administration (1)	5 November 2001	2	2	q
Review (1)	21 October and 26 October to 1 November 2002	3	17	a,k,q
Review (2)	29 November to 5 December 2003	1	7	a
Review (3)	8-12 December 2004	1	5	a
Review (4)	23-26 December 2005	1	4	a
Special Loan Administration (2)	23-24 November 2006	1	2	a
Project Completion Review	22-30 September 2008	2	16	a, k

^a a – engineer, b – financial analyst, c – counsel, d – economist, e – procurement specialist, f – control officer, g – programs officer, h – environmental specialist, i – social development specialist, j – poverty reduction specialist, k – assistant project analyst, l – resettlement specialist, m – disbursement assistant, n – consultant, o – Resident Representative, p – Manager, q – project implementation officer, r – Director, s – cofinancing officer

^b The report was prepared by Vallabha Rao Karbar, Senior Project Implementation Officer (Energy), Michael Gomes, Assistant Project Analyst and a Staff Consultant, who assisted the PCR Mission in the financial and economic analysis.

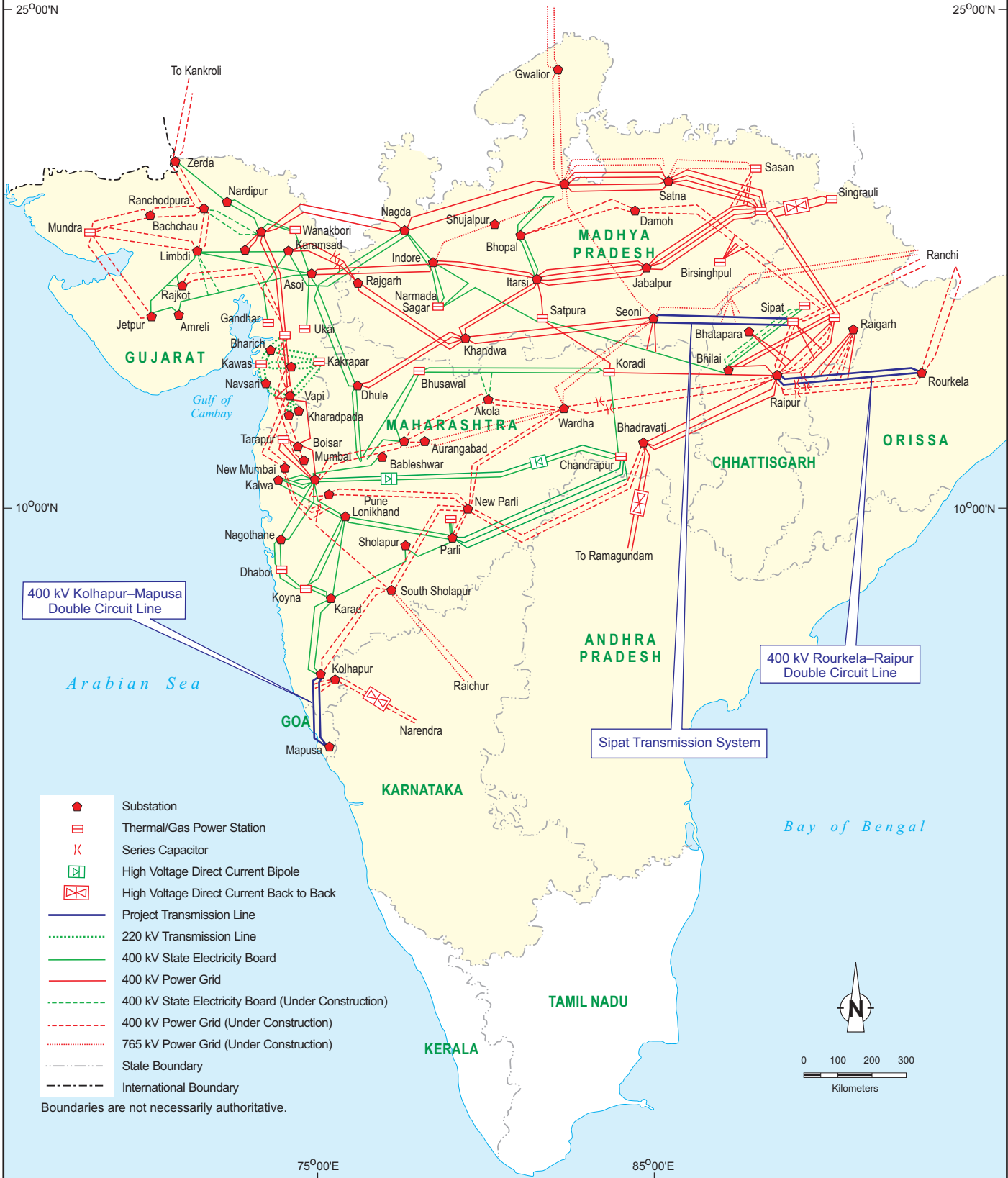
Source: Back-to-Office Reports of the Asian Development Bank.

(v)

INDIA POWER TRANSMISSION IMPROVEMENT (SECTOR) PROJECT (as completed)



INDIA POWER TRANSMISSION IMPROVEMENT (SECTOR) PROJECT (as completed)



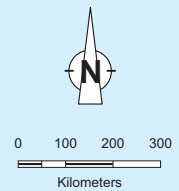
400 kV Kolhapur-Mapusa Double Circuit Line

400 kV Rourkela-Raipur Double Circuit Line

Sipat Transmission System

- Substation
- Thermal/Gas Power Station
- Series Capacitor
- High Voltage Direct Current Bipole
- High Voltage Direct Current Back to Back
- Project Transmission Line
- 220 kV Transmission Line
- 400 kV State Electricity Board
- 400 kV Power Grid
- 400 kV State Electricity Board (Under Construction)
- 400 kV Power Grid (Under Construction)
- 765 kV Power Grid (Under Construction)
- State Boundary
- International Boundary

Boundaries are not necessarily authoritative.



I. PROJECT DESCRIPTION

1. In October 2000, the Asian Development Bank (ADB) approved a power transmission improvement sector project loan of \$250 million to Power Grid Corporation of India Limited (POWERGRID) to meet part of the public sector company's investment needs¹. The Project's objectives were to strengthen POWERGRID's transmission system to improve system reliability, reduce transmission losses, improve the quality of its power supply, and allow efficient utilization of existing and planned generation plants. The Project also involved broader indirect objectives, which were pursued in response to ADB's policy dialogue with the Government. These included supporting the restructuring of India's power sector by facilitating the unbundling of generation, transmission, and distribution, as well as the entry of independent power producers (IPPs). It was expected that the Project would facilitate the reform of the power sector at the state level by allowing investments that benefited only those states with records of payment to POWERGRID. The Project also aimed to put all bulk power supply and transmission service on a sound economic basis by establishing appropriate pricing and to enhance the autonomy of POWERGRID.

2. The Project had two components²: Part A—upgrading and expanding 400 kilovolt (kV), 220 kV, and 132 kV transmission systems to transfer additional power, improve system reliability, and enhance the efficient utilization of power plants; and Part B—installing 400 kV and 220 kV transmission systems to evacuate the power generated by central power utilities. Part A comprised (i) interregional link strengthening between the east and west regions, (ii) grid strengthening for Goa, and (iii) reinforcement of the central grid in the southern region. Part B comprised the Ramagundam-III transmission system and the Sipat transmission system.

3. At appraisal, India had an installed power generation capacity of 98,000 megawatts (MW). Power shortages, poor quality supply with significant voltage fluctuations, and frequent load shedding in most parts of the country undermined industrial competitiveness and posed severe constraints on economic development. Demand for electricity was estimated to reach 975 billion kilowatt-hours (kWh) at the end of the 11th five-year plan in 2012. This would require an installed capacity of about 200,000 MW, with matching augmentation of transmission and distribution facilities. Financing these capacity expansions was a major challenge for state electricity boards (SEBs) that were already reeling under heavy debts arising from inadequate tariffs, payment defaults by consumers, and huge transmission and distribution losses.

4. The power system in India is organized into five electrical regions: northern, northeastern, eastern, western, and southern. Each electrical region attempts to connect and synchronize power systems of neighboring states within the region but transmission capacity between regions was limited. This means that some regions with surplus installed capacity are unable to export power to regions in deficit. Furthermore, the investment ratio for generation and transmission in India, including distribution, is about 70:30, compared with the recommended 50:50. This has limited the scope for interregional and intraregional power transfer capabilities and inhibited (i) optimal use of existing installed generation capacities, and (ii) development of megapower plants. Before the establishment of POWERGRID in October 1989, the National Thermal Power Corporation (NTPC), the National Hydro Power Corporation, and Neyveli Lignite

¹ ADB. 2000. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to India for the Power Transmission Improvement (Sector) Project*. Manila.

² The three Part A subprojects and the Ramagundam-III transmission system under Part B were the candidate projects identified and approved by ADB for inclusion under the ADB assistance at the time of project appraisal. The second subproject under Part B, the Sipat transmission system, was appraised and approved by ADB for inclusion under ADB financing after the initial project appraisal.

Corporation constructed and operated the transmission facilities that evacuated power from their power plants and transmitted it to client SEBs. Because the requirements for transmission facilities had grown considerably since the establishment of these and other generating companies, the Government of India recognized that it would be more efficient to have a national transmission utility that would (i) be responsible for developing transmission systems to evacuate power from central power sector plants and (ii) construct and operate transmission facilities to transfer power among SEBs within a region and between regions.

5. New government policies adopted in the last 10 years to promote megapower plants prioritized (i) development of additional transmission capacity to evacuate power from planned power plants, (ii) provision of high-voltage transmission corridors to facilitate interregional power transfers, (iii) implementation of system-strengthening schemes, and (iii) formation of a national grid. With these objectives, POWERGRID formulated a detailed, long-term transmission development plan. The capital requirements for this plan were estimated at about \$5.0 billion from FY2001 to FY2006. ADB agreed to finance part of these requirements through the transmission sector loan.

6. Under the original financing plan, ADB was to finance \$250 million (51.0%) of the total project cost of \$491.5 million. The balance, the equivalent of \$241.5 million (49.0%), was to be financed by POWERGRID from (i) its own resources (\$105.2 million), (ii) domestic borrowings (\$16.3 million), and (iii) commercial cofinancing (\$120 million), with a partial credit guarantee from ADB. However, POWERGRID did not avail of this partially guaranteed cofinancing facility. The funding requirements to complete the subprojects were met entirely from POWERGRID's own resources and domestic borrowings. The project components funded under the loan included (i) substation equipment; (ii) transmission line towers, aluminum conductors, and insulators; and (iii) part of the erection works.

II. EVALUATION OF DESIGN AND IMPLEMENTATION

7. The main events in project implementation are presented chronologically in Appendix 1.

A. Relevance of Design and Formulation

8. The Project design was rated *highly relevant*.

9. Although total electrical energy production in India has grown from 480.7 billion kWh at appraisal, with an installed capacity of 98,000 MW, to about 710 billion kWh, with an installed capacity of 141,079 MW as of 31 January 2008, the country is still experiencing a peak power shortage of 15.2% and an energy shortage of 9%. It is estimated that demand for electricity will grow to 975 billion kWh in 2012, requiring an installed capacity of over 200,000 MW. The interregional power transfer capacity of 500 MW in 1995 grew to 5,000 MW in 2000 and to 17,000 MW in 2008 and will increase to 37,000 MW by 2012. The Project has (i) made a significant contribution to providing a transmission system capable of evacuating more than 3,500 MW from the new generating plants commissioned during 10th five-year plan period (2002–2007); (ii) strengthened the transmission system in southern, western, and eastern regions, enabling these regions to meet increased power demands; and (iii) facilitated interregional power transfers to the tune of 1,000–1,400 MW. The Project remained *highly relevant* at completion and will continue to be so, since the demand for power is still growing in India and bulk power transmission and interregional power exchanges will continue to increase because energy sources in the country are unevenly distributed. In addition, the Government is strongly emphasizing the development of transmission corridors across the regions, with a goal

of providing power exchanges of 37,000 MW by 2012. The Project's components will help in achieving this objective.

10. At appraisal, ADB's country operational strategy for India supported reinforcing and expanding existing transmission and distribution systems related to existing and new generation, and establishing regional and national grids. ADB's assistance was designed to support POWERGRID's efforts to establish a transmission infrastructure to (i) evacuate power from the new generating plants being constructed at coal pitheads, (ii) use existing generating capacities efficiently by facilitating interregional power exchanges, and (iii) increase the availability of power and improve the reliability of the power supply in the southern and western regional grids. ADB support to POWERGRID was also a key element of ADB's strategy to improve power sector efficiency, since the infrastructure provided under the Project has made the utilization of existing generating capacities more efficient and has improved the performance of the eastern regional grid by establishing the eastern and western interregional transmission link which improved the plant load factor of the power plants in eastern region and reduced grid disturbances. The support to POWERGRID and government assurances during project processing also helped implement an availability-based tariff (ABT), improve grid discipline in the power sector, and determine bulk supply and transmission tariffs on a commercial basis. In the future, the subprojects will help POWERGRID establish and operate a national grid on a real-time basis, which will result in efficient utilization of the existing power infrastructure facilities and optimal long-term use of energy resources.

11. The Project's components were implemented without deviating from the designs adopted at appraisal. POWERGRID is able to operate all the components of the Project satisfactorily and the annual availability of the transmission system is 99.2%. The Project has helped to (i) evacuate the power from the new central sector power plants to the beneficiary states in western and southern regions; (ii) facilitate the transfer of power from the power-surplus eastern region to the power-deficit western region; (iii) improve the plant load factor of power stations in the eastern region; (iv) enhance the power transfer capability of the central transmission sector, as well as improve the system reliability and stability of the southern regional grid; (v) optimize existing installed capacities by facilitating interregional power exchanges; and (vi) strengthen the power evacuation system for Goa, particularly to import its share of power from the central sector power generating units in western region. This demonstrates the appropriateness of the project design and rationale.

12. The Project was formulated in close coordination with POWERGRID and India's Ministry of Power and Department of Economic Affairs.

13. Thus, the Project was and still is consistent with the Government's objectives to establish an adequate electricity transmission system in the country to evacuate power from the generating stations, to provide links to facilitate the interregional exchange of power, and to strengthen the regional grids to improve the system's reliability and stability. The Project was also consistent with ADB's strategy for the Indian energy sector at appraisal and at completion (paras. 9 and 10).

B. Project Outputs

14. All the components of the Project have been completed as envisaged. The updated project framework is in Appendix 2. A brief review of the status of the completion of project components follows:

1. Interregional Link Strengthening Between East and West Regions

15. This subproject comprised construction of (i) 403 kilometers (km) of 400 kV Raipur–Rourkela double-circuit (D/C) transmission line, and (ii) bay extensions at Rourkela and Raipur 400/220 kV substations. The subproject was completed in March 2003 and has been operating satisfactorily since then. Although the subproject was intended to facilitate export of 1,000 MW of surplus power from the eastern region to the western region, the subproject is exporting power in the range of 1,000–1,400 MW. The power transfer through this interconnector has improved the reliability and efficiency of the power systems of both the regions because of the differences in load diversity and generation mix between the two regions. The average annual power transfer from the eastern region to the western region during the past 4 years was 6.5 billion kWh. This subproject was completed on time and it has helped meet part of the growing power demand in the power-deficit western region states and improve the utilization of existing generating capacities in the eastern region. Additionally, the establishment of an alternate current (AC) link between the regions is helping POWERGRID operate the eastern and western regions in synchronous mode.

2. Grid Strengthening for Goa

16. The Goa subproject comprised (i) construction of 150.3 km of a 400 kV Kolhapur–Mapusa D/C transmission line; (ii) construction of a 400/220 kV substation at Mapusa; and (iii) extension of bays at the 400/200 kV substation at Kolhapur. Completed in December 2002, the subproject was formulated to establish a direct transmission link between the western region grid and Goa to allow Goa to draw its share of 395 MW power from the central generating stations of the western region. This transmission line has evacuated an average of 1,265 million kWh of power annually since its commissioning, helping Goa meet increased demand with improved reliability and stability. POWERGRID was able to make the system available more than 99% of the time. Prior to this project, POWERGRID reported that the 220 kV system was always heavily overloaded due to Goa's inadequate transmission system and voltage levels were very poor, leading to frequent trippings. Since the subproject was commissioned, no major trippings have occurred in the state and the reliability of the power supply has been substantially enhanced.

3. Reinforcement of Central Grid in Southern Region

17. The southern region subproject comprised construction of (i) a 144.6-km 400 kV Khammam–Nagarjunasagar single-circuit (S/C) transmission line; (ii) a 340.3-km 400 kV Hyderabad–Kurnool–Gooty S/C transmission line; (iii) a 256.1-km 400 kV Gooty–Neelamangala S/C transmission line; and (iv) bay extension of 400/220 kV substations at Hyderabad, Khammam, Nagarjunasagar, Gooty, Neelamagala, and Kurnool. This subproject was completed in March 2005. Prior to the strengthening of the 400 kV network in the southern region, POWERGRID was able to transmit power from central sector generating stations and from the eastern and western regions to the northern part of Andhra Pradesh but there were network constraints for further distribution to such major load centers as Kadapa, Bangaluru, Raichur, and Chennai. The subproject was therefore formulated to strengthen the 400 kV network to facilitate the smooth displacement of about 200 MW of power to the southern region states without overloading the existing system. POWERGRID informed the PCR Mission that the subproject had achieved this objective and had also substantially improved system reliability and stability.

4. Ramagundam–III Transmission System

18. This subproject comprised construction of (i) a 391.1 circuit-km 400 kV Ramagundam–Hyderabad D/C transmission line; and (ii) bay extension of the 400/220 kV Hyderabad substation. Completed in November 2004, the subproject has enabled the evacuation of power from the third unit of the 500 MW central sector generating plant of NTPC at Ramgundam to the states of Andhra Pradesh, Karnataka, Tamil Nadu, and Kerala. An average 3,500 million kWh of energy is being transferred annually through this line, compared with the estimated figure of 2,270 million kWh per annum.

5. Sipat Transmission System

19. The Sipat subproject comprised construction of (i) two S/C 765 kV Sipat–Seoni transmission lines totaling 703.27 km in length; and (ii) a 765/400/220 kV substation at Seoni, with 10 single-phase 500 MVA 765/400 kV and two 315 MVA 400/220 kV auto-transformers and associated bays. The first circuit of the Sipat–Seoni 765 kV line works and the associated Seoni substation works were completed in September 2007. The rest of the Seoni substation and the second circuit were finished in April 2008, the subproject's full completion date. The subproject was designed to evacuate 2,980 MW power from NTPC's Sipat generation project but only one 500 MW generating unit has been commissioned to date and the system has been limited to date to that level of power transmission. The remaining generating units—one of 500 MW and three of 660 MW—are expected to be commissioned progressively by September 2009. Once they are commissioned, the Sipat transmission project will evacuate the generation station's entire power production to its beneficiary states of the western region. The average annual power evacuation through this subproject will then range from 12 billion kWh to 14 billion kWh, considerably improving the power supply situation in Madhya Pradesh, Gujarat, Maharashtra, and Chhatisgarh.

C. Project Costs

20. The project³ cost was estimated at appraisal to be the equivalent of \$478.45 million, comprising \$379.82 million in foreign currency (79.5%) and the equivalent of \$98.63 million (20.5%) in local currency. The ADB loan at appraisal was \$250 million. It was fully utilized. Overall cost savings were equivalent to \$87.52 million (18.29%). Appendix 3 compares estimated with actual project costs. The summary of contracts appears in Appendix 4. Appendix 5 provides the average exchange rates used to convert local currency to the dollar equivalent.

21. Appendix 6 compares the project financing plan. The appraisal initially envisaged a foreign currency expenditure of \$250 million from the ADB loan (52.25% of total project cost), with \$129.82 million in foreign currency and the equivalent of \$98.63 million in local currency from international commercial cofinancing, the internal resources of POWERGRID, and domestic borrowings. However, POWERGRID did not avail of the cofinancing facility that was to be partially guaranteed by ADB. The funds requirements for the completion of the subprojects were met from POWERGRID's own resources and domestic borrowings. ADB's share of financing increased from 52.25% to 63.95%.

³ For comparison purposes, the revised estimated cost of the Project—i.e., the appraisal estimates of subprojects that were finally financed under ADB loan—were considered.

22. The cost savings of \$87.52 million can be attributed to (i) lower-than-estimated procurement costs incurred in equipment and erection packages (\$48.63 million), due to competitive rates obtained; and (ii) savings in interest during construction (\$38.89 million).

D. Disbursements

23. ADB approved a loan of \$250 million from ordinary capital resources on 6 October 2000. Disbursements totaled \$250 million out of the original loan amount of \$250 million. A reimbursement procedure approved by ADB was used for disbursement purposes. Initial disbursements under the loan started on 8 March 2001 and the final disbursement was on 10 August 2007, 77 months later. In April 2003, POWERGRID asked ADB to reallocate the \$34.114 million amount available under IDC-category to the project category. This was approved by ADB on 26 May 2003. POWERGRID expressed satisfaction with the disbursement procedures of ADB and informed the PCR Mission that it had encountered no disbursement problems. The projected and actual disbursements are given in Appendix 7. The disbursements actually achieved are very close to the projected disbursement figures.

E. Project Schedule

24. The planned implementation steps of the subprojects are compared with the actual sequence of events in Appendix 8. It was estimated at appraisal that all subprojects would be completed before the loan closing date of 31 March 2006. All subprojects except for the Sipat transmission system were completed well before the original closing date. However, to complete the disbursements for the contracts awarded under the Sipat transmission system subproject and to facilitate the completion of the subproject, the loan closing date was extended to 31 July 2007 at the request of the borrower. To enable the disbursements under the loan account to be completed, the account was kept open until 10 August 2007. The major milestones in the implementation of the subprojects follow.

1. Interregional Link Strengthening Between East and West Regions

25. Advance procurement action (APA) was taken for this subproject with prior approval of ADB and all seven contract packages were awarded by May 2001, compared with an appraisal schedule of January 2001. Despite the 4-month delay in contract award, the subproject was completed by March 2003, against the scheduled target of January 2004. Although the original implementation schedule for the subproject was in line with the time required for execution of similar transmission line projects in India, POWERGRID reduced the implementation period at the time of tendering and awarded the contract accordingly, due to the benefits it expected would accrue to the beneficiary states by enabling the earlier export of power from the eastern region to the western region.

2. Grid Strengthening for Goa

26. With ADB's prior approval, APA was taken for the Goa subproject and all four contract packages were awarded by March 2001, against an appraisal schedule of December 2000. The subproject was completed in December 2002, against the scheduled date of July 2003. APA and timely approval of the required statutory clearances helped in completion of the subproject earlier than planned.

3. Reinforcement of Central Grid in Southern Region

27. As required for the works under the southern region subproject, 11 contract packages were awarded between December 2001 and September 2002. The subproject was completed in March 2005, compared with the target date of August 2005. POWERGRID informed the PCR Mission that, due to the urgent need for strengthening the central transmission network in the southern region, the company reduced the implementation schedule and awarded the contracts accordingly. This helped advance completion.

4. Ramagundam–III Transmission System

28. Four contract packages were awarded between December 2001 and September 2002, as per the requirements of various works under this subproject. The subproject was completed, as originally scheduled, in November 2004.

5. Sipat Transmission System

29. Between February 2004 and April 2005, 14 contracts were awarded for construction of the Sipat transmission line and two for establishment of the 765/400/220 kV substation. The subproject was originally planned for commissioning by February 2007, to match the commissioning schedule of NTPC's Sipat generation project. However, due to delays in execution of the generation project and to match its implementation schedule, POWERGRID revised the implementation schedule of the Sipat transmission project. Accordingly, the first circuit of the transmission system and associated substation works were completed in September 2007 and the second circuit and its associated substation works were completed in April 2008.

F. Implementation Arrangements

30. The implementation arrangements remained as envisaged at appraisal. ADB found them adequate. Overall responsibility for project implementation was with the director (projects) of POWERGRID, who was assisted by the corporate monitoring group. Construction supervision of each subproject was under the executive directors of the respective regions, assisted by the planning, engineering, finance, and personnel departments at regional headquarters. Engineering and contracting activities for all contract packages funded under the ADB loan component were carried out from the corporate headquarters of POWERGRID in Gurgaon, Haryana. The company's executive director (corporate planning) was in charge of overall coordination with ADB. POWERGRID's computerized integrated project management system enabled (i) a master network schedule for each project; (ii) separate work schedules for each contract package with contractors to meet the master network schedule; and (iii) regular progress review and monitoring at field, regional, and corporate levels. Subproject progress was periodically monitored by the respective regional executive directors through weekly and monthly review meetings. The implementation progress of each subproject was reviewed regularly by POWERGRID's top management at quarterly project review meetings. Forest clearances, land acquisition for substations, and rehabilitation of project-affected persons were planned and executed as and when required to avoid delays. The organization chart of POWERGRID is in Appendix 9.

G. Conditions and Covenants

31. There were no particular conditions for the effectiveness of the loan agreement. No covenant was modified, suspended, or waived during implementation. The status of compliance with covenants is given in Appendix 10. POWERGRID was generally in compliance with all loan covenants. POWERGRID submitted its audited accounts and financial statements to ADB within the time stipulated in the loan agreement.

H. Related Technical Assistance

32. No technical assistance is related to this Project.

I. Consultant Recruitment and Procurement

1. Consultants

33. Although it was not envisaged that consultants would be engaged, POWERGRID recruited an international consulting firm to provide technical assistance for preparation of technical specifications for the 765 kV Sipat transmission system and substation. POWERGRID appointed the consultant using its own resources and followed its own guidelines for recruitment.

2. Procurement

34. POWERGRID's made use of the advance procurement facility was agreed to by ADB. Because of this, POWERGRID was able to award all major contracts for first set of subprojects immediately after loan approval. ADB cooperated with POWERGRID to achieve the important milestones in project implementation by according necessary approvals expeditiously. In general, POWERGRID carried out all procurement activities for ADB-financed contract packages in accordance with ADB's *Procurement Guidelines (2007, as amended from time to time)*.

J. Performance of Consultants, Contractors, and Suppliers

35. POWERGRID reported that the consultants performed the assigned tasks diligently and professionally and in accordance with their terms of reference. POWERGRID also reported that the performance of all contractors was generally satisfactory. All goods and services procured for the Project complied with the specifications and other operational performance standards.

K. Performance of the Borrower and the Executing Agency

36. POWERGRID was both the borrower and the executing agency. The overall performance of POWERGRID in both roles was *highly satisfactory*. All the project components, with the exception of the Sipat transmission subproject, were completed well before the original envisaged dates of completion. The Sipat project was delayed primarily due to delays in implementation of NTPC's Sipat generation project. POWERGRID was also able to operate and maintain all the subprojects at very high levels of availability, which was commendable. Overall annual availability of POWERGRID's transmission system during 2006/07 was 99.2%, which compares well with the best transmission utilities in the world. Overall, POWERGRID has demonstrated its capacity to formulate and appraise, arrange finance for, and carry out engineering, procurement, and construction of a variety of projects across the country, conforming to approved specifications and standards and to the satisfaction of ADB.

L. Performance of the Asian Development Bank

37. ADB closely and regularly monitored the project progress through review measures and quarterly progress reports, and provided useful advice in several areas, including procurement and project management. ADB accorded timely approvals that enabled project milestones to be achieved, which contributed to smooth project execution.

38. ADB's India Resident Mission also closely monitored project administration. Administration of the Project was delegated to the resident mission in January 2003. ADB, POWERGRID, and officials from the Indian Department of Economic Affairs held many tripartite meetings, which helped in the successful implementation of the Project. The resident mission also closely monitored project administration, and timely corrective measures were proposed on several occasions. Thus, ADB's overall performance was rated *highly satisfactory*.

III. EVALUATION OF PERFORMANCE

A. Relevance

39. At appraisal and completion, the Project was rated *highly relevant* to the power sector objectives of the Government and to ADB's sector strategy and country strategy for India. At appraisal, the Government's objective was to improve efficiency in the power sector by removing transmission bottlenecks to facilitate better utilization of existing and planned generating stations and entry of independent power producers. ADB's country strategy was to fund infrastructure projects in key sectors that contributed to economic growth. Its sector strategy focused on (i) reinforcing and expanding existing transmission and distribution systems related to existing and new generation, and establishing regional grids and the national grid; (ii) reforming state power sectors, with particular emphasis on SEBs restructuring, and commercialization; (iii) rationalizing power tariffs at bulk and retail levels; (iv) reforming the regulatory framework; and (v) improving energy efficiency. Because of the critical services it provides, POWERGRID was also considered by ADB to be a significant agent for change in the power sector, which had been undergoing radical reforms since early 1990s. At project completion, ADB's strategy for the power sector in India was in synergy with the Government's 11th five-year plan objectives (2007–2012) to develop infrastructure for economic growth and poverty reduction. ADB's current strategy for assistance to India's power sector includes (i) reinforcing the power sector; (ii) promoting higher efficiency and low-carbon power sources; (iii) expanding and optimizing transmission and distribution systems; (iv) providing institutional strengthening to implement reforms required by Electricity Act of 2003; (v) promoting private sector participation; and (vi) encouraging energy conservation and ensuring environmental and social sustainability. The project outputs contributed to achieving these objectives.

40. India's central and state governments are pursuing capacity expansion, reforms, provision of a transmission infrastructure that optimally utilizes existing installed capacities, the setting of bulk and retail tariffs on commercial terms by independent regulators, and private sector participation. To achieve these objectives, the Government enacted a comprehensive Electricity Act in 2003. The Project was aimed at making the transmission sector more efficient and it was therefore *relevant* at appraisal and at completion. The Project will continue to be relevant in the future because of the rapid expansion of the power sector, including the need for bulk transmission of power and greater interregional power exchanges. The subprojects will also continue to facilitate the future implementation of the open access policy under the Electricity Act.

B. Effectiveness in Achieving Outcome

41. The Project achieved its immediate objectives of (i) upgrading and expanding 400 kV transmission systems to transfer additional power, to improve system reliability, and to enhance the efficient utilization of power plants; (ii) establishing adequate transmission systems to evacuate the power generated by central power utilities to the beneficiary states in the western and southern regions of India; and (iii) facilitating the export of power from the power-surplus eastern region to the power-deficit western region. POWERGRID was able to operate all the project components at very high levels of efficiency. The Project achieved the physical targets established at appraisal. The original implementation schedule for the subprojects of Part A and for the Ramagundam-III transmission system under Part B was in line with the time normally required for construction of such transmission line projects in India. POWERGRID management, however, mobilized all possible resources to complete these subprojects well before envisaged completion dates, with the aim of optimizing the benefits to the beneficiary states. This effort was well appreciated by these states. The Project achieved its expected outcomes. The Project was rated as *effective*.

C. Efficiency in Achievement of Outputs and Purpose

42. The Project is rated *efficient*. It has been implemented efficiently and all the subprojects have been operating continuously at almost full capacity from the date of commissioning, except the Sipat transmission system subproject (paras 15–19). The power flow through this transmission system is still much lower than envisaged because the associated generation project is yet to be fully completed. After all units at the Sipat generation project are commissioned, now expected in late September 2009, the Sipat subproject will be operating continuously to its capacity.

43. The financial internal rate of return (FIRR) of the subprojects, except Sipat Transmission project⁴, is well above POWERGRID's weighted average cost of capital (WACC) of 5.35%. The economic internal rate of return (EIRR) of the subprojects (except the Sipat Transmission project) has been reevaluated at more than 12%. Major assumptions used in the financial evaluation, economic evaluation, and detailed calculations of FIRR and EIRR are in Appendix 11.

D. Preliminary Assessment of Sustainability

44. Technically, the design of all the subprojects and the technology adopted are robust and appropriate, given the technical parameters, requirements of the Indian power sector, and the Project's long-term sustainability. Future funding for the required operation and maintenance is not expected to be a problem. Transmission tariffs are determined based on cost-plus methodology, which ensures the recovery of costs incurred at normative availability of the transmission system at 98% and a return on equity of 14% per annum. As the FIRR of all the subprojects exceed the WACC, the Project is financially viable, and its returns will contribute to

⁴ FIRR and EIRR were not evaluated for the Sipat transmission system subproject because the power flow through this line was still only about 15% of the total envisaged at appraisal. This was due to the fact that only one 500 MW unit at NTPC's Sipat generation project, which will provide the electricity for this line, compared with the total capacity of 2,980 MW (2X500+3X660). All the units are expected to be commissioned progressively by September 2009. After these units go into operation, the subproject will be fully utilized. Also, POWERGRID informed the PCR mission that, due to delays in commissioning of generation project, it is entitled to compensation for the investments made in establishing the transmission link, as per the Central Electricity Regulatory Commission (CERC). The compensation will be paid by the generation company to the POWERGRID, as per CERC norms.

POWERGRID's overall financial health. Furthermore, the Project is expected to remain financially sustainable because (i) POWERGRID has executed commercial contracts with all the project beneficiaries to provide transmission system and (ii) POWERGRID is also holding a letter of credit (LC) for 101% of the monthly billing of the beneficiaries. According to government forecasts, power shortages and constraints in the power delivery system will continue in the future. As a result, there will be adequate demand for the evacuation of power from existing stations and for the transfer of power from regions with a surplus to regions with a deficit, ensuring the optimum utilization of the transmission systems established under the Project. The technical standards and quality systems adopted, and the material and equipment procured and installed are superior and are unlikely to become obsolete. POWERGRID also has in-house capacity to operate and maintain the subprojects effectively and efficiently. Hence, all the components are expected to be used optimally throughout the life of the Project. The Project benefits and development impacts are *sustainable*.

E. Impact

1. Environmental Impacts

45. In line with the initial environmental assessment (IEA) and initial environmental examination (IEE) reports submitted to ADB, along with respective project appraisal reports, POWERGRID has taken adequate safety measures to minimize the Project's impact on the environment. These measures include (i) special care in route selection of transmission lines to avoid alignments through developed areas, human settlements, and cultural and historical places⁵, (ii) attention to avoiding damage to forests, as far as possible⁶, and (iii) efforts to create robust institutional arrangements for monitoring of environmental mitigation measures.

46. As per the Forest Conservation Act, all transmission lines infringing on ecologically sensitive areas require prior approval by the Ministry of Environment and Forests (MOEF). Approval from MOEF was obtained in a timely manner for all the subprojects that infringed on forest lands. Forests were avoided as far as possible in the selection of the transmission line route. Where this was not possible, the routing in a forest area was conducted in consultation with respective forest authorities to minimize damage and ensure that the impact of the transmission lines on wildlife would be nil. Over the 2,942 cct-km of transmission lines built under the Project, 617.22 hectares (ha) of forest area were affected, for which Rs475.32 million (about \$11.72 million equivalent) was paid under the government rules to the state forest departments for compensatory afforestation. The transmission routes avoided wetlands and unstable areas and were selected to avoid relocation of people and threats to common property resources. POWERGRID informed the PCR mission that necessary engineering and biological measures were taken to prevent soil erosion along the routes.

47. The impact of the Project on agricultural land along the transmission line route was restricted to the construction phase. Adequate compensation was determined by the district

⁵ POWERGRID tried to align the transmission line in such a manner that it would pass through underdeveloped areas and have negligible potential for adverse impacts.

⁶ (i) forest was avoided as far as possible, (ii) where ever not possible to avoid forest, routing of transmission lines in forest was done in consultation with concerned divisional forest officers, (iii) line routes avoided wetlands and unstable areas, (iv) routing of lines were selected in such a way that the impact of transmission lines on wildlife will be nil or bare minimum, (v) lopping of trees in forest areas to maintain line clearances is being done under direction from Forest Department, and (vi) compensatory afforestation was carried out as per the laws of central government.

authorities and paid to the affected persons. POWERGRID has paid Rs116.92 million in compensation (the equivalent of \$2.88 million) for loss of crops during construction and losses due to damage to trees. To minimize crop loss, the construction activities were carried out during the off-season where possible.

48. The transformers and other equipment used in the Project are free from polychlorinated biphenyl (PCB). Used batteries and transformer oil are disposed of in accordance with the provisions of MOEF. Compliance with these provisions is reported to MOEF through biannual reports.

49. At Mapusa substation, POWERGRID has converted about 8.1 ha of surrounding barren land into green belt by planting 11,500 plants. POWERGRID has also constructed a rain harvesting tank at the substation site for increasing the ground water level in surrounding areas. At the Seoni substation, 1.22 ha of land is earmarked for plantation. POWERGRID informed the PCR Mission that its corporate policy since 2001 has been to construct a rain harvesting tank at all new substations.

50. POWERGRID has established a full-fledged environment management department headed by an executive director at its corporate office. The deputy general manager/chief manager at regional headquarters is responsible for monitoring the implementation of the environmental impact mitigation and rehabilitation measures for the subprojects. POWERGRID has not submitted quarterly monitoring reports on the compensatory forests status as required (refer para. 24 of Appendix 10).

2. Social Impacts

51. The Project is gender-neutral with regard to beneficiaries, as all categories of electricity consumers—domestic, agricultural, industrial, and commercial—derive benefits from the Project. These benefits include increased power availability, fewer supply interruptions, and less load shedding. The Project increased the availability and reliability of power supply in the southern and western regions. Other benefits include increased industrial productivity and job creation in the manufacturing sector through additional power supply.

52. Satisfactory measures have been taken by POWERGRID to address the concerns of the project-affected persons (PAPs) and to provide rehabilitation assistance to them. These included (i) special care in route selection of transmission lines to avoid human rehabilitation, threats to survival of vulnerable communities, and common property resources; (ii) adequate compensation for damages to crops, trees, and buildings/structures, if any; (iii) adequate compensation and rehabilitation assistance for PAPs; (iv) robust institutional arrangements for monitoring of rehabilitation measures; (v) employment for PAPs and local people by contractors during construction; (viii) employment for PAPs and local residents through contractors after project completion.

53. The Project involved construction of two new substations for which land was acquired, at Mapusa and Seoni. A total of 30.342 ha of land was acquired for the Mapusa substation. Of this, 27.567 ha was state government land and 2.775 ha were acquired from private owners, for which POWERGRID paid Rs4.472 million (\$0.11 million equivalent), as fixed by the state revenue authorities. The private land was barren and not used for agricultural activity. In addition to providing employment for local residents during construction of substations and the transmission line, POWERGRID also employed 57 persons full-time through contractors as security guards, housekeeping staff, horticulturists, drivers, and guest house maintenance staff.

As part of social responsibility, POWERGRID constructed (i) a culvert 32 meters in length and 8 meters in width across the KER river that improved connectivity between KER village and other parts of Goa and reduced the travel distance for village commuters; and (ii) a roof-covered bus stand in Chikalim village for the benefit of the villagers. POWERGRID informed the PCR mission that the acquisition of government land did not displace non-titled users.

54. In the case of the Seoni substation, 54.94 ha of land was acquired for construction, 1.79 ha of which was state government land and 53.14 ha privately owned. Total compensation of Rs15.82 million (\$0.39 million equivalent) was paid to 58 PAPs, in accordance with a compensation amount fixed by the respective district administrative authorities based on replacement cost criteria. POWERGRID informed the PCR mission that the acquisition of government land did not displace non-titled users. As agreed at the time of appraisal, POWERGRID carried out the social impact assessment (SIA) and prepared a rehabilitation action plan (RAP). Based on the RAP, apart from compensation paid to the PAPs, POWERGRID also (i) provided rehabilitation assistance of Rs1.75 million (equivalent to \$0.04 million) to 58 PAPs; (ii) provided full-time employment through contractors to 51 persons as security guards, drivers, housekeeping staff, horticulturists, and electricians; (iii) constructed 0.6 km of road in the villages; (iv) installed a tube well; (v) constructed 20 public lavatories; and (vi) earmarked budget funds to provide PAPs with training programs to develop their technical and entrepreneurship skills.

55. As required, POWERGRID issued necessary prior notification during the land acquisition process and conducted consultations with the PAPs. Compensation for private land was paid, including compensation for trees, crops, and structures,⁷ as fixed by the respective district administration. Apart from adequate compensation for land and crops, additional measures were taken for the rehabilitation of the PAPs, as noted in para. 54. The Project is expected to have a positive impact on poverty by enabling increased investments in the beneficiary states of the southern and western regions and creating long-term, stable, direct and indirect employment opportunities for skilled and unskilled workers during the operation of the subprojects established under the Project. Further, POWERGRID project site officials stated that the skilled and semi-skilled workers enhanced their skills during implementation and have increased their future employment opportunities.

56. In 1998, POWERGRID was the first agency in India to adopt environmental and social policy and procedures (ESPP), with guidance from ADB and World Bank. POWERGRID is also certified for ISO 9001, 14001, and OHSAS 18001. POWERGRID told the PCR mission that, in April 2007, it had achieved the distinction of being the first power utility and the second company in the world to be certified with PAS 99:2006, integrating the requirements of ISO 9001:2000, ISO14001:2004 and OHSAS 18001:1999. The ESPP, which is substantially consistent with ADB's social and environmental policies, lays out POWERGRID's commitment and approach to dealing with environmental and social issues raised by its transmission projects, and describes the management procedures it will employ to mitigate these problems. The ESPP includes a framework for identification, assessment, and management of environmental and social concerns at corporate and project levels. It outlines POWERGRID's commitment to the goal of sustainable development through conserving natural resources, continually improving its management system, accessing specialist knowledge for the management of significant

⁷ No permanent structure or house were affected due to land acquisition, excepting one temporary shed was affected at the site of Seoni substation, which was used as a roadside hotel by the owner, for which compensation of Rs44,947 (\$1,108 equivalent) was paid for the land and Rs106,641 (\$2,628.6 equivalent) for the construction of permanent shed by the owner of this.

environmental and social issues, and introducing state of the art, internationally proven technologies while strictly following the basic principles of avoidance, minimization, and mitigation. Under the ESPP, rehabilitation action plans and the environmental assessment management plan are prepared and implemented in the first 12 months of the project construction period and are monitored at the corporate level. Feedback is gathered to enable continuous improvements.

IV. OVERALL ASSESSMENT AND RECOMMENDATIONS

A. Overall Assessment

57. Project formulation and design were consistent with ADB's country and sector strategies and with POWERGRID's plan to develop a national grid. The performance of the executing agency and the borrower, consultants, and contractors was *highly satisfactory*. All the subprojects were implemented as conceived at appraisal without cost overruns. All but one of the subprojects achieved a high level of performance within few months of being commissioned. The exception was the Sipat transmission system subproject, which was delayed primarily because of delays in implementation of the associated Sipat thermal power generation project of NTPC. POWERGRID has the capability to operate and maintain the subprojects to derive maximum benefits from them. The Project in general has met its objectives.

58. The PCR mission observed that the indirect and broader objectives of the Project have also been realized: (i) bulk power transmission is being carried out on a commercial basis; (ii) CERC was constituted in 1998 and it fixed transmission charges, ensuring a 14% return on equity in investments; (iii) the Electricity Act of 2003 made it mandatory for all SEBs to unbundle and restructure; (iv) of the 23 SEBs, 13 have unbundled and corporatized and two have privatized distribution. The remaining eight states are in the process of formulating schemes for reorganization of their SEBs; (v) twenty-three states have constituted state electricity regulatory commissions (SERCs); (vi) about 7,000 MW of IPP plants are now in operation and several more are in various stages of implementation; and (vii) the Power for All by 2012 program launched by the Government in 2002 envisages the addition of 100,000 MW of generation capacity and matching augmentation of transmission and distribution infrastructure by 2012 to ensure access to electricity for the entire population of the country. These important initiatives are considered very important steps in the development of the power sector in India.

59. POWERGRID indicated that, after implementation of the Ahluwalia committee recommendations, the dues of SEBs to POWERGRID have declined to an average of 0.19 months' billing⁸. SEBs are maintaining LC up to 101% of monthly billings for current payments.

⁸ In an attempt to bail out the central power sector utilities, the Government of India had constituted an expert group under the chairmanship of Mr. Montek Singh Ahluwalia in 2001. Based on the recommendations of this expert group, the Government in March 2002, approved an one-time settlement scheme for clearing outstanding dues and current payments from state electricity boards (SEBs) and other power utilities. To ensure prompt payment of current dues and settlement of the outstanding dues by the SEBs under this scheme, the Government proposed a tripartite agreement to be signed between the Government, respective state government, and the Reserve Bank of India. The Ahluwalia Committee's recommendations provide for securitization of total dues as of 30 September 2001, including surcharge by issue of tax-free bonds by respective state governments with a coupon rate of 8.5% per annum. The recommendations also envisage provision of current dues (from 1 October 2001) by opening irrevocable letters of credit with SEBs/power utilities for an amount equal to 105% of their average monthly billing for the preceding 12 months, and failure to open the requisite letters of credit will attract regulation of power supply to respective defaulters and suspension of government assistance to SEBs through the Accelerated Power Development Reforms Program.

The PCR mission is of the opinion that these arrangements are adequate to ensure the financial viability of the Project. Further, the provisions of the Electricity Act of 2003, such as open access to transmission and the introduction of ABT and commercial contracts with SEBs or state power utilities, will improve the financial viability of the Project. The benefits generated by the projects are observable and the EIRR and FIRR computed using actual project benefits confirm this. Overall, the Project is rated *successful*.

B. Lessons Learned

60. With proper planning, effective project monitoring mechanisms, and motivated and well-trained personnel, infrastructure projects can be implemented successfully.

61. POWERGRID took advance action to acquire land and to obtain statutory clearances, which helped in timely project implementation. In some of the earlier ADB-assisted power sector projects, delays in land acquisition delayed the start of construction.

62. Regular discussions with the Government on implementing assurances under the Project prompted the Government to (i) address the issue of dues from state electricity boards, (ii) take necessary actions to enable POWERGRID to enter into commercial contracts with beneficiaries, and (iii) bring in the regulatory regime at central and state level. The implementation of ABT in all the regions also helped POWERGRID operate the regional grids with improved system stability and reliability.

C. Recommendations

1. Project-Related

a. Future Monitoring

63. All subprojects have been successfully implemented and are operating without operational problems. As POWERGRID has a long and successful track record of not only operating and maintaining the transmission system but also operating the five regional grids on a real-time basis, no future project monitoring by ADB is required.

b. Covenants

64. Most of the covenants were complied with. The details are given in Appendix 10.

c. Further Action

65. The Project does not require any specific follow-up action by ADB. The reliability and future performance of the project components are being closely monitored by POWERGRID, as well as by beneficiaries of the Project.

d. Timing of Project Performance Audit Report

66. A project performance audit report mission may be fielded in the first quarter of 2010 to prepare a report.

2. General

67. The past record of POWERGRID illustrates its capacity and capability for successful project implementation and World Bank and ADB have approved several loans to POWERGRID. A third loan of \$400 million was approved by ADB in December 2004 and a multitranche facility of \$600 million was also approved by ADB in March 2008.⁹

68. The Project implemented by POWERGRID has contributed to (i) overall growth of the power sector; (ii) a reduction of transmission system losses; and (iii) enhancement of interregional power exchange capacity, and an improvement in the plant load factor of generating stations, particularly in the eastern region. The Electricity Act of 2003, which ensures open access to transmission, has heralded an era of power trading activities that make use of the POWERGRID transmission system for interstate and interregional power trading. The interregional links and the grid-strengthening projects implemented under the ADB loan are expected to enhance the open access to the state level utilities. With continuing support from ADB and World Bank, POWERGRID should be able to establish a robust national grid in India by 2012, facilitating the transfer of 37,000 MW power across the five regional grids and thus help India make optimal use of its already installed and planned generating capacities. This will also help India in the optimal utilization of its energy resources.

⁹ ADB. 2004. *Report and Recommendation of the President to the Board of Directors on the Proposed Loan to India for the Power Grid Transmission (Sector) Project*. Manila.

ADB. 2008. *Report and Recommendation of the President to the Board of Directors on the Proposed Multitranche Financing Facility to India for the National Power Grid Development Investment Program*. Manila.

**CHRONOLOGY OF MAIN EVENTS IN PROJECT PROCESSING
AND IMPLEMENTATION**

Date	Event
1998	
16–31 Jan	Consultation
9–12 Mar	Consultation
1 Apr	First listing in ADB Business Opportunities
11–22 May	Fact-finding mission
23 June	Management Review Meeting
29 July	Summary Initial Environmental Examination /Summary Environmental Impact Assessment Board circulation
10–11 Aug	Project specific contact mission
5–19 Sep	Appraisal mission
2000	
17–25 Feb	Consultation mission
26 April	Country Program / Concept clearance obtained
12 July	Staff Review Committee meeting
1 Aug	ADB approved the Grid Strengthening for Goa subproject for ADB financing
20–21 Aug	Loan negotiations
6 Oct	Board consideration and approval
10 Oct	ADB approved the East–West Interregional Link strengthening subproject for ADB financing
4 Dec	Loan agreement signed
2001	
10 Jan	Loan declared effective
8 Mar	First disbursement under the subproject A2: Grid Strengthening of Goa
22 Mar	First disbursement under the subproject A1: East West Inter-Regional Link
30 Apr–2 May	Project inception mission activities carried out
7 June	ADB approved the Ramagundam III Transmission system subproject for ADB financing
15 June	ADB approved the Reinforcement of Central Grid in Southern Region subproject for ADB financing
5 Nov	Special loan administration mission fielded
28 Nov	ADB approved the Sipat Transmission system subproject for ADB financing
2002	
6 Aug	First disbursement under the subproject B1: Ramagundam III Transmission system
28 Aug	First disbursement under the subproject A3: Reinforcement of Central Grid in Southern Region
21 Oct and 26 Oct–1 Nov	First review mission
1 Dec	Commissioning of Grid Strengthening of Goa (subproject A2)

Date	Event
2003	
1 Jan	The loan project transferred to INRM for administration
2 Mar	Commissioning of interregional link strengthening between east and west regions (subproject A1)
26 May	ADB approved POWERGRID's request to reallocate \$34.11 million, the balance under the Interest During Construction category to the Cost Project Expenditure category. Further, ADB approved POWERGRID's request for (i) inclusion of supply portion of 400 kV and 220 kV equipment of Seoni 765/400/220 kV substation and (ii) deletion of erection portion of works of two subprojects, namely, the Ramagundam III transmission system and the reinforcement of central grid strengthening in the southern region from ADB financing.
29 Nov–5 Dec	Second review mission
2004	
3 Feb	First extension of loan closing date by 12 months, from 31 March 2006 to 31 March 2007
24 Jun	First disbursement under the subproject B2: Sipat transmission system subproject
1 Nov 2004	Commissioning of Ramagundam III transmission system (subproject B1)
8–12 Dec	Third review mission
2005	
1 Mar	Commissioning of reinforcement of central grid in southern region (subproject A3), implemented as per original implementation schedule.
23–26 Dec	Fourth review mission
2006	
31 March	Original loan closing date
23–25 Nov	Special Loan Administration Mission. The mission requested POWERGRID to expedite submission of withdrawal applications so that the disbursements could be effected before closure of accounts for CY2006 and to review the Sipat subproject.
2007	
27 Mar	Second extension of loan closing date by 4 months, from 31 March 2007 to 31 July 2007.
10 Aug	Final disbursement under the loan and closure of loan account. The loan fully disbursed.
1 Sep	First circuit of Sipat–Seoni 765 kV line and associated Seni substation works completed
2008	
1 Apr	Second circuit of Sipat–Seoni 765 kV line and entire Seoni substation completed (subproject B2)
22–30 Sep	Project Completion Report Mission

ADB = Asian Development Bank

Source: Asian Development Bank records

PROJECT FRAMEWORK

Design Summary	Targets	Achievement	Remarks
<p>1. Goal Meet present and future demands for electrical energy in India</p>	<ul style="list-style-type: none"> • No load shedding by 2005 • Applications for new electrical connections pending for not more than 2 months by 2005 in reforming states 	<ul style="list-style-type: none"> • No-load-shedding condition is still not achieved. Energy shortage still exists. During FY2008, the India's overall shortage in electrical energy supply was about 9%. • It appears that the reforming states such as Andhra Pradesh, Gujarat, and Goa have achieved the target regarding the pending connections. 	<p>The Government has set a target to achieve this goal by 2012.</p>
<p>2.0 Purpose 2.1 Expand and strengthen network and reduce losses</p>	<ul style="list-style-type: none"> • Network to be able to handle 100,000 MW peak load 	<p>Although India's transmission network can handle about 100,000 MW peak load, due to generation constraints during FY2008, it could help the system to meet peak demand of 90,793 MW.</p>	<p>The peak demand of about 100,000 MW is expected to be achieved during FY2009.</p>
<p>2.1 Collect adequate revenue for operation and maintenance and expansion</p>	<ul style="list-style-type: none"> • EHV transmission losses to decrease to 2.5% of power import by 2005 • Availability of the EHV network to improve to 99.5% • ROE to be greater than 16% • SFR to be greater than 25% 	<ul style="list-style-type: none"> • Losses in POWERGRID transmission system are consistently in the range of 3–4%. These losses are technical in nature. • Average availability of transmission systems during the year 2007–08 was maintained at 99.65%. • As per Electricity Act of 2003, CERC has been mandated to fix tariffs for central sector generation as well as for transmission projects. With effect from 1 April 2004, CERC changed the tariff structure and reduced ROE from 16% to 14%. • For the last five years, POWERGRID has been maintaining an SFR of more than 25%. 	<p>The target of 2.5% is too ambitious.</p>

Design Summary	Targets	Achievement	Remarks
2.2 Establish sustainable and efficient power sector institution(s) in India	<ul style="list-style-type: none"> Autonomy of board from Government for decision making 	<ul style="list-style-type: none"> POWERGRID has been conferred with the status of a Miniratna Category I Public Sector Enterprise, with effect 9 October 1997, which gives a certain extent of autonomy to its board of directors—i.e., powers to approve investments for projects costing less than Rs5,000 million. On 1 May 2008, POWERGRID was conferred with the status of Navratna Public Sector Enterprise, which has given the company flexibility and autonomy in making investment and operational decisions without a ceiling. 	
2.3 Improve governance in the sector	<ul style="list-style-type: none"> Increased transparency in investment and operational decision making 	<p>Transparency is maintained by POWERGRID from project evolution through procurement, implementation, and operations of projects. Transmission projects are evolved in consultation with CEA and in discussions with the beneficiaries in regional power committees. To facilitate transparency in procurement, POWERGRID has developed standardized procurement procedures, documented in its <i>Works and Procurement Policy and Procedures</i> manual, and procurements are made through open tenders. For ADB funded projects, procurement was done through the international competitive bidding process.</p>	
3.0 Components/Outputs			
3.1 Interregional ties established	<ul style="list-style-type: none"> Eastern and western regions interconnected 	<ul style="list-style-type: none"> Interregional link between eastern and western regions established. As of March 2008, interregional power transfer capacity between these regions was about 1,790 MW. 	
3.2 Competitive-cooperative pool established	<ul style="list-style-type: none"> Central generating companies dispatch based on ABTs 	<ul style="list-style-type: none"> ABT was notified by CERC on 4 January 2000. 	

Design Summary	Targets	Achievement	Remarks
3.3 POWERGRID's board reconstituted	<ul style="list-style-type: none"> Three nongovernment directors appointed and number of government directors reduced to two 	<ul style="list-style-type: none"> ABT was implemented in the country in a phased manner from 1 July 2002 to 1 November 2003. POWERGRID's board of directors now comprises of the chairman and managing director, two functional directors, two government nominee directors, and seven non-official part-time directors. 	
3.4 New plant installed	Establishment of: <ul style="list-style-type: none"> 400 kV and 220 kV transmission lines 400 kV and 220 kV substations Regional system control centers HVDC transmission 	<ul style="list-style-type: none"> During the 10th Five-Year Plan period (2002–2007), transmission projects involving about 19,000 ckt-kms of transmission lines (including about 2,735 ckm of HVDC lines), 36 new substations, along with transformation capacity of about 25,000 MVA, were implemented. As of 31 March 2008, transmission projects with an estimated cost of about Rs22 billion and involving 20,000 ckt-kms of transmission lines and 29 new substations are in various stages of implementation. 	
4.0 Inputs Finance: <ul style="list-style-type: none"> Foreign Exchange, \$394.2 million Local Currency, \$97.3 million 		Actual: <ul style="list-style-type: none"> Foreign Exchange, \$250.0 million Local Currency, \$ 140.94 million 	At the time of loan appraisal, a commercial cofinancing loan of \$120 million was envisaged. However, this did not materialize and, accordingly, foreign exchange was

Design Summary	Targets	Achievement	Remarks
			reduced from \$394.2 million to \$250 million. Necessary funds were raised by POWERGRID from domestic resources.

ABT = availability-based tariffs, CEA = Central Electricity Authority, CERC = Central Electricity Regulatory Commission, ckt-kms = circuit kilometers, EHV = extra-high voltage, HVDC = high voltage direct current, kV = kilovolt, MW = megawatt, MVA = megavolt amperes, POWERGRID = Power Grid Corporation of India Limited, ROE = return on equity, SFR = self-financing ratio.

Source: POWERGRID.

COST BREAKDOWN BY PROJECT COMPONENTS
(\$ million)

Item	Appraisal Estimate			Revised Estimate ^a			Actual		
	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total
A. Project Expenditure									
1. Inter-Regional link strengthening between East and West Regions	51.15	15.77	66.92	51.15	15.77	66.92	36.09	6.58	42.67
2. Grid Strengthening for Goa	34.38	13.67	48.05	34.38	13.67	48.05	18.51	4.63	23.14
3. Kawas-II (650 MW) Transmission System ^b	20.65	10.37	31.02	0.00	0.00	0.00	0.00	0.00	0.00
4. Gandhar-II (650 MW) Transmission System ^b	12.16	3.34	15.5	0.00	0.00	0.00	0.00	0.00	0.00
5. Anta-II (650 MW) Transmission System ^b	35.27	12.44	47.71	0.00	0.00	0.00	0.00	0.00	0.00
6. Reinforcement of Central Grid in Southern Region	0.00	0.00	0.00	38.72	14.51	53.23	29.27	13.38	42.65
7. Ramagundam-III Transmission System	0.00	0.00	0.00	15.85	5.84	21.69	18.73	0.23	18.96
8. Tala Transmission System ^b	176.79	30.41	207.20	0.00	0.00	0.00	0.00	0.00	0.00
9. Sipat Transmission System				186.03	27.49	213.52	141.81	85.56	227.36
Subtotal (A)	330.40	86.00	416.40	326.13	77.28	403.41	244.42	110.38	354.79
B. Interest During Construction	63.80	11.30	75.10	53.69	21.35	75.04	3.09	30.56	33.65
C. Front End Fee	0.00	0.00	0.00	0.00	0.00	0.00	2.50	0.00	2.50
Total (A+B+C)	394.2	97.3	491.5	379.82	98.63	478.45	250.00	140.94	390.94

^a Revised estimate as on 26 May 2003. The revised estimate includes only the candidate subprojects that were finally financed under the ADB loan.

^b These candidate subprojects were dropped from ADB financing.

Source: Power Grid Corporation of India Limited and Asian Development Bank's loan financial information system.

SUMMARY OF CONTRACTS

PCSS No.	Category No.	Item Description	Contract Amount (\$)	Contract Disbursed (\$)
0001	01	Supply, erection and commissioning for tower package (Kolhapur-Mapusa)	3,832,195	3,832,195
0001	01	Supply, erection and commissioning for tower package (Kolhapur-Mapusa	1,528,373	1,528,373
0002	01	Supply of equipment & materials for Kanaktura-Rourkela of 400 kV D/C R-R transmission	5,509,732	5,509,732
0002	01	Supply of equipment & materials for Kanaktura-Rourkela of 400 kV D/C R-R transmission	2,683,746	2,683,746
0003	01	Supply of ACSR moose conductor for Kanaktura-Rourkela of 400 kV D/C R-R transmission line	6,640,662	6,640,662
0004	01	Supply of DISC insulator for Raiput-Kanaktura of 400 kV D/C R-R transmission line	968,049	968,049
0005	01	Supply of DISC insulators for Kanaktura-Rourkela of 400 kV D/C Raipur-Rourkela	1,004,757	1,004,757
0006	01	Supply of equipment & materials for substation package associated with Kohlapur-Mapusa Transmission	5,543,291	5,543,291
0006	01	Supply of equipment & materials for substation package associated with Kohlapur-Mapusa Transmission	1,050,815	1,050,815
0007	01	Package I-A tower package for Raiput-Ranaktura of 400 kV D/C/ Raipur Rourkela transmission lines	5,422,441	5,422,441
0007	01	Package I-A tower package for Raiput-Ranaktura of 400 kV D/C/ Raipur Rourkela transmission lines	2,418,599	2,418,599
0008	01	Supply of ACSR moose conductor for Kolhapur-Mapusa associated with power transmission	5,490,407	5,490,407
0009	01	Supply of ACSR moose conductor for Raipur-Kanaktura of 400 kV Raipur-Rourkela transmission line	8,274,158	8,274,158
0010	01	Supply of DISC insulators for Kohlapur-Mapusa transmission system	1,061,734	1,061,734
0011	01	Supply of DISC insulators (package C-1)	660,052	660,052
0012	01	Supply of DISC insulators (package C-2)	685,954	685,954
0013	01	Supply of DISC insulators (package C-3)	463,357	463,357
0014	01	Supply of equipment and materials for 400 kV Raipur and Rourkela substation package plus erection	3,170,693	3,170,693
0015	01	Supply of equipment and materials for 400 kV Ramagundam-Hyderabad transmission line	6,913,398	6,913,398
0016	01	Equipment and material for 400 kV S/C Hyderabad-Kurnool-Gooty transmission line associated with Ramagundam III	5,563,734	5,563,734
0017	01	Supply of equipment for 400 kV tower for Khamman Nagarjuna Sagar associated with Ramagundam III	2,929,296	2,929,296
0018	01	Supply of DISC insulators for 400 kV S/C Khamman Nagarjuna Sagar	398,619	398,619
0019	01	Supply of ACSR moose conductor for 400 kV Ramagundam-Hyderabad transmission	7,828,496	7,828,496
0019	01	Supply of ACSR moose conductor for 400 kV Ramagundam-Hyderabad transmission	11,042	11,042
0020	01	Supply of ACSR moose conductor for 400 kV Hyderabad Kurnool Gooty transmission lines	6,072,624	6,072,624
0020	01	Supply of ACSR moose conductor for 400 kV Hyderabad Kurnool Gooty transmission lines	5,521	5,521
0021	01	Supply of ACSR moose conductor for 400 kV Gooty-Neelamangala	4,730,794	4,730,794
0022	01	Supply & erection for substation package B associated with Ramagundam III and reinforcement of central grid	2,916,855	2,916,855
0023	01	Supply & erection of substation package A associated with Ramagundam and reinforcement of central grid	1,778,912	1,778,912
0024	01	Supply of conductor for 400 kV S/C for transmission system associated with Ramagundam III	2,931,916	2,931,916
0024	01	Supply of conductor for 400 kV S/C for transmission system associated with Ramagundam III	2,761	2,761
0025	01	Supply and erection for tower package (A3) associated with Ramagundam III	3,946,309	3,946,309
0025	01	Supply and erection for tower package (A3) associated with Ramagundam III	165,065	165,065
0027	01	Supply & delivery for conductor package (B2) associated with Sipat Stage I project	8,225,044	8,225,044
0028	01	Supply & delivery for conductor package (B3) associated with Sipat Stage I project	9,878,970	9,878,970
0029	01	Supply of 765 kV single circuit transmission line circuit (Part I) towers/tower extension	14,302,846	14,302,846
0030	01	Supply of DISC insulators for 765 kV Sipat Seoni S/C transmission line circuit -I (Part-I)	4,457,716	4,457,716
0031	01	Supply of 2,160 kms of ACSR conductor for 765kV Sipat Seoni S/C transmission circuit (Part I)	9,001,998	9,001,998
0032	01	Supply & erection for tower package (A3) for 765 kV transmission line associated with Sipat Stage-I	14,837,861	14,837,861
0033	01	Supply & erection for insulator package (C2) for 765 kV transmission line of Sipat Stage I project	2,169,392	2,169,392
0034	01	Supply & erection for tower package (A2) for 765 kV transmission line associated with Sipat Stage-I	11,627,222	11,627,222
0035	01	Supply & erection for conductor package (B4) for 765 kV transmission line associated with Sipat	10,421,593	10,421,593
0036	01	Supply & erection for insulator package (C4) for 765 kV transmission line associated with Sipat	2,292,036	2,292,036
0037	01	Supply & erection for insulator package (C3) for 765 kV transmission line of Sipat Stage-I	2,921,836	2,921,836
0037	01	Supply & erection for insulator package (C3) for 765 kV transmission line of Sipat Stage-I	58,424	58,424
0038	01	Supply & erection for 765 kV auto transformer shunt reactor package associated with Sipat	30,919,081	30,919,081
0039	01	Supply of 765 kV Seoni substation package associated with 765kV Sipat transmission system	11,065,507	11,065,507
0039	01	Supply of 765 kV Seoni substation package associated with 765kV Sipat transmission system	9,629,786	9,629,786
0000	02	Interest during construction	3,086,329	3,086,329
0000	03	Front end fees	2,500,000	2,500,000

No. = number, PCSS = procurement contract summary sheet.

Source: loan financial information system of Asian Development Bank.

ANNUAL AVERAGE EXCHANGE RATE

Year	Indian Rupee for every United States Dollar
2000	43.33
2001	45.61
2002	47.53
2003	48.27
2004	45.33
2005	44.11
2006	45.33
2007	39.54

Source: Reserve Bank of India.

PROJECT FINANCING PLAN
(\$ million)

Source	Appraisal			Revised ^a			Actual		
	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total
ADB	250.0	0.0	250.0	250.0	0.0	250.0	250.0	0.0	250.0
International Commercial Borrowing	120.0	0.0	120.0	0.0	0.0	0.0	0.0	0.0	0.0
Domestic Borrowing	0.0	16.3	16.3	0.0	0.0	0.0	0.0	0.0	0.0
POWERGRID	24.2	81.0	105.2	129.8	98.6	228.4	0.0	140.94	140.94
Total	394.2	97.3	491.5	379.8	98.6	478.4	250.0	140.94	390.94

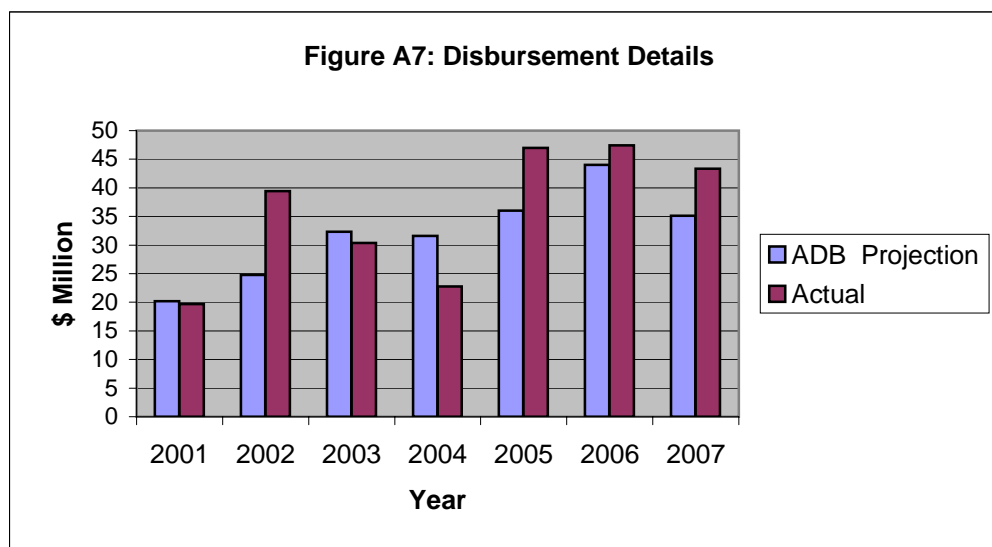
^a Revised estimate as on 26 May 2003. The revised estimate includes only the candidate subprojects that were finally financed under ADB loan proceeds.
Source: Power Grid Corporation of India Limited.

PROJECTED AND ACTUAL DISBURSEMENTS OF LOAN PROCEEDS
(\$ million)

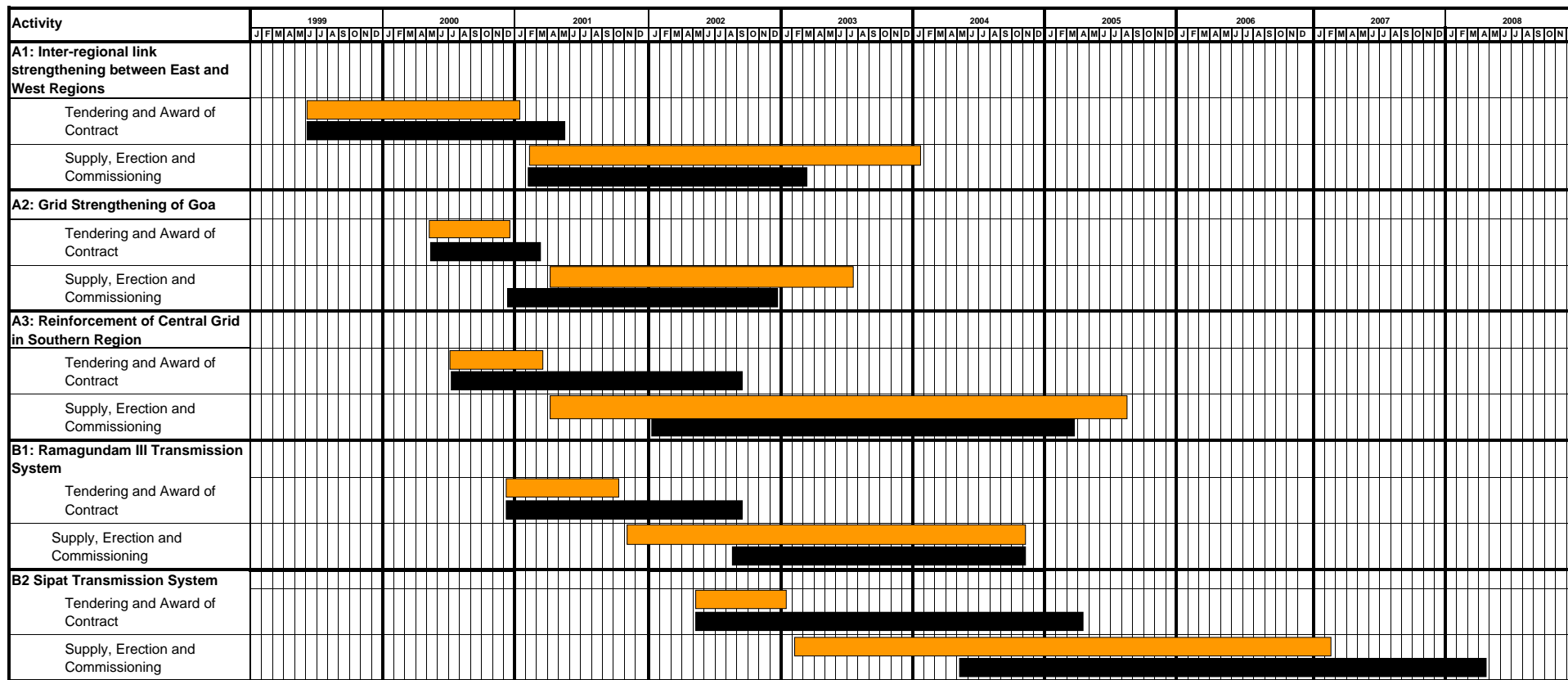
Calendar Year	Projected ^a		Actual	
	For the year	Cumulative	For the year	Cumulative
2001	20.19	20.19	19.68	19.68
2002	24.76	44.96	39.41	59.09
2003	32.30	77.26	30.38	89.48
2004	31.60	108.86	22.77	112.24
2005	36.00	144.86	46.99	159.23
2006	44.00	188.86	47.42	206.65
2007	35.10	223.96	43.35	250.00

^a Projections are made in Asian Development Bank's Loan Financial Information System

Source: Asian Development Bank Loan Financial Information System.



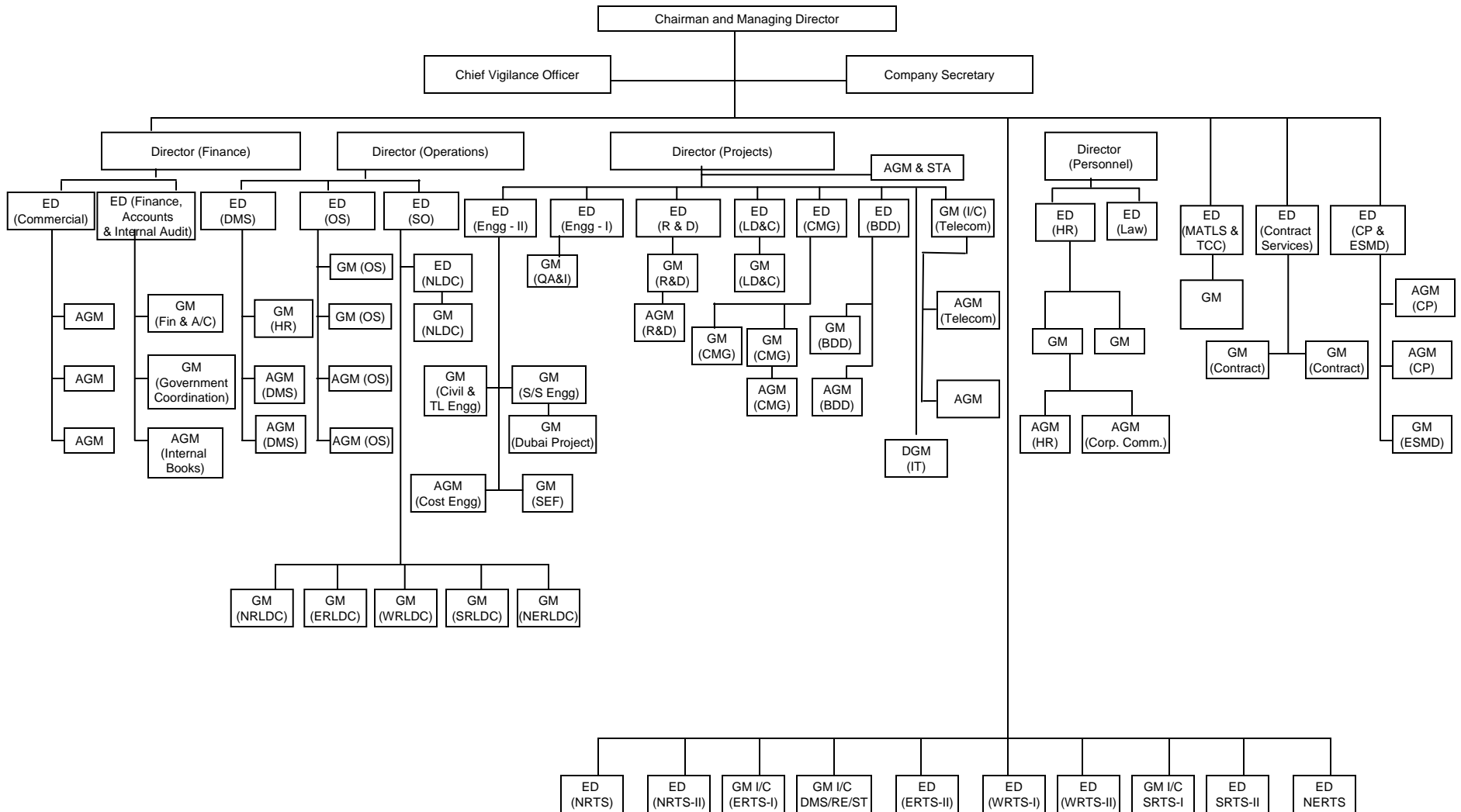
PROJECT IMPLEMENTATION SCHEDULE



Projected
 Actual

Source: Power Grid Corporation of India Limited.

ORGANIZATION CHART OF POWERGRID



AGM = Assistant General Manager, CP = Contract Planning, ED = Executive Director, Engg = Engineering, ERTS = Eastern Region Transmission System, ERLDC = Eastern Region Load Despatch Centre, GM = General Manager, HR = Human Resources, NRLDC = Northern Region Load Despatch Centre, NRTS = Northern Region Transmission System, NERLDC = North-Eastern Regional Load Despatch Centre, NERTS = North-Eastern Regional Transmission System, O&M = Operation and Maintenance, OS = Operation Service, S/S = substation, SRLDC = Southern Region Load Despatch Centre, SO = Systems Operation, S/S = substation, SRTS = Southern Region Transmission System, WRLDC = Western Region Load Despatch Centre, WRTS = Western Region Transmission System

Source: Power Grid Corporation of India Limited.

STATUS OF COMPLIANCE WITH MAJOR LOAN COVENANTS

Srl	Covenant	Reference in Loan/Project Agreements	Status of Compliance
1.	The Borrower shall carry out the Project with due diligence and efficiency and in conformity with sound administrative, financial, engineering, environmental and public electric utility practices.	Article (Art) IV, Section (Sec) 4.01 (a) of the Loan Agreement (LA)	Complied with.
2.	In the carrying out of the Project and operation of the Project facilities, the Borrower shall perform, or cause to be performed, all obligations set forth in Schedule 4 to this Loan Agreement to the extent that they are applicable to the Borrower.	Art IV, Sec 4.01 (b) of LA	Complied with.
3.	The Borrower shall make available, promptly as needed, the funds, facilities, services, land and other resources which are required, in addition to the proceeds of the Loan, for the carrying out of the Project and for the operation and maintenance of the Project Facilities.	Art IV, Sec 4.02 of LA	Complied with.
4.	In carrying out of the Project, the Borrower shall employ competent and qualified contractors acceptable to the Bank and to an extent and upon terms and conditions satisfactory to the Bank and the Borrower.	Art IV, Sec 4.03 (a) of LA	Complied with.
5.	The Borrower shall carry out the Project in accordance with plans, design standards, specifications, work schedules and construction methods acceptable to the Bank and the Borrower. The Borrower shall furnish, or cause to be furnished, to the Bank, promptly after their preparation, such plans, design standards, specifications and work schedules, and any material modifications subsequently made therein, in such detail as the Bank shall reasonably request	Art IV, Sec 4.03 (b) of LA	Complied with.
6.	The Borrower shall take out and maintain with responsible insurers, or make other arrangements satisfactory to the Bank for, insurance against such risks and in such amounts as shall be consistent with sound practice.	Art IV, Sec 4.04 (a) of LA	Complied with.
7.	The Borrower shall maintain, or cause to be maintained, records and accounts adequate to identify the goods, services and other items of expenditure financed out of the proceeds of the Loan to disclose the use thereof in the Project, to record the progress of the Project (including the cost thereof) and to reflect, in accordance with consistently-maintained, sound accounting principles, the operations and financial condition of the Borrower.	Art IV, Sec 4.05 of LA	Complied with.
8.	The Borrower shall furnish to the Bank all such reports and information as the Bank shall reasonably request concerning (i) the Loan, and the expenditure of the proceeds and maintenance of the service thereof including for each of the Subprojects; (ii) the goods, services and other items of expenditure financed out of the proceeds of the Loan including for each of the Subprojects; (iii) the Project and each of the Subprojects; (iv) the administration, operations and financial condition of Borrower, (v) notification and	Art IV, Sec 4.06 (a) of LA	Complied with.

Srl	Covenant	Reference in Loan/Project Agreements	Status of Compliance
	revisions (if any) in the Availability Tariff as required under paragraph 8 of Schedule 4 to this Loan Agreement; and (vi) any other matters relating to the purposes of the Loan		
9.	The Borrower shall (i) have its accounts and financial statements (balance sheet, statement of income and expenses, Project accounts, and related statements) audited annually, in accordance with appropriate auditing standards consistently applied, by independent auditors whose qualifications, experience and terms of reference are acceptable to the Bank; (ii) furnish to the Bank, as soon as available but in any event not later than six months after the end of each related financial year, certified copies of such audited accounts and financial statements and the report of the auditors relating thereto (including the auditor's opinion on the use of the Loan proceeds and compliance with the covenants of this Loan Agreement) all in the English language; and (iii) furnish to the Bank such information concerning such accounts and financial statements, and the audit thereof, as the Bank may from time to time reasonably request	Art IV, Sec 4.07 (a) of LA	Complied with.
10.	The Borrower shall, commencing from November 2000 and thereafter not later than 31 December in each year, prepare and furnish to the Bank its ten-year financial projections, including its investment program, financial plan, income statements, cash flow statements and balance sheets for at least the succeeding 5 years	Art IV, Sec 4.07 (b) of LA	Complied with.
11.	The Borrower shall, promptly as required, take all action within its powers to maintain its corporate existence, to carry on its operations and to acquire, maintain and renew all rights, properties, powers, privileges and franchises which are necessary in the carrying out of the Project or in the conduct of its business.	Art IV, Sec 4.09 (a) of LA	Complied with.
12.	The Borrower undertakes that, except as the Bank may otherwise agree, (i) if the Borrower shall create any lien on any of its assets or that of any of its Subsidiary, as security for any debt, such lien will <u>ipso facto</u> equally and ratably secure the payment of the principal of, and interest and other charges on, the Loan; and the Borrower, in creating or permitting the creation of any such lien, will make express provision to that effect; and (ii) if any statutory lien shall be created on any assets of the Borrower, or of that any Subsidiary, as security for any debt, the Borrower shall grant to the Bank an equivalent lien satisfactory to the Bank.	Art IV, Sec 4.11 (a) of LA	Complied with.
13.	Except as the Bank may otherwise agree, the Borrower shall produce for each of its fiscal years, funds from internal resources equivalent to not less than twenty percent of the annual average of the Borrower's capital expenditures incurred, or expected to be incurred for the previous, current and following fiscal year.	Art IV Sec 4.12 (a) of LA	Complied with. During FY 2008 funds generated through internal resources is more than 20%.

Srl	Covenant	Reference in Loan/Project Agreements	Status of Compliance
14.	Except as the Bank may otherwise agree, the Borrower shall not incur any debt, if after such debt may be incurred the ratio of debt to equity would be greater than 80:20.	Art IV Sec 4.13 (a) of LA	Complied with. During FY2008, Debt:Equity ratio is 65:35.
15.	The Borrower shall be responsible for the planning, design and procurement under the Project as well as for coordination of the Project.	Schedule (Sch) 4, para 1 of LA	Complied with.
16.	Promptly upon finalization of the appraisal of each Subproject and before its implementation, the Borrower shall submit to the Bank for approval a Subproject appraisal report in the format agreed upon with the Bank. The report shall provide data on the Subproject, including detailed design and description, load flow diagrams, cost estimates, financing plan, evaluation of alternatives, supporting technical information and the Borrower's certification that the Subproject meets the criteria set out in paragraph 4 of Schedule 4. No procurement action in respect of contracts to be financed by the Bank will be initiated by the Borrower prior to the Subproject approval by the Bank.	Sch 4, para 6 of LA	Complied with.
17.	The Guarantor shall implement the Availability Tariffs in accordance with the time schedule notified by the Central Electricity Regulatory Commission of the Guarantor.	Sch 4, para 7 of LA	Complied with.
18.	The Borrower shall periodically review and seek adjustment in its Tariffs to comply with their respective financial obligations under this LA and the Guarantee Agreement.	Sch 4, para 8 of LA	Complied with.
19.	The Borrower shall promptly exercise its rights under the commercial contracts with the State Electricity Boards (SEBs) including, but not without limitation, the right to suspend service to an SEB, which is delinquent in its payments to the Borrower.	Sch 4, para 9 of LA	Complied with. As of 31 March 2008, POWERGRID's accounts receivables stood at 0.19 month equivalent of the income proceeds for the preceding 3 months of billable amount. Further, irrevocable letter of credit from SEBs stood at about 101% of average monthly billings of previous financial year, as on 31 March 2008.
20.	In addition to providing a certification of the environmental soundness of the Subprojects in accordance with paragraph 6 of Schedule 4, the Borrower shall take all necessary steps to monitor the environmental activities and impacts of each Subproject, and ensure that the design, implementation and operation of the Subprojects are carried out in such a way that any adverse environmental impact will be minimized	Sch 4, para 11 of LA	Complied with.

Srl	Covenant	Reference in Loan/Project Agreements	Status of Compliance
21.	The Borrower shall maintain its environmental and social management department to continually implement its internal 'Environmental and Social Policy and Procedure' (ESPP), and assign an environment officer at each of its regional offices involved in the Project who will be responsible for monitoring the ESPP and the Project components.	Sch 4, para 12 of LA	Complied with. An Environmental and Social Management Department (ESMD) exists at Corporate Office of the Borrower which is responsible for implementation and monitoring of ESPP measures in the projects. Environment officer at each of its regional offices has been assigned to implement ESPP who in turn reports to ESMD.
22.	The Borrower shall ensure that all applicable federal and state environmental laws, regulations, guidelines and standards of the Guarantor as well as those of the Bank are complied with during the project construction and operational stages. The Borrower shall also ensure that adverse environmental impacts related to the construction and operation of each Subproject are minimized through implementation of the environmental monitoring program and mitigation measures set out in the Environmental Impact Assessment, Summary Environmental Impact Assessment, and Initial Social Assessment for each Subproject.	Sch 4, para 13 of LA	Complied with.
23.	Without limiting the generality of Section 4.02, the Borrower shall provide adequate funds in a timely manner for implementation of environmental and social mitigation measures as necessary.	Sec 4, para 14 of LA	Complied with.
24.	The Borrower shall provide the Bank with quarterly monitoring reports on the compensatory forests' status for a period of five years after establishing each plantation (required as a consequence of the laying of transmission towers under the Subprojects).	Sch 4, para 15 of LA	POWERGRID has already paid the amount towards compensatory Afforestation to the Forest Department. In spite of follow up by POWERGRID, Forest Department is not providing the details regarding compensatory forests' status. Issue has been taken up with Ministry of Environment & Forest. In line with the directives of the Supreme Court, MoEF has appointed Compensatory Afforestation Management & Planning Authority.
25.	The Borrower shall take all necessary action to ensure that all land, rights of way, easements and other rights in land or privileges required for the Project shall be made available on a timely basis.	Sch 4, para 17 of IA	Complied with.

Srl	Covenant	Reference in Loan/Project Agreements	Status of Compliance
26.	The Borrower shall take all necessary steps during the planning and design of the Project Facilities to ensure conformity with the Bank's Guidelines on Involuntary Resettlement.	Sch 4, para 18 of LA	Complied with.
27.	The Borrower shall continue to function as the central transmission utility under the Guarantor's Electricity Act 2003, as amended from time to time, provide transmission services, and facilitate private participation in power transmission	Sch 4, para 19 of LA	Complied with.
28.	The Guarantor shall maintain the composition of the Borrower's Board of Directors, (of at least three non-Government directors and restriction on the number of Government appointed directors to not more than two).	Sch 4, para 20 of LA	Complied with.
29.	The Borrower shall not seek funds guaranteed by the Guarantor for projects in each case costing less than Rs. 1,000 million, after financial year 2002.	Sch 4, para 21 (a) of LA	Complied with.
30.	The Guarantor shall allow the Borrower, the self-approving power for any projects costing less than Rs. 3,000 million, subject to the statutory clearances, approvals, and Guarantor's policies as applicable.	Sch 4, para 21 (b) of LA	<p>POWERGRID has been conferred with status of "Miniratna (Category-I, Public Sector Enterprise)" with effect from 9 October 1997 which gives autonomy to the Board of Directors of the Company to certain extent including powers to approve investments for the projects costing less than Rs5,000 million.</p> <p>On 1 May 2008, POWERGRID has been conferred with the status of "Navratna Public Sector Enterprise" which has provided the Company flexibility and autonomy in terms of making investment and operational decisions without any ceiling.</p>
31.	The Borrower shall maintain its Accounts Receivables at a level not exceeding an amount equivalent to the income proceeds of its transmission and other services for the preceding two preceding months and the Guarantor shall ensure timely liquidation of central appropriation based on the agreed annual payment schedule.	Sch 4, para 22 (a) of LA	<p>Complied with.</p> <p>As on 31 March 2008, accounts receivables stands at 0.19 months.</p>

Srl	Covenant	Reference in Loan/Project Agreements	Status of Compliance
32.	In the event that the Cofinancing Loan does not materialize within six months from the date of approval of the Loan by the Bank, the Borrower shall raise the necessary funds of up to \$120 million, to the satisfaction of the Bank, subject to the provisions of Section 4.11, to ensure timely completion of the Project.	Sch 4, para 25 of LA	Government of India, in their letter of 31 August 2001, advised ADB that there is no need for commercial cofinancing through ADB as they were able to raise the funds required from the domestic market.

FINANCIAL AND ECONOMIC EVALUATION

1. The major assumptions used in the financial and economic evaluation of the Project are discussed in this appendix.

A. Financial Evaluation

2. The financial evaluation of the Project was carried out in real terms using the concept of financial cost incurred and benefits streams realized on a subproject basis.¹¹ Costs and benefits were evaluated for each subproject, with the exception of the Sipat transmission system, where only one unit of 500 MW (out of 2980 MW) had been commissioned at the time of the evaluation. All costs and revenues in the calculations are expressed at constant March 2008 prices.

3. The capital costs considered for financial evaluation include all capital expenditure for the project components, including interest during construction.

4. The cost of capital is calculated for the Project as a whole. The Project was financed by foreign debt (the ADB loan) and domestic borrowing/equity. The cost of borrowing from ADB in rupees is 6.20%, while the cost of domestic borrowing/equity has been considered at 14.00% in rupee terms (as per POWERGRID). The weighed average cost of capital (WACC) is estimated in real terms and shown in Table A11.1.

Table A11.1: Weighted Average Cost of Capital
(Rs million)

Source	Amount	Cost (%)	Weighted (%)
ADB Loan	11,020	6.2	2.84
Domestic Commercial Loan/Equity	4,550	14.0	2.50
Weighted Average Cost of Capital	15,570		5.35

Source: POWERGRID

1. Capital Cost

5. All five subprojects have been completed. Financial and economic analysis has been carried out for subprojects A1, A2, A3, and B1. Although the subproject B2—the Sipat transmission system—has been completed, financial and economic analysis has not been carried out because it had not become fully operational due to delays in the associated generation project. Capital costs considered include all capital expenditure for the various subprojects, including interest during construction. No salvage value has been assumed at the end of the useful life of various components.

2. Energy Transfer, Revenue, and Operating Cost

6. Actual energy transfer (million kWh per year) and annual revenue¹² are considered for estimating the benefits on a subproject basis. The revenue for POWERGRID is primarily the

¹¹ The subprojects were: A1—interregional link strengthening between the east and west regions; A2—grid strengthening for Goa; A3—reinforcement of central grid in the southern region; B1—Ramagundam - III transmission system; and B2—Sipat transmission system

¹² Transmission charges are regulated by the Central Electricity Regulatory Commission or, in the case of intrastate lines, by the respective state electricity regulatory commissions.

transmission charges, which are based on the Central Electricity Regulatory Commission (CERC) norms for tariff determination of transmission systems, considering 98% of transmission availability and 14% return on equity. The revenue realized for each subproject is on the basis of transmission charges and booked against these subprojects to the respective beneficiary states.

7. Annual operating cost has been worked out on a normative basis, as per the CERC norms for computing the operation and maintenance charges for various subprojects.

3. Financial Internal Rate of Return

8. At the time of appraisal, the financial internal rate of return (FIRR) on a total project basis was estimated as 7.8%, which was higher than the WACC of 5.1% in real terms. The estimated FIRR at project completion for the subprojects is given in the Table A11.2.

A11.2: Financial Internal Rate of Returns of Subprojects

Subproject	FIRR at Appraisal	FIRR at Project Completion
A1: Inter-regional link strengthening between east and western regions	7.8%	12.5%
A2: Grid strengthening for Goa	7.8%	6.3%
A3: Reinforcement of central grid in southern region	7.8%	7.6%
B1: Ramagundam - III transmission system	7.8%	7.6%

Note: Financial internal rate of return calculations on a subproject wise were not carried out during appraisal.

9. The FIRR of each of the subprojects at the time of preparation of the PCR is higher than the WACC of 5.35%. The FIRR of the Goa grid strengthening subproject is lower than what was expected at appraisal because this line has been designed to meet Goa's long-term load requirements and so is still only partially loaded. This subproject is expected to be fully utilized by 2012. The subproject to strengthen the interregional link between the east and west regions has a higher FIRR than estimated at appraisal because the actual transfer of power has been greater than the appraisal estimate of about 1,000 MW of surplus power. The actual annual exports in the last 3 years have been in the region of 1,000–1,400 MW.

B. Economic Evaluation

10. The economic analysis of the subprojects was carried out using two approaches depending upon the economic benefits of the subprojects on the basis of economic benefits of power consumption to the final consumers represented by their willingness to pay (WTP) as applicable.

11. The economic analysis was carried out using the world price numeraire. The economic costs were derived from the financial costs by deducting the taxes and duties. The costs were separated into foreign exchange, indirect foreign exchange, and local currency costs. Local costs were further separated and a specific conversion factor of 0.95 was used for unskilled labor. Labor cost was assumed to be 10% of the local currency costs, and unskilled labor costs were assumed to be 35% of the labor costs.

1. Interregional link strengthening between east and west regions

12. The east–west interconnector enables the transfer of about 1,000–1,400 MW of power from Rourkela in the eastern region to Raipur in the west. The actual energy transfer through this link under the prevailing condition is taken into account for computing the economic benefits. The cost toward electricity generation in the eastern region, as published by the Central Electricity Authority for the year 2006-07, and toward distribution of the incremental energy arising out of this subproject is also taken into consideration. Based on WTP, the economic internal rate of return (EIRR) is estimated at 34.95%, against 22.39% at appraisal.

2. Grid Strengthening for Goa

13. Goa is one of the beneficiary states of the western region grid and has a share of about 294 MW¹³ from central sector generating stations. Because Goa has no generating resources, it meets most of its requirements through power transfer from western regional grid. This subproject has been designed to enable Goa to draw its full share from central generating stations in the western region and thereby improve the reliability of its power supply. The actual energy transfer through this link under the prevailing condition is taken into account for computing the economic benefits. At present, this line is partially loaded and is expected to be fully utilized by 2012. The cost towards electricity generation of central sector projects located in the western region and distribution of the incremental energy arising out of this subproject is also taken into consideration. Based on the sales mix in Goa and willingness to pay, EIRR is estimated at 20.28%, compared with 23.00% at appraisal.

3. Reinforcement of Central Grid in Southern Region

14. The subproject strengthened the 400 kV network in the southern region, enabling POWERGRID to transfer the power from central sector generating stations in the region and from the eastern and western regions to its beneficiary states in southern region. The actual benefits that are accrued to the beneficiary states under the prevailing condition are taken into account in computing the economic benefits. The cost towards electricity generation in the western region and distribution of the incremental energy arising out of this subproject is also taken into consideration. Based on sales mix and WTP of southern region, EIRR is estimated at 25.81%.

4. Ramagundam - III Transmission System

15. This subproject helps to evacuate 500 MW of power from the Ramagundam-III generation project of NTPC to southern region states like Andhra Pradesh, Karnataka, Tamil Nadu, and Kerala. The actual energy transfer to these states from Ramagundam-III through this transmission line under the prevailing condition is taken into account for computing the economic benefits. The cost towards electricity generation of the Ramagundam-III generation project and distribution of the incremental energy arising out of this subproject is also taken into consideration. Based on WTP of southern region, the EIRR is estimated at 32.68%.

16. The EIRR estimated for the subprojects are shown in Table A11.3.

¹³ Central Electricity Authority, Ministry of Power, Government of India.

A11.3: Economic Internal Rate of Returns of Subprojects

Subproject	EIRR at Appraisal	EIRR at Project Completion
A1: Inter-regional link strengthening between east and western regions	22.39%	34.95%
A2: Grid strengthening for Goa	23.00%	20.28%
A3: Reinforcement of central grid in southern region	-	25.81%
B1: Ramagundam - III Transmission System	-	32.68%

Note: EIRR calculations for A3 and B1 subprojects were not carried out during appraisal.

Table A11.4: Financial Internal Rate of Return of Inter-regional link strengthening between east and west regions
(Rs million)

Fiscal Year	Capital Investment	O&M Cost	Annual Energy Transfer Million kWh	Revenue Earned	Profit Before Tax	Net Benefits
2001	204					(204)
2002	1,429					(1429)
2003	1,293					(1293)
2004	73	30	5,798	406	372	298
2005	0	30	7,215	505	475	475
2006	1	31	7,643	535	504	503
2007		32	5,402	378	346	346
2008		32	5,402	456	424	424
2009		32	5,000	456	424	424
2010		32	5,000	456	424	424
2011		32	5,000	456	424	424
2012		32	5,000	456	424	424
2013		32	5,000	456	424	424
2014		32	5,000	456	424	424
2015		32	5,000	456	424	424
2016		32	5,000	456	424	424
2017		32	5,000	456	424	424
2018		32	5,000	456	424	424
2019		32	5,000	456	424	424
2020		32	5,000	456	424	424
2021		32	5,000	456	424	424
2022		32	5,000	456	424	424
2023		32	5,000	456	424	424
2024		32	5,000	456	424	424
2025		32	5,000	456	424	424
2026		32	5,000	456	424	424
2027		32	5,000	456	424	424
2028		32	5,000	456	424	424
	3,000				Financial Internal Rate of Return	12.50%

kWh=kilowatt-hour, O&M=operation and maintenance.

Source: POWERGRID

Table A11.5: Financial Internal Rate of Return of grid strengthening for Goa
(Rs million)

Fiscal Year	Capital Investment	O&M Cost	Annual Energy Transfer Million kWh	Revenue Earned	Profit Before Tax	Net Benefits
2001	198					(198)
2002	841					(841)
2003	461	25			(25)	(486)
2004	118	27	1,164	176	149	31
2005		43	1,270	181	138	138
2006		45	1,262	181	136	136
2007		47	1,364	181	134	134
2008		47	1,364	181	134	134
2009		47	1,364	181	134	134
2010		47	1,364	181	134	134
2011		47	1,364	181	134	134
2012		47	1,364	181	134	134
2013		47	1,364	181	134	134
2014		47	1,364	181	134	134
2015		47	1,364	181	134	134
2016		47	1,364	181	134	134
2017		47	1,364	181	134	134
2018		47	1,364	181	134	134
2019		47	1,364	181	134	134
2020		47	1,364	181	134	134
2021		47	1,364	181	134	134
2022		47	1,364	181	134	134
2023		47	1,364	181	134	134
2024		47	1,364	181	134	134
2025		47	1,364	181	134	134
2026		47	1,364	181	134	134
2027		47	1,364	181	134	134
2028		47	1,364	181	134	134
2029		47	1,364	181	134	134
	1,617				Financial Internal Rate of Return	6.30%

kWh=kilowatt-hour, O&M=operation and maintenance.

Source: POWERGRID

Table A11.6: Financial Internal Rate of Return of Reinforcement of central grid in southern region
(Rsmillion)

Fiscal Year	Capital Investment	O&M Cost	Annual Energy Transfer Million kWh	Revenue Earned	Profit Before Tax	Net Benefits
2003	893					(893)
2004	1,023					(1023)
2005	557	10	2,726	58	48	(509)
2006	117	39	2,726	220	181	64
2007		42	2,726	231	189	189
2008		43	2,726	233	189	189
2009		43	2,726	308	264	264
2010		43	2,726	308	264	264
2011		43	2,726	308	264	264
2012		43	2,726	308	264	264
2013		43	2,726	308	264	264
2014		43	2,726	308	264	264
2015		43	2,726	308	264	264
2016		43	2,726	308	264	264
2017		43	2,726	308	264	264
2018		43	2,726	308	264	264
2019		43	2,726	308	264	264
2020		43	2,726	308	264	264
2021		43	2,726	308	264	264
2022		43	2,726	308	264	264
2023		43	2,726	308	264	264
2024		43	2,726	308	264	264
2025		43	2,726	308	264	264
2026		43	2,726	308	264	264
2027		43	2,726	308	264	264
2028		43	2,726	308	264	264
2029		43	2,726	308	264	264
2030		43	2,726	308	264	264
2031		43	2,726	308	264	264
	2,590					
Financial Internal Rate of Return						7.60%

kWh=kilowatt-hour, O&M=operation and maintenance.
Source: POWERGRID

Table A11.7: Financial Internal Rate of Return of Ramagundam - III Transmission System
(Rs million)

Fiscal Year	Capital Investment	O&M Cost	Annual Energy Transfer Million kWh	Revenue Earned	Profit Before Tax	Net Benefits
2002	483					(483)
2003	640					(640)
2004	151					(51)
2005	0	6	1,528	41	35	35
2006		15	3,481	98	82	82
2007		16	3,517	103	87	16
2008		17	3,502	105	88	88
2009		17	3,502	175	159	159
2010		17	3,502	175	159	159
2011		17	3,502	175	159	159
2012		17	3,502	175	159	159
2013		17	3,502	175	159	159
2014		17	3,502	175	159	159
2015		17	3,502	175	159	159
2016		17	3,502	175	159	159
2017		17	3,502	175	159	159
2018		17	3,502	175	159	159
2019		17	3,502	175	159	159
2020		17	3,502	175	159	159
2021		17	3,502	175	159	159
2022		17	3,502	175	159	159
2023		17	3,502	175	159	159
2024		17	3,502	175	159	159
2025		17	3,502	175	159	159
2026		17	3,502	175	159	159
2027		17	3,502	175	159	159
2028		17	3,502	175	159	159
2029		17	3,502	175	159	159
	1,274				Financial Internal Rate of Return	7.60%

kWh=kilowatt-hour, O&M=operation and maintenance.

Source: POWERGRID

Table A11.8: Economic Internal Rate of Return of Inter-regional link between east and west regions
(Rs million)

Fiscal Year	Capital Investment	O&M Cost	Generation Incremental Cost	Distribution Incremental Cost (Capital and O&M)	Total Cost	Annual Energy Transfer Million kWh	WTP for Users	Net Benefits
2001	185		3,647	1,520	5,351			(5,351)
2002	1,298		5,471	2,280	9,048			(9,048)
2003	1,185		1,824	760	3,768			(3,768)
2004	67	34	10,710	114	10,925	5,798	19,429	8,504
2005	0	30	13,261	114	13,404	7,215	24,178	10,773
2006	1	31	14,031	114	14,177	7,643	25,612	11,435
2007		32	9,997	114	10,144	5,402	18,102	7,959
2008		32	9,997	114	10,144	5,402	18,102	7,959
2009		32	9,274	114	9,420	5,000	16,755	7,335
2010		32	9,274	114	9,420	5,000	16,755	7,335
2011		32	9,274	114	9,420	5,000	16,755	7,335
2012		32	9,274	114	9,420	5,000	16,755	7,335
2013		32	9,274	114	9,420	5,000	16,755	7,335
2014		32	9,274	114	9,420	5,000	16,755	7,335
2015		32	9,274	114	9,420	5,000	16,755	7,335
2016		32	9,274	114	9,420	5,000	16,755	7,335
2017		32	9,274	114	9,420	5,000	16,755	7,335
2018		32	9,274	114	9,420	5,000	16,755	7,335
2019		32	9,274	114	9,420	5,000	16,755	7,335
2020		32	9,274	114	9,420	5,000	16,755	7,335
2021		32	9,274	114	9,420	5,000	16,755	7,335
2022		32	9,274	114	9,420	5,000	16,755	7,335
2023		32	9,274	114	9,420	5,000	16,755	7,335
2024		32	9,274	114	9,420	5,000	16,755	7,335
2025		32	9,274	114	9,420	5,000	16,755	7,335
2026		32	9,274	114	9,420	5,000	16,755	7,335
2027		32	9,274	114	9,420	5,000	16,755	7,335
2028		32	9,274	114	9,420	5,000	16,755	7,335
	2,735						Economic Internal Rate of Return	34.95%

kWh=kilowatt-hour, O&M = operation and maintenance, WTP = willingness to pay.

Source: POWERGRID

Table A11.9: Economic Internal Rate of Return of Grid strengthening for Goa
(Rs million)

Fiscal Year	Capital Investment	O&M Cost	Generation Incremental Cost	Distribution Incremental Cost (Capital and O&M)	Total Cost	Annual Energy Transfer Million kWh	WTP for Users	Net Benefits
2001	179		1,966	819	2,965			(2,965)
2002	766		1,966	819	3,552			(3,552)
2003	422	25	1,966	819	3,234			(3,234)
2004	107	27	2,243	61	2,438	1,164	4,488	2,050
2005		43	2,433	61	2,538	1,270	4,897	2,359
2006		45	2,419	61	2,526	1,262	4,866	2,340
2007		47	2,603	61	2,711	1,364	5,259	2,548
2008		47	2,603	61	2,711	1,364	5,259	2,548
2009		47	2,603	61	2,711	1,364	5,259	2,548
2010		47	2,603	61	2,711	1,364	5,259	2,548
2011		47	2,603	61	2,711	1,364	5,259	2,548
2012		47	2,603	61	2,711	1,364	5,259	2,548
2013		47	2,603	61	2,711	1,364	5,259	2,548
2014		47	2,603	61	2,711	1,364	5,259	2,548
2015		47	2,603	61	2,711	1,364	5,259	2,548
2016		47	2,603	61	2,711	1,364	5,259	2,548
2017		47	2,603	61	2,711	1,364	5,259	2,548
2018		47	2,603	61	2,711	1,364	5,259	2,548
2019		47	2,603	61	2,711	1,364	5,259	2,548
2020		47	2,603	61	2,711	1,364	5,259	2,548
2021		47	2,603	61	2,711	1,364	5,259	2,548
2022		47	2,603	61	2,711	1,364	5,259	2,548
2023		47	2,603	61	2,711	1,364	5,259	2,548
2024		47	2,603	61	2,711	1,364	5,259	2,548
2025		47	2,603	61	2,711	1,364	5,259	2,548
2026		47	2,603	61	2,711	1,364	5,259	2,548
2027		47	2,603	61	2,711	1,364	5,259	2,548
2028		47	2,603	61	2,711	1,364	5,259	2,548
2029		47	2,603	61	2,711	1,364	5,259	2,548
	1,475							Economic Internal Rate of Return 20.28%

kWh=kilowatt-hour, O&M = operation and maintenance, WTP = willingness to pay.

Source: POWERGRID

Table A11.10: Economic Internal Rate of Return of Reinforcement of central grid in southern region
(Rs million)

Fiscal Year	Capital Investment	O&M Cost	Generation Incremental Cost	Distribution Incremental Cost (Capital and O&M)	Total Cost	Annual Energy Transfer Million kWh	WTP for Users	Net Benefits
2003	811		4,713	1,964	7,487		0	(7,487)
2004	933		4,713	1,964	7,610		0	(7,610)
2005	507	10	5,143	98	5,758	2,726	9,802	4,044
2006	106	39	5,143	98	5,387	2,726	9,802	4,415
2007		42	5,143	98	5,283	2,726	9,802	4,519
2008		43	5,143	98	5,285	2,726	9,802	4,518
2009		43	5,143	98	5,285	2,726	9,802	4,518
2010		43	5,143	98	5,285	2,726	9,802	4,518
2011		43	5,143	98	5,285	2,726	9,802	4,518
2012		43	5,143	98	5,285	2,726	9,802	4,518
2013		43	5,143	98	5,285	2,726	9,802	4,518
2014		43	5,143	98	5,285	2,726	9,802	4,518
2015		43	5,143	98	5,285	2,726	9,802	4,518
2016		43	5,143	98	5,285	2,726	9,802	4,518
2017		43	5,143	98	5,285	2,726	9,802	4,518
2018		43	5,143	98	5,285	2,726	9,802	4,518
2019		43	5,143	98	5,285	2,726	9,802	4,518
2020		43	5,143	98	5,285	2,726	9,802	4,518
2021		43	5,143	98	5,285	2,726	9,802	4,518
2022		43	5,143	98	5,285	2,726	9,802	4,518
2023		43	5,143	98	5,285	2,726	9,802	4,518
2024		43	5,143	98	5,285	2,726	9,802	4,518
2025		43	5,143	98	5,285	2,726	9,802	4,518
2026		43	5,143	98	5,285	2,726	9,802	4,518
2027		43	5,143	98	5,285	2,726	9,802	4,518
2028		43	5,143	98	5,285	2,726	9,802	4,518
2029		43	5,143	98	5,285	2,726	9,802	4,518
2030		43	5,143	98	5,285	2,726	9,802	4,518
2031		43	5,143	98	5,285	2,726	9,802	4,518
	2,357						Economic Internal Rate of Return	25.81%

kWh=kilowatt-hour, O&M = operation and maintenance, WTP = willingness to pay.

Source: POWERGRID

Table A11.11: Economic Internal Rate of Return of Ramagundam - III Transmission System
(Rs million)

Fiscal Year	Capital Investment	O&M Cost	Generation Incremental Cost	Distribution Incremental Cost (Capital and O&M)	Total Cost	Annual Energy Transfer Million kWh	WTP for Users	Net Benefits
2002	179		1,475	614	2,269			(2,269)
2003	766		1,475	614	2,855			(2,855)
2004	422		1,475	614	2,512			(2,512)
2005	107		1,475	614	2,196			(2,196)
2006		6	2,898	61	2,965	1,528	5,494	2,528
2007		15	6,413	61	6,490	3,481	12,515	6,025
2008		16	6,478	61	6,556	3,517	12,645	6,090
2009		17	6,451	61	6,529	3,502	12,591	6,062
2010		17	6,451	61	6,529	3,502	12,591	6,062
2011		17	6,451	61	6,529	3,502	12,591	6,062
2012		17	6,451	61	6,529	3,502	12,591	6,062
2013		17	6,451	61	6,529	3,502	12,591	6,062
2014		17	6,451	61	6,529	3,502	12,591	6,062
2015		17	6,451	61	6,529	3,502	12,591	6,062
2016		17	6,451	61	6,529	3,502	12,591	6,062
2017		17	6,451	61	6,529	3,502	12,591	6,062
2018		17	6,451	61	6,529	3,502	12,591	6,062
2019		17	6,451	61	6,529	3,502	12,591	6,062
2020		17	6,451	61	6,529	3,502	12,591	6,062
2021		17	6,451	61	6,529	3,502	12,591	6,062
2022		17	6,451	61	6,529	3,502	12,591	6,062
2023		17	6,451	61	6,529	3,502	12,591	6,062
2024		17	6,451	61	6,529	3,502	12,591	6,062
2025		17	6,451	61	6,529	3,502	12,591	6,062
2026		17	6,451	61	6,529	3,502	12,591	6,062
2027		17	6,451	61	6,529	3,502	12,591	6,062
2028		17	6,451	61	6,529	3,502	12,591	6,062
2029		17	6,451	61	6,529	3,502	12,591	6,062
	1,475							Economic Internal Rate of Return 32.68%

kWh=kilowatt-hour, O&M = operation and maintenance, WTP = willingness to pay.

Source: POWERGRID