India

Northern India Transmission System Project

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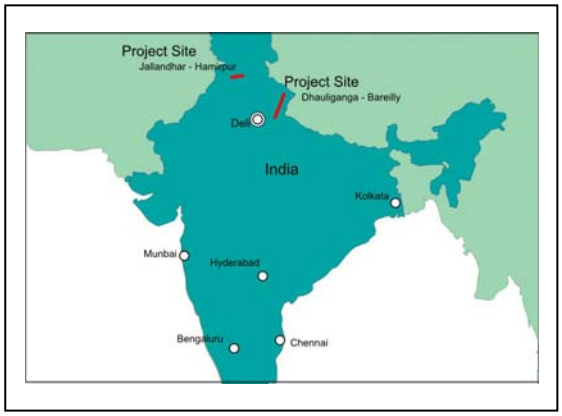
Field survey: October, 2008

1. Project Description and Outline of the ODA Loan Assistance



Project Location

Jalandhar-Hamirpur Transmission Line constructed by this project

1.1. Background

The northern India consists of the states of Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab, Rajasthan, Uttar Pradesh and Uttaranchal, and the Delhi National Capital Territory. The total population of these states is about 274.9 million (1996) and correspond to about 30% of the entire national population. The major industry in the north is agriculture, and after the "Green Revolution[1]" the region centered in Punjab State known as the "Granary of India" significantly contributed to the country's agricultural production. The main agriculture products are wheat, rice, and other grains; and the region produces about 79.3% of the total wheat produced in India.

In addition, the northern region has the second largest electric power grid after the western region and the scope of its power supply and demand is also second to the western region. The supply-demand gap (1994) is about equivalent to the nationwide

[1] The movement spread all over the world in the 1940s to the 1960s. It recommended cultivation of many species of grain in conjunction with technical innovation in irrigation, manure, agricultural chemicals, and farming machinery. The idea was to abandon traditional agricultural techniques to increase food production, to cope with the increase in population in the developing regions, and covered a wide spectrum of sectors from crop breeding to socioeconomics (Yasumitsu Ienaga "The World Encyclopedia" (Heibonsha)).

average (-16.5 % at the peak power base and -7.1% at the power consumption base).

Although the supply-demand gap has gradually been reduced over the years, the acuteness of the situation has not changed and continued shortages during both peak supply and consumption volume are projected. Adequate countermeasures to rectify the demand-supply gap and alleviate the power supply shortage are pressing demands.

1.2. Project Objective

The objective of this project is to improve the electric power supply in Himachal Pradesh State and to raise the reliability of power supply by constructing Dhauliganga-Bareilly and Jalandhar-Hamirpur transmission lines, thereby contributing to the regional economic growth and the development of domestic industries.

1.3. Borrower /Executing Agency

PGCIL (Power Grid Corporation of India Limited)

1.4. Outline of the Loan Agreement (L/A)

Approved Amount/ Disbursed Amount	8,497 million yen/3,726 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	January 1997 / February 1997
Terms and Conditions	Interest Rate: 2.3% Repayment Period: 30 years (Grace Period: 10 years) Conditions for Procurement: General Untied
Final Disbursement Date	June 2006
Main Contractor (Over 1 billion yen)	Sterlite Industries Ltd. (India), Poona (India), Tata Projects Ltd. (India)
Main Consultant (Over 100 million yen)	None
Feasibility Studies, etc.	POWERGRID prepared F/S for Dhauliganga transmission line and Jalandhar - Hamirpur transmission line in 1995.
Related Projects (if any)	None

2. Evaluation Results (Overall rating: A)

2.1. Relevance (Rating: a)

2.1.1. Relevance at Appraisal

The amount of the public sector gross investment projected in the Eighth Five-year Plan (April 1992 to March, 1997) was 4,341 billion rupees, and the GDP growth rate for the corresponding period was projected as 5.6%. For the electric power sector including this project, an investment capital of 795,900 million rupees equivalent to 18.3% of government expenditure was allocated, the highest among all sectors. The power sector is recognized as very important sector for the sound development of domestic industries, and the need to secure a sufficient and reliable power supply is also recognized.

Further, the power transmission and distribution loss that was 22.9% at the end of the Seventh Five-year Plan increased to 24.8% at the end of the Eight Five-year Plan and continues to be high. The cause is due to low investment in the power transmission and distribution sector and delays in establishing a higher voltage distribution network.

2.1.2. Relevance at Ex-Post Evaluation

During the Tenth Five-year Plan (2002 to 2006), a 7.7% economic growth rate was achieved. An improved supply performance of the power transmission and distribution networks and power plant construction in the power sector was achieved, however it remains inadequate in terms of demand; and the power sector continues to be a priority sector. Though the northern regional grid facilities have a capacity of 37,879 MW as of 2007, it is only able to supply 29,495MW against a power demand of 32,462MW during peak hours; and there is a 9.1% shortage (the shortage of power supply volume is 3.0% in Himachal Pradesh State). It is surmised that these shortages can continue in future and the annual demand rate is projected to rise to 7.5% due to expansion of industrial zones. According to the Draft National Electricity Plan by Central Electricity Authority (CEA), the shortage of peak power supply in the northern area is projected to rise to 19% by 2012. In the Eleventh Five-year Plan, eight new power transmission projects are planned in the northern region.

Among the northern states, Uttar Pradesh, in particular, continues to suffer from major shortages in output and power supply during peak hours and from long hours of planned outages. In addition, power failures due to frequent malfunctions and voltage fluctuations continue. Since the demand in power supply is anticipated to grow during peak hours at a high annual rate of 6% to 8%, strengthening the transmission network in conjunction with generating capacity continues to be a priority issue.

As mentioned above, to mitigate the growing supply-demand gap in future, the need and urgency of this project that aims to enhance the power transmission capacity is high; implementation of this project was seen as highly relevant. This project has been highly relevant with the country's national policies and development needs at the times of both appraisal and ex-post evaluation, therefore its relevance is high.

2.2. Efficiency (Rating: b)

2.2.1. Project Outputs

Plan	Actual Performance
(1) Dhauliganga Transmission System	(1)Dhauliganga Transmission System
Newly installed transmission line: Dhauliganga Hydro Electric Power Station to the Bareilly substation.	Constructed as planned.
Power line: Length 330km2, 400kV, 2 conductors, 2 lines (210km of mountainous area, 120km of plains) heat capacity: 500MVA/Ckt	Power line: Double circuits 233km, 220kV, 2 conductors (125km of mountain ranges, 108km of Plain)
Steel tower: 960 two-line steel towers (Double circuit). (690strained towers, 270suspension towers)	Steel tower: 606 steel towers (Double circuit). (277 stressed towers, 329 suspension to
Substation line bays extension	Substation line bays extension
Bareilly substation: 220kV line bays 2cct (double main + transfer bus line) 3 220kV Shunt Reactors, 50MVAR x 4	Bareilly substation Installation of shunt reactor is moved to the Dhauliganga generating plant.
	Dhauliganga plant (under the control of NHPC) switch yard 220kV line reactors 25MVAR x 2 (new construction)
(2) Jalandhar-Hamirpur Transmission System	(2) Jalandhar - Hamirpur Transmission System
to Construct transmission line Jalandhar to Hamirpur S/S.	constructed as planned.
Power line: Double circuits 130km, 220kV, Single conductor (about 10km of mountain ranges, about 120km of Plain) transmission capacity: 235 MVA/Ckt	Power line: Double circuits 124km, 220kV, Single conductor (About 63.5km of mountain ranges, 60.5km of Plain)
Steel tower: Steel towers (Double circuit) x 433 numbers (245 stressed towers,188 suspension towers)	Steel tower: Steel towers (Double circuit) x 354 numbers (188 stressed towers, 166 suspension towers)
Substation line bay extension	Substation line bay extension
Jalandhar substation 220kV Line Bays (double main + transfer bus line) 2 Ckt.	Jalandhar substation: No change
Hamirpur substation 220kV Line Bays (double main + transfer bus line) 2 Ckt	Hamirpur substation: No change
Transformer is supplied by own fund.	

[2] Horizontal distance between power transmission steel towers

The Dhauliganga is a mountain range with an altitude of more than 3,000m. During project implementation, the length of Dhauliganga-Bareilly transmission line was reduced by about 100km than the route initially proposed to avoid the mountainous area. This reduction took place as a detailed survey and revised design suggested for straight line route. In conjunction with this, there revealed a need for adjusting the voltage due to the shortened line length, and the National Hydraulic Power Company (NHPC) was contracted for the construction work. The installation site of the reactor was then moved to the outlet side of the Dhauliganga hydroelectric power station side.

The transmission line capacity is designed for 400kV, however at present, it transmits only 220kV and it can operate at 400kV as the number of power stations increase. During the ex-post-evaluation, plans to increase generation capacity at Dhauliganga could not be ascertained, hence, power transmissions at 400kV could not be projected, although it is surmised that there will be a need to do so in future.

Regarding the length of the Jalandhar- Hamirpur transmission line through hilly terrain, the appraisal stating "about 10km of line passing through hilly terrain" was clearly an underestimation in view of the geographical features of Himachal Pradesh State; the executing agency (PGCIL) also recognizes it.

2.2.2. Project Period

Although Dhauliganga transmission line project was originally planned for constructing during February 1997 to February, 2003 (73 months), the actual project period was from December 1997 to July 2005 (92 months), thus exceeding the plan by 126 percent. Reasons for delay include the lengthy documentation procedures on administrative and budget approvals for undertaking the proposed works, reexamination of the construction period of the transmission related facilities due to the delay in starting operations at the Dhauliganga hydroelectric power station, and acquisition of forest clearance for the portion of line which passes through Ascot Wild Life Sanctuary reserve area. The two-year suspension of the construction work was due to the delay in obtaining permission for forest clearance, the unforeseen revision of the law, creation of an independent Uttaranchal State, which is the authority that grants the approval, and the unavailability of an alternate route.

While the original plan for the Jalandhar-Hamirpur transmission line was for the period February 1997 to September 1999 (32 months), the actual period was from December 1997 to February 2001 (39 months), exceeding the plan by 122 percent. The delay was derived from upgrading the Himachal Pradesh State Electric Board (HPSEB)’s 132Kv s/s at Hamirpur to 220kV, which delayed the construction by six months. However, since the

overall operations of the power plant were also delayed, the power transmission side was not liable for the delay. The lesson learned was the importance of collaboration between the power generation and transmission sides.

2.2.3. Project Cost

The actual project cost was 5,583.8 million yen in contrast to the estimation of 13,788.4 million yen. The planned output was attained, however, the excessively over-estimated distance of the transmission line and the fluctuating exchange rate resulted in the decrease in actual cost to 59.5% against the estimated plan.

Table 1 Project Cost Details

	Plan			Actual Performance			Increase and decrease (%)
Items	Foreign Currency (million yen)	Local Currency (million rupees)	Total (million yen)	Foreign currency (million yen)	Local Currency (million rupees)	Total (million yen)	
Dhauliganga transmission line construction expenses							
Subtotal	6,117.1	1,636.5	11,255.7	3,080.1	519.3	4,433.6	-60.6%
Jalandhar Hamirpur transmission line construction expenses							
Subtotal	1,069.6	219.7	1,759.4	407.6	193.3	911.6	-48.2%
Interest during construction	773.2	-	773.2	238.6	-	238.6	-69.1%
Total incl. IDC	7,959.9	1,856.2	13,788.3	3,726.3	712.6	5,583.8	-59.5%

Source: Reply from PGCIL to Questionnaire

Although the project cost was lower than planned, the project period was longer than planned, therefore efficiency of the project is fair.

Jalandhar Substation

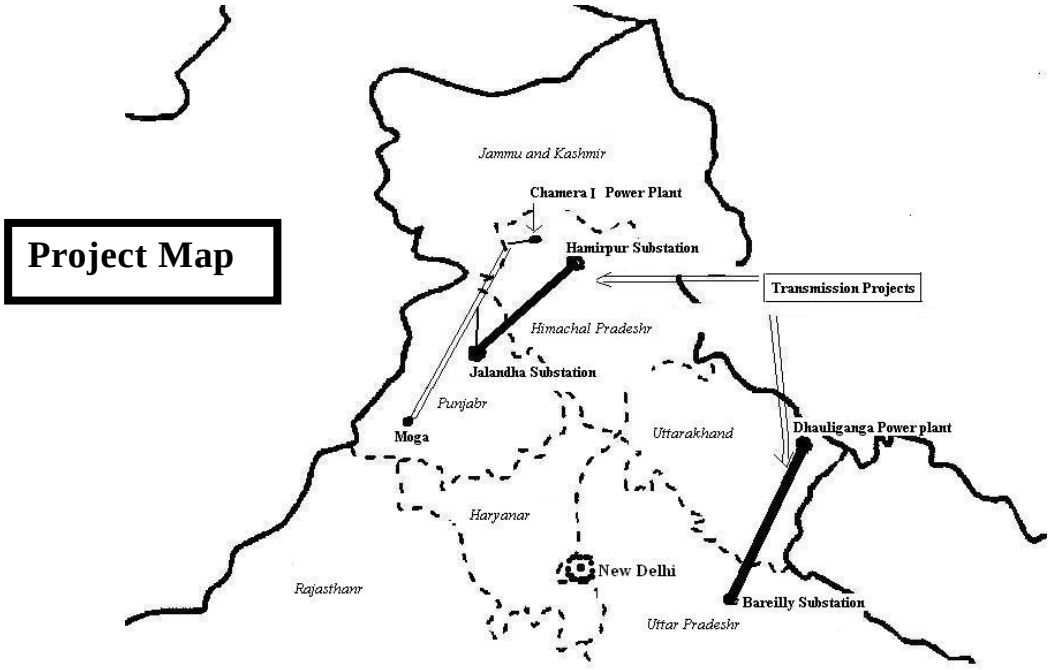
Transmission line built in the forest area

2.3. Effectiveness (Rating: a)

2.3.1. Stable Supply of Electricity

Dhauliganga-Bareilly transmission line has been built as part of integrated power transmission system for the planned power plant project in the northern region and the existing transmission network. Initially, the 400kV transmission line was operating at 220kV to supply power generated from the Dhauliganga hydro power plant to the grid from Bareilly. The Bareilly substation supplies power to other substations in the northern area, contributes to meeting the electric power supply demand of the region. The transmission line is about 140 MW/Ckt with 280 MW capacities and is capable of meeting the maximum output of the Dhauliganga hydro power plant.

Power generated by Chamera I (540 MW) and Chamera II (300 MW) hydroelectric power stations owned by National Hydraulic Power Company (NHPC) in Himachal Pradesh was not directly linked to the state transmission network of Himachal Pradesh until the completion of Jalandhar - Hamirpur transmission line. With this transmission line (220 kV D/C), the Himachal Pradesh State Electric Board (HPSEB) can directly receive power from the national grid. Therefore, it has improved the power supply to the state much more stably than the past—the electricity for the state was supplied from other state.



Source: Prepared by the evaluator based on the PGCIL map

Table 2 Power Capacity of the Targeted Facilities

(Unit: Million units)

Transmission Lines	Planned Values	Actual Values (ratio over the Planed Values)		
		2005	2006	2007
Dhauliganga - Bareilly	1,000	312.86	1090.45	1177.09
		31.3%	109.0%	117.8%
Jalandhar - Hamirpur	470	332.26	432.28	481.84
		70.7%	91.97%	102.5%

Source: Reply from PGCIL to Questionnaire

The actual operations value of these power transmission facilities in the initial plan projected a 98.0% facility usage rate, but actual 2007 values showed that the average facility usage rate was 99.0%, which exceeded the initial plan[3]. The facility operation ratio during peak hours (the maximum load (MW)/equipment rated capacity multiplied by power factor) showed differing maximum load during a fixed time for each year, thus variations in the values were seen.

Table 3 Annual Usage Rates of Transmission Lines (%)

Transmission line		2004	2005	2006	2007
Dhauliganga - Bareilly transmission line	Ckt-1[4]	-	99.36	99.70	97.37
	Ckt-2	-	99.12	99.93	98.05
Jalandhar - Hamirpur transmission line	Ckt-1	99.95	99.29	99.40	99.84
	Ckt-2	99.88	99.26	99.65	99.90

Source: Reply from PGCIL to Questionnaire

Table 4 Peak hour operational ratio (unit: MVA)

	Year	2001	02	03	04	05	06	07	08
Dhauliganga transmission line	Max	-	-	-	-	-	290	294	426
	%	-	-	-	-	-	52.2	52.9	76.7
Jalandhar transmission line	Max	189.2	206.0	164.12	203.8	177.8	166.4	193.8	158.8
	%	72.4	79.0	62.8	78.0	68.2	63.8	74.2	60.8
Hamirpur substation	Max	-	-	-	-	-	163.9	193.95	161.86
	%	-	-	-	-	-	82.0	97.0	82.0

Source: Reply from PGCIL to Questionnaire

In spite of minor modification to the project's scope of works, as shown in the above-mentioned operational effect indicators (power transmission volume, facility usage

[3] In India, Availability = annual hours worked / 8,760hrs is used as an index of operating ratio.

[4] The 1st conductor of two.

ratio, and facility operations ratio), with the exception of one segment (Dhauliganga - Bareilly's unplanned outage hours as shown in Table 5 below), the project accomplished as planned; it secured reliable power transmission, increased supply hours, and stable voltage.

Table 5 Annual power outages (number of hours)

Facility		Year				
		2004	2005	2006	2007	2008
Dhauliganga - Bareilly Ckt-I	Planned	0.20	35.20	12.34	71.14	-
	Unplanned	-	0.20	13.26	159.51	-
Dhauliganga - Bareilly Ckt-II	Planned	1.36	47.30	3.49	104.38	-
	Unplanned	-	1.36	1.58	66.53[5]	-
Jalandhar - Hamirpur Ckt-I	Planned	4.11	63.01	49.54	12.59	-
	Unplanned	0.21	0.28	1.35	0.49	-
Jalandhar - Hamirpur Ckt-II	Planned	10.11	65.00	30.26	8.08	-
	Unplanned	0.05	0.07	0.00	0.22	-
Hamirpur Substation Ckt-I	Planned	1.12	-	3.3	-	1.25
	Unplanned	0.46	18.73	-	1.55	11.25
Hamirpur Substation Ckt-II	Planned	0.52	-	-	-	57.32
	Unplanned	-	10.18	1.46	-	-

Source: Reply from PGCIL to Questionnaire

Table 6. Number of disturbances/outages in transmission line network managed by the executing agency (times/year)

Fiscal year	Minor	Major	Total
2001-02 [6]	74	3	77
2002-03	53	4	57
2003-04	7	0	7
2004-05	2	0	2

Source :PGCIL Annual Report 2004-05

The numbers of outages cases decreased with the introduction of the computer monitoring system of entire transmission network. The main causes of the power outage include the line's "contact with trees" etc. Recently, preventive measures through monitoring have been implemented and the number of outages is nearly nil; transmission losses in developing countries generally range from 3% to 4%.

The construction of the power plants and the implementation of this project improved the supply and demand shortage ratio of the northern grid during peak hours, which was 15.7% in 1994, 9.1% in 2007. However, this shortage is surmised to continue in future, and, with the expansion of the industrial sector, the power demand is expected to grow

[5] Repeated repairs caused by natural disaster in 2007 resulted power outage-unplanned time long.
[6] Prior to the introduction of such computing system that took place in 2003, the fault locations could not be easily identified.

annually at 7.5%. The Central Electricity Authority (CEA) estimates that the shortage in supply during the peak hours in the northern region may rise to 19% by 2012.

2.3.2. Economic Internal Rate of Return (EIRR)

Since the EIRR value was not computed at the time of appraisal, the following preliminary conditions during the ex-post evaluation were used in the computation.

Benefit: Transmission revenue, facility residual value, and purchase and operating cost of alternative stand-by generator

Cost: Facility construction costs and operation and maintenance expense

Dhauliganga - Bareilly: 12.3%
Jalandhar - Hamirpur: 17.0%

2.3.3. Beneficiary Surveys

During beneficiary surveys (carried out in Himachal Pradesh, Uttar Pradesh, and Uttaranchal states, including a large scale industrial consumer, targeted 25 respondents in each state, extracted from a total of 75 samples), the subjects including factory managers were asked about the effect on electricity before and after the implementation of the project, voltage stability, income of neighboring residents, living environment, and access to social services. Survey findings show a stable power supply (stabilized voltage), reliability the improvement in quality of supply (stabilization of voltage) of power, reliability (a longer period of power supply), and other benefits of the project.

Table 7 Results of Beneficiary survey

Questionnaire	Response	%
Did outage hours from Bareilly substation change before and after the project?	An average of 7 hours → 5 hours (average value per day in every house)	-
Please select the project's direct benefits (multiple choices).	Stabilization of voltage	100.00%
	Being able to use electrical appliances for longer periods of time.	100.00%
	Streetlight lights available at night.	98.66%
	Increased access of information from radio.	98.66%
	Increased the time for family conversations	89.00%

Source: Beneficiary Survey

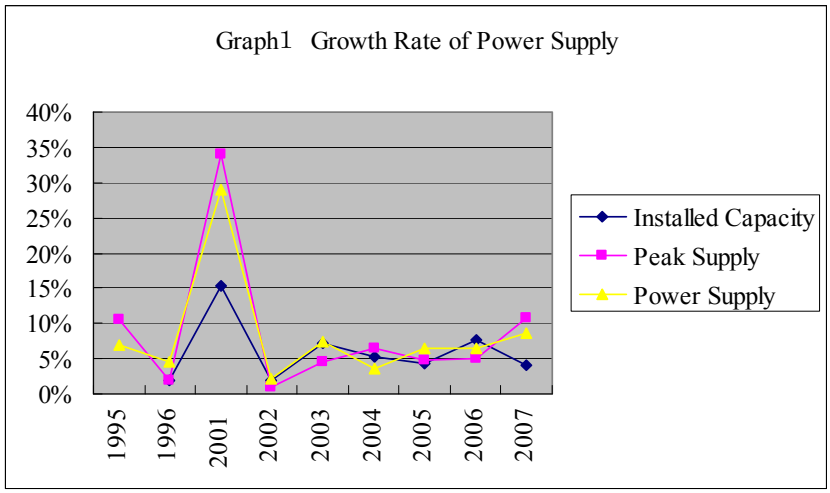
Based on the above, this project has largely produced the planned effects, and its effectiveness is high.

2.4. Impact

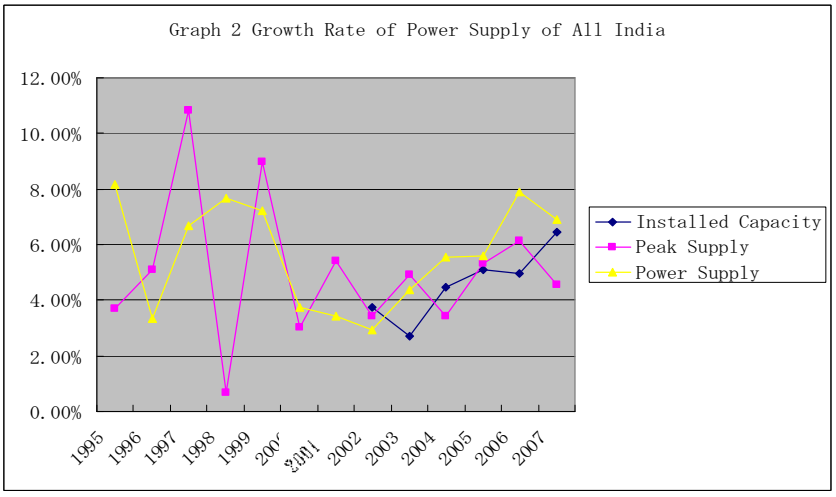
2.4.1. Impacts on the Northern Region's Electric Power Supply

In the State of Himachal Pradesh, despite the power shortage may continue in future, the shortage situation has relatively improved after the project was implemented—3.0% in the FY 2007. As shown Graph 1, Graph 2 and Table 8, the capacity of facilities and power supply has gradually increased in other areas in the north.[7]

This trend reflects the power supply situation nationwide; and the average growth rate during 1995 to 2007 as shown by the three indicators above was 4% to 5%. Therefore, it can be said that the project has contributed partially to balancing supply and demand in the northern area. Further, it is expected that investments in facility expansion to meet the increased demand due to economic growth will continue to improve this balance.



Source: Annual Report 2007-08, Northern Regional Power Committee



Source: Growth of Electricity Sector in India, Central Electricity Authority, 2007

[7] According to the Ninth Five-year Plan (1997-2002), investment to the power sector increased much in 2001.

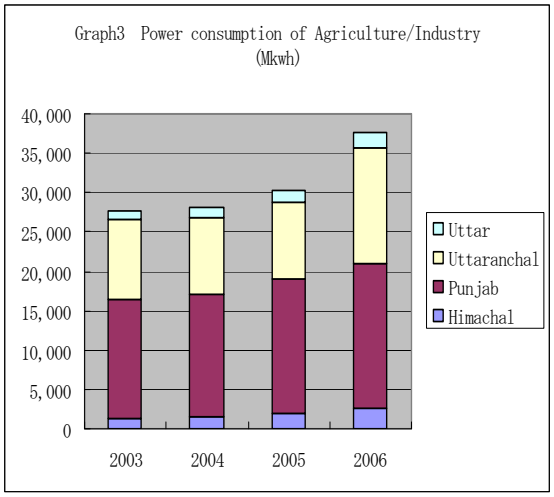
Table 8 Supply and Demand Conditions of the Northern Area

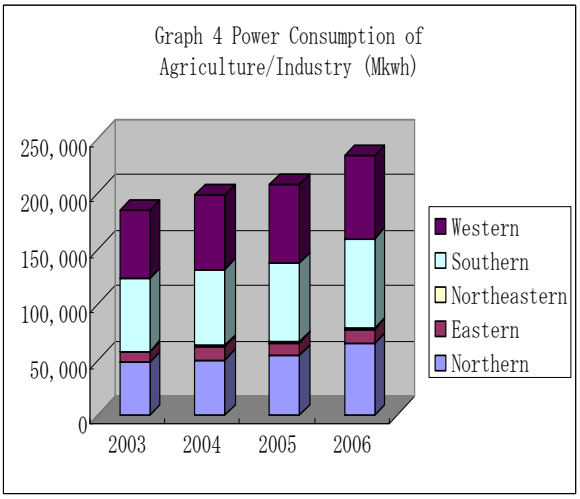
Fiscal Year	Unit	1994	1995	1996	2001	2003	2005	2007
Facility capacity	MW		23,913	24,350	28,087	30,699	33,757	37,879
Peak supply	MW	14,290	15,804	16,109	21,586	22,746	25,362	29,495
Peak demand	MW	16,950	17,729	17,833	23,137	24,067	29,044	32,462
Gap	MW	-2,660	-1,925	-1,724	-1,551	-1,321	-3,682	-2,967
Ratio	%	-15.7	-10.9	-9.7	-6.7	-5.5	-12.7	-9.1
Power supply	GWh	97,068	103,834	108,591	140,058	153,713	169,421	196,147
Required power supply	GWh	104,746	110,938	129,587	118,481	163,320	190,927	219,797
Gap	GWh	-7,678	-7,104	-20,996	-7,968	- 9,607	-21,506	-23,650
Ratio (%)	%	-7.3	-6.4	-16.2	-5.4	-5.9	-11.3	-10.8

Source: Annual Report 2007-08, Northern Regional Power Committee

2.4.2. Impacts on the Regional Economic and Development of Domestic Industries

As seen in the following tables/graphs, power consumption volume by agriculture and manufacturing, which sum up to one-forth of the entire country, in the northern region, and the GDP exceed the average of ones in the entire India. Since it is expected to increase over the long term, this project can be said to contribute to the economic growth and the development of domestic industries in the region.





Source: Report on the Performance of The State Power Utilities for 2003 to 2006, Power Finance Corp. Ltd.

Table 9 GDP Growth Rate (%)

State Name	2000	2001	2002	2003	2004	2005	2006
Himachal Pradesh	10.98	9.49	10.25	9.61	11.11	10.47	11.26
Punjab	11.22	6.67	3.32	9.08	8.50	12.60	12.45
Uttar Pradesh	3.64	4.95	8.71	9.65	8.60	13.44	11.82
Uttaranchal	14.99	8.90	16.64	10.67	10.15	13.23	15.93
Whole country	1.96	3.11	4.73	7.48	8.96	5.82	6.83

Source: Economics & Statistics of respective State Governments
and for All-India, Central Statistical Organization

2.4.3. Impacts on Beneficiaries

The main power transmission areas from the Bareilly substation are Bareilly city[8], Moradabad industrial area, and Uttaranchal State. According to the field survey conducted through personal interaction with a large supply industrial consumer in Bareilly city, it was observed that since the implementation of this project the quality of supply has improved and voltage has stabilized, power supply has been available for 22 hours (for domestic consumers, around 17 hours), and the stand-by generator that was regularly used in the past is now no longer in use. In addition, following findings were obtained from the beneficiary survey as quoted in "Effectiveness" (carried out in Himachal, Uttar Pradesh, and Uttaranchal State targeting 25 respondents in each state including a large scale industrial user, for a total of 75 samples).

Table 10 Beneficiary Survey Findings

Questionnaire	Response	%
Please select the indirect benefits of the project (multiple choices).	Living conditions becoming convenient with the use of electric appliances	100.00%
	Reduced hours of suspension of water-supply hours	97.33%
	Increased income from business	94.66%
	Increased study hours	80.00%
	Increased business hours	49.33%

Source: Beneficiary Survey

By the implementation of the project, it can be said that the construction of new transmission lines has contributed to mitigate a chronic power shortage, indirectly to increase agricultural production volume, and to effect the regional economic development,

[8] Located at approximately 15km from Bareilly Substation, the population is one million and ranked the sixth largest in the state.

as the existing industries acquired additional production capacity to gain much more benefits.

2.4.4. Impacts on the Natural and Social Environment

Environmental conservation concerns were addressed according to the "Environmental Social Consideration Guideline: Environmental and Social Policy & Procedure (ESPP)", PGCIL's summary of development concepts and procedure. For example, in the year 1998, although the distance of the transmission line that passed through forest area was 27,000 Ckt km, or 6% of the whole forest area, it decreased to about 2%, or 20,500 Ckt km (actual value), being constructed during the six years of construction from 1999 to 2005.

Since 33.54km of the total Dhauliganga-Bareilly transmission line was designed to pass through Ascot Wild Life Sanctuary (WLS) based on the forest conservation guidelines enforced in 1980, PGCIL acquired the forest permit from the Forestry Commission in October 1992. However, as any activities against forestry plants or grass on the ground of Sanctuaries were suddenly forbidden in February 2000 by the Supreme Court, State Forestry Commission did not grant permission for construction in the national park and the preservation area. As a result, construction work in the area was held up for about two years. Although the permission was finally acquired in October 2004, a total of Rs.216 million was paid as forest clearance acquisition expense for the whole transmission line, including the compensation expense of Rs75.2 million, or 5% of total project cost, as ordered by the Supreme Court. According to the EIA and monitoring reports, the installing location of the transmission line was examined also with an environmental viewpoint, but as the Wild Life Sanctuary was located south of the Dhauliganga Plant, an alternative route could not be chosen.

As approximately 1.6km of a total of 130km of Jalandhar - Hamirpur transmission line passed through the forest area, a primary survey of the transmission line route was conducted in September 1996, followed up by a detailed survey. Subsequently, the application for forest clearance was submitted as early as December 1996, and it was approved about six months later. The compensation to cover alternative planting costs in the amount of Rs.17.8 million was paid in conjunction with the permit.

The plan concerning land acquisition of the extension yard proposed for the Jalandhar Substation was not changed. Residents affected by the project have been compensated properly according to the PGCIL resettlement plan. No dispute in this regard has been reported to date.

Bareilly Sub-station

Sub-station Control Room

2.5 Sustainability (Rating: a)

2.5.1. Executing Agency

2.5.1.1. Structural Aspects of Operation and Maintenance

PGCIL carries out the operation and maintenance of its 170 substations (as of March 2008) across the country according to its own maintenance standards. The substations possess maintenance manuals conforming to ISO 9001, being granted ISO 9001 certification for quality control. They have received certifications of ISO 14001—for environmental management—and ISO18001—for labor safety and health. Table 11 indicates the managed transmission line length (km) per employee.

Table 11. Managed Transmission Line Length (km) per Employee

1992	2003	2004	2005	2006	2007	2014 (target)
3.93	6.99	7.37	7.76	8.01	8.74	10.0

Source :PGCIL Annual Report 2007-08

Power Grid Corporation of India Limited (PGCIL) is responsible for the operation and maintenance of the facilities constructed for the project. While 20 persons are deployed for maintenance in the plains, about 10 persons are deployed per 150km to 200km of transmission lines in the hilly terrain. Each employee/engineer of PGCIL, Himachal Pradesh State Electric Board (HPSEB) and UPPCL (Uttar Pradesh Power Corporation Limited) resides in the substation residential complex permanently. Their division of roles is as shown in Table 12 below.

Table 12 Role Assignment of Utilities for Operation and Maintenance

Items (Transmission line/Substation)	Operations	Maintenances	Employees (Engineers)
Jalandhar-Hamirpur transmission line	PGCIL	PGCIL	54(45)

Jalandhar substation	PGCIL	PGCIL	
Hamirpur substation	HPSEB	HPSEB	22(12)
Dhauliganga transmission line	PGCIL	PGCIL	20(14)
Bareilly substation of UPPCL	UPPCL	UPPCL	40(20)

Source: Reply from PGCIL to Questionnaire

There is no large-scale modification regarding the organization of the executing agency (PGCIL) before and after implementation of the project, and the executing agency works in close coordination with the power utilities of the concerned states based on a consignment contract. The present institutional capacity for operation and maintenance after project implementation is adequate to sustain project effectiveness.

2.5.1.2. Technical Aspects of Operation and Maintenance

In terms of its management and technical capabilities, PGCIL has gained experience through working with institutions such as World Banka and ADB in addition to Japan's ODA loan projects. In the area of employee training, "Training Need Assessment" for 3,800 employees annually with 125 trainers who provide training on substation management, automation with emphasis on operation and maintenance, latest survey techniques, developing marketing skills for telecom business, advanced features in IT, networking administration and security, and power system analysis.

Further, a standardized operation and maintenance manual has been developed by PGCIL, and regular training is conducted at the headquarters' training facility. It may thus be safely concluded that PGCIL, the executing agency, has adequate experience and skills for operating and maintaining the various facilities.

2.5.1.3 Financial Aspects of Operation and Maintenance

PGCIL is wholly owned by the Indian government, but due to the trend and policies promoting privatization, a joint venture with private companies has been actively pursued.

Table 13 below shows the financial index for various parameters/ratios. The ratio of net profit to capital employed indicates the profitability of the executing agency in the range of 5 - 6%, which is at a reasonable level. Although the feature of facility industry has higher ratio of fixed assets which show solvency, the liquidity ratio is below 100%, which needs to be improved[9]. The state power utilities are the main customers of PGCIL and this is expected to continue, but the financial condition of most state utilities are structurally in poor condition. There is the possibility of improvement in some financial indices of the

[9] The current ratio has improved to 107% in the latest financial accounts in March 2008.

executing agency, provided PGCIL is engaged on sustainable basis in the project management, operation and maintenance of the existing facilities, and can take strategic financial decision for appropriately undertaking new investments. The administrative and maintenance expenses as reported by PGCIL are indicated in Table 14 below. The annual reports published by PGCIL point out that it secured necessary expenses for monitoring of transmission lines performances, regular inspections, and maintenance.

Table 13 Financial Indicators (%)

Year	Net profit to Capital employed	Net profit to Net worth	Earnings per share (Rp)	Debt/equity ratio	Liquidity ratio	Fixed asset ratio
2003-04	4.98	9.47	2.57	61:39	1.05	188.3
2004-05	5.07	9.12	2.69	61:39	0.76	189.1
2005-06	6.13	10.39	2.68	61:39	0.57	190.7
2006-07	6.51	11.50	2.79	64:36	0.54	204.1
2007-08	5.68	10.73	3.21	62:38	1.07	202.6

Source: PGCIL Annual Report 2007-08

Table 14 Maintenance Expenses

(Units: 10 Mil. Rs.)

Year	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
Northern region	117.07	117.19	123.33	126.50	188.52	223.83
Entire country	318.40	357.57	370.19	267.79	304.37	614.96

Source: Reply from PGCIL to Questionnaire

In Uttar Pradesh State, as a result of structural reforms in the power sector in 2003, the distribution operation of Uttar Pradesh Power Transmission Corporation Limited (UPPCL), which produced continuous deficits, was divided into four separate distribution entities. However, the company still tends to operate at a loss in the red. The deficits, also shown in other states (Table 15), are being made up by providing subsidies to the distribution companies by the respective states.

Table 15 Profits and Losses of the State Electric Power Utilities

(Unit: Rs Mil. lower figures after govt. subsidy)

State (State power utilities)	2003	2004	2005
Himachal (HPSEB)	-460	-370	-560
	-460	-370	-200
Punjab (PSEB)	-6,630	- 47,570	-14,020
	10,410	-24,720	340
Uttar Pradesh (UP power distribution utilities)	-19,500	-36,410	-39,510
	-15,440	-29,110	-30,000

Source: Teri Energy Data & Yearbook 2007

In the power sector of India, power generation companies and transmission company (PGCIL) regulated by the central government are structurally profit making, unlike the

transmission and distribution sector (power board, transmission and distribution corporations) regulated by the States, which is financially fragile. While the tariff of most up-stream organizations are protected on the basis of cost plus fee computation, down-stream section has a serious constraint that distribution loss rate reaches about 30% in both technical and commercial loss (due to rate restrictions, neglected power leakage, and pilferage of power). This may become a risk for sustainable revenue to be secured. To cope with this, the Indian government launched a program aiming at reducing transmission and distribution losses to less than 15% by 2012, and its achievement will be important to mitigate the above risk.

2.5.2. Current Status of Operation and Maintenance

At the Jalandhar substation, the major equipment suppliers, such as ABB and Siemens, conduct training sessions periodically and maintain high technical advancements. The substation appears to ensure high level capabilities of operation and maintenance of the various installations at the substations and transmission lines. Also, the PGCIL material management guidelines instruct to store adequate quantity of spare parts.

PGCIL uses computing systems for operation and maintenance monitoring for both transmission lines through central control using computer system.

Although PGCIL's operation and maintenance after project completion has been appropriately performed, immediately subsequent steps should be to clear the weeds spread over the switch yard at Hamirpur 220Kv substation of HPSEB, which was observed during ex-post evaluation field visit.

No major problem has been observed in the capacity of the executing agency nor its operation and maintenance system, therefore sustainability of the project is high.

3. Conclusion, Lessons Learned and Recommendations

3.1 Conclusion

It can be said that overall evaluation of this project is very high.

3.2 Lessons Learned

None

3.3 Recommendations

None

Comparison of the Original and Actual Scope

Items	Plan	Actual
(1) Project Output	(1) Dhauliganga Transmission System <Construction of transmission line between Dhauliganga Hydro Electric Power Station and Bareilly substation> - Power line: Double circuits 330km, 400kV, 2 conductors (210km of mountain ranges, 120km of Plain) - Power carrying capacity: 500 VA/Ckt - Steel tower: 960 towers (Double circuit) 690 stressed towers, 270 suspension towers - Substation line bays extension - Bareilly substation 220kV Line Bays 2cct (double main + transfer bus line) 220kV Shunt Reactor, 50MVAR x 4	(1)Dhauliganga Transmission System - Power line: Double circuits 233km, 400kV, 2 conductors (125km of mountain ranges, 108km of Plain) - Steel tower: 606 towers (Double circuit) 277 stressed towers, 329 suspension towers - Substation line bays extension - Bareilly substation (Installation of a shunt reactor is moved to the Dhauliganga generating plant.) - Dhauliganga plant (enforcement by NHPC) switch yard - 220kV line reactors 25MVAR x 2 sets (new construction)
	(2) Jalandhar - Hamirpur transmission system <Construction of transmission line between Jalandhar substation and Hamirpur substation> - Power line: Double circuits 130km, 220kV, Single conductor (about 10km of mountain ranges, about 120km of Plain) Calorific capacity: 235 MVA/Ckt - Steel tower: 433 towers (Double circuit) 245 stressed towers, 188 suspension towers - Substation line bay extension - Jalandhar substation - 220kV Line Bays (double main + transfer bus line) 2 Ckt. - Hamirpur substation - 220kV Line Bays (double main + transfer bus line) 2 Ckt Transformer is supplied by self-finance.	(2)Jalandhar - Hamirpur transmission system - Power line: Double circuits 124km, 220kV, Single conductor (about 63.5km of mountain ranges, about 60.5km of Plain) - Steel tower: 354 towers (Double circuit) 188 stressed towers, 166 suspension towers - Substation line bay extension - Jalandhar substation: No change - Hamirpur substation: No change - Change of transmission length is based on detailed survey and design.
(2) Project Period	(1) Dhauliganga transmission line project - Transmission line - Feb. 1997 to Feb. 2003 (73 months) - Substations - Feb. 1997 to Dec., 2002 (71 months) (2) Jalandhar - Hamirpur transmission line project - Transmission line - Feb. 1997 to Sep., 1999 (32 months) - Substations - Feb. 1997 to Aug., 1999 (31 months)	(1) Dhauliganga transmission line project - Transmission line - Dec. 1997 to Jul. 2005 (92 months) - Substations - Dec. 1997 to Jun., 2005 (91 months) (2) Jalandhar - Hamirpur transmission line project - Transmission line - Dec. 1997 to Feb., 2001 (39 months) - Substations - Dec. 1997 to Feb., 2001 (39 months)
(3) Project cost		
Foreign Currency	7,959.9 million yen	3,726. 3 million yen
Local Currency	5,828. 5 million yen	1,857.5 million yen
	(1,856. 2 millions Rs)	(712.6 millions Rs)
Total	13,788. 4 million yen	5,583.8 million yen

- Japanese ODA loan portion	8,497 million yen	3,726 million yen
-Exchange rate	1Rs = 3.14 yen (As of Jan. 1996)	1Rs = 2.61 yen (Average between Jan.1999 and Mar. 2006)