India

Power System Improvement and Small Hydroelectric Project

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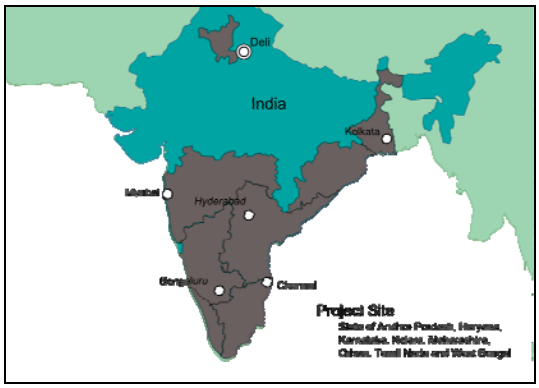
Field survey: October 2008

1. Project Description and Outline of the ODA Loan Assistance



Project Location

Small Hydroelectric Plant
(State of Tamil Nadu)

1.1 Background

Following the Fourth Five-year Plan (1969-1974), India has pursued policies prioritizing agriculture and rural development. In 1969, the Rural Electrification Corporation Limited (REC), the executing agency of the project, was created and the task began to improve agricultural infrastructure including the expansion of fertilizer production and irrigation facilities. As a result, the need for rural electrification rose. The number of villages with electricity increased from 74,000 at the end of March 1969 to about 157,000 villages in 1974, greatly exceeding the spread of electrification to approximately 29,000 villages from 1966 to 1969. Despite this fact, this was only about 76% or 435,653 villages of the total village electrification rate of 576,126 villages as of the end of March 1988 to the present (1971 Census). Thus, this project was implemented based on a need to provide electric power to the rural regions.

This project was requested as an ODA loan candidate project for FY1988, and a SAPROF (Special Assistance for Project Formation) investigation was conducted from October 1988 to February 1989.

1.2 Project Objective

The objective is to mitigate chronic power supply shortages in rural areas and provide an efficient electric power supply at the national level over the long-term by improving the electric-power-distribution system and installing small hydroelectric power plants, thereby contribute to increased food production in the region and balanced rural development.

1.3 Borrower/ Executing Agency

Borrower: President of India
Executing Agency: Rural Electrification Corporation Limited: REC

1.4 Outline of the Loan Agreement (L/A)

Loan Amount / Disbursed Amount	24,379 million yen / 13,718 million yen
Approved Amount/ Disbursed Amount	November 1989 / January 1991
Terms and Conditions	Interest Rate: 2.5 % Repayment Period: 30 years (Grace Period: 10 years) Conditions for Procurement: LDC Untied
Final Disbursement Date	February 2002
Main Contractor (Over 1 billion yen)	BSES LTD. (India), CROMPTON GREAVES LTD. (India), LARSEN & TOUBRO LTD. (India), M/S ANDREW YULE & CO.LTD., CALCUTTA (India), TATA PROJECTS LTD. (India)
Main Consultant (Over 100 million yen)	None
Feasibility Studies, etc.	1988: SAPROF (Special Assistance for Project Formation) 1995: SAPI (Special Assistance for Project Implementation)
Related Projects (if any)	None

2. Evaluation Results (Overall rating: C)

2.1 Relevance (Rating: a)

2.1.1 Relevance at Appraisal

The need for pump irrigation[1] to increase food production and rural electrification were promoted in the Seventh Five-year Plan (April 1985 to March 1990) due to the drought suffered in India during the 1960s. Thus, the plan to operate 8,090,000 irrigation pumps (5,700,000 at the end of the Sixth Plan as well as 2,390,000 during the Seventh Plan) was formulated. At the start of the project at the end of May 1988, 7,225,000 pumps were installed and energized for operation and the electrification of an additional 118,101 villages (equivalent to 85% of the total villages) was planned under the Seventh Five-year Plan.

In conjunction with the rapid electrification of rural areas and the installation of an enormous number of irrigation pumps, unplanned expansion of electric power distribution to meet the latent electricity demand of each rural region was carried out. As a result, the amount of power loss at the time when the project was planned in FY1985 marked as high as 22% of the total amount of electricity generated. Thus, it was an urgent issue to reduce the power loss by strengthening the rural power supply infrastructure through an improved power distribution system and development of small hydroelectric power facilities.

As a nationwide project that would be implemented during the Eighth Five-year Plan that started from 1990, the project was expected to improve the implementation system and operational methods of the REC and the State Electricity Board (SEB), to standardize the planning, design, procurement tender documents, standardized selection and evaluation procedures of a series of sub-projects, in order to implement them efficiently.

2.1.2. Relevance at Ex-Post Evaluation

India achieved an economic growth rate of 7.7% during the Tenth Five-year Plan (2002 to 2006). However, in the power development sector, only 21,080MW with net supply volume of about 18,000MW was actually achieved against a targeted capacity of 41,110MW. Thus, the performance of the power development plan in the Tenth Five-year Plan fell greatly short of the targeted value. Thus, power development has now become an urgent issue.

One of the priority issues listed in the subsequent Eleventh Five-year Plan (2007 to 2012), was the loss in power transmission and distribution. The plan as well states as follows;

> "Greater emphasis is being laid on handling the more serious problem of reducing the AT&C losses[2]. Although most of the States are taking measures to reduce these losses, however these are still very high and in some of the States are as high as 40%. It is envisaged to bring down the AT&C losses to 15% during the plan period".

[1] To irrigate the field by diesel or power pumping up the ground water.

[2] Aggregate Technical and Commercial losses

To raise the efficiency rate in this area, various measures have been proposed and it is estimated that an investment of more than 20 trillion rupees is needed.

In the area of rural electrification, the government of India has implemented the "Rajiv Gandhi Grameen Vidyutikaran Yojana" (RGGVY) scheme for rural electricity infrastructure and household electrification since 2005. This scheme aims at providing access to electricity to all rural household in five years and to improve electrification infrastructure for villages designated under the “National Common Minimum Programme (NCMP)”. The total budget is approximately 160 billion rupees, and 650,000 rupees is allocated per village to construct an electricity grid and improve the electricity infrastructure for 125,000 villages in total.

The village electrification and electric pump programs at the time of appraisal and ex-post evaluation have been ranked as priority works in the various five-year plans. Even today, there is a need to further expand the power distribution network, and power transmission losses remain high. In view of the need for continuous improvement, the needs towards the project and compliance remain high.

Moreover, the objectives of expanding village electrification and reducing power transmission losses meet the strategy of REC. 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)

Efficiency rates as moderate, as the duration far exceeded the plan, although the actual project costs revealed less than the planned amount. Although the project cost was lower than planned, the project period was significantly longer than planned, therefore efficiency of the project is fair.

2.2.1 Project Outputs

The output planned at the time of appraisal covered the following major four items.

(1) Formulating project implementation and establishing management approach;
(2) Standardizing the formulation and implementation of sub-projects and implementing a basic study on medium and long-term implementation of sub-projects;
(3) Implementing urgently required sub-projects to improve the power transmission and distribution system (96 sub-projects in 10 states);
(4) Implementing urgently required small hydroelectric power sub-projects (top 5 out of 8 sub-projects in 5 states).

The first and second items above were implemented mostly as planned; the project established a project group (PG), which was responsible for the actual management of each sub-project, and a management approach and system that enhanced the integration of the REC and SEB. As standardizing and regularizing the sub-projects, the project introduced *The Operational Guidelines for System Improvement Category of Schemes,* in addition to other comparable guidelines and manuals.

Since the selection criteria for the sub-project candidate list at the time of appraisal were not clearly defined, Special Assistance for Project Implementation (SAPI) in 1995 conducted a complete review of the sub-projects. Each SEB proposed 39 sub-projects as new urgently needed candidate projects; 34 of them were selected based on screening results that incorporated technical, economic, and the environmental viewpoints. Of these it eliminated, seven sub-projects of the State of West Bengal, which were not suitable for implementation by SEB, and two sub-projects of the State of Tamil Nadu, which used own funds for implementation. As of the end of December 1998, a total of 41 sub-projects (of which 16 were initially selected as urgently needed) were implemented. Also, nine new applications were made, of which four were accepted based on screening results, and the total became 45 projects. SAPI's project selection criteria were urgency of the project, the effect of reducing power distribution and transmission losses, the capacity to carry out various field surveys. The initial candidate sub-projects that were eliminated were later implemented by each SEB using their own budgetary resources.

The main content of the sub-projects was to construct new substations and to install transmission and distribution lines; only six projects being involved with rehabilitating existing power stations. The detailed output of case examples are shown below.

1. Andhra Pradesh State SAP-32 Nizmabad (North) System	2. Maharashtra State WMH-35 PUNE
Upgrade 33kV substation to 132kV	Construction of new 220/33/22 kV substation at one site
Construction of new 33/11kV substation at one site, strengthen 4 sites	Construction of five new 132/33/22 kV substations
33kV/11kV new power line construction	Expand high-pressure substations at three sites
132kV substation expansion	220kV-132kV new power line construction
33kV/11kV substation expansion	Construction of 33/11kV new substations at seven sites
33kV/11kV circuit breaker installation	Construction of 33/22kV new substations at four sites
11kV circuit breaker installation	33kV/22kV/11kV new power line construction

The Small hydroelectric power sub-projects were reduced to one sub-project per state from the initial plan. Five out of eight candidate projects were selected by SAPROF implemented in 1988/1989. Yet, due to their insufficient progress, SAPI took over their implementation in 1995. Under SAPI's management, each SEB proposed four alternative projects that were all selected based on screening results that incorporated technical, economic, and the environmental viewpoints. However, in the State of Karnataka, problem over water rights could not be resolved and in the State of Kerala, the projects were eliminated due to the involvement of private capital. Finally (as of the end of December 1998) only one sub-project in the State of Tamil Nadu remained for implementation.

Based on the above, although the number of sub-projects has greatly changed through SAPI, they have been implemented as planned subsequent to the change. In addition the output of each sub-project has also been achieved as planned.

2.2.2 Project Period

The overall project period of this project was from January 1991 to December 1993, but the sub-project on small hydroelectric power construction was completed in February 2007. The project required 194 months in contrast to the originally planned 36 months, which signified a 539% delay. The final loan disbursement took place in May 2002, and the construction works of the sub-projects, such as a hydro project in Tamil Nadu. It since then continued by using their own funds.

The implemented sub-projects can be divided into the three categories of (1) projects selected at the time of appraisal; (2) projects selected by SAPI; and (3) projects added during the final stages. Compared with their original plan, the project period for the sub-projects selected at the time of appraisal showed a 283%, those selected by SAPI revealed a 188%, and the small hydroelectric project demonstrated a 352% delay. Also, the sub-projects to improve the power-distribution system that were added at the very last showed a 279% delay. They greatly exceeded the period of implementation projected in their plans; the small hydroelectric project, particularly, the supply of equipment was greatly delayed due to the financial problems by the prime contractor, which was unexpected to the implementing agency; this affected the overall progress of the project.

In reviewing the project implementation period of the sub-projects implemented in each state, although there revealed an overall delay of 276%, a wide variance was seen: one in Maharashtra State was under 150% and 120% in Andhra Pradesh and Karnataka states.

The delays in sub-project implementation can be attributed to the following reasons:

(1) Since the selection criteria for the candidate sub-projects at the time of appraisal

were not clearly defined and the implemented design was delayed, their implementation did not progress satisfactorily. Subsequently, SAPI substantially re-examined the various sub-projects. Nevertheless, the screening capacity of the executing agency was inadequate. As well, the implementing agency took relatively longer in time wise for processing official procedures, and part of the reasons may be that for the implementing agency this project was the first loan funded by Japanese ODA;

(2) The project is divided into a number of small sub-projects. Also, to utilize the loan amount fully, some sub-projects were added at later stage after the projects began;

(3) Sub-projects were scattered in eight different states all over the country;

(4) There were delays in acquiring forest clearance for some of the sub-projects;

(5) Due to an unexpected increase in electricity demand stemming from rapid economic growth between the project planning stages to the start of project implementation, there arose the need to carry out construction works that differed from the original plan.

The complexity of the projects as well as the length of time between planning and implementing due partially to its complexity should be taken into consideration when assessing the main reasons for the delays. However, it cannot be denied that the inadequate capacity to implement projects by the implementing agency was one reason for the delays.

2.2.3 Project Cost

In the original plan, the project cost was estimated as 41,072 million yen, but only 17,530 million yen was disbursed, corresponding to a 42.7% decrease in the projected cost. The underlying factors are the drastic change in the number of sub-projects from the time of appraisal and the sharp appreciation of the yen in the foreign exchange rate.

The appreciation of the exchange rate from the period of appraisal to ex-post evaluation tended toward a strong-yen rate as seen in the table below. Thus, during the project planning stage, the share of the Japanese ODA loan (foreign currency) was only about half the total project cost. However, in actuality, the project was implemented mostly on the loan in yen with only limited use of local currency.

At the time of appraisal (1989)	1 rupee = 8.50 yen
SAPI report (1995)	1 rupee = 2.89 yen
April 1998	1 rupee = 3.25 yen
February 2002	1 rupee = 2.75 yen

(Exchange rates in 1998 and 2002 are as reported under the Ministerial Ordinance of International Department, the Bank of Japan.)

Since the Amaravathy small hydroelectric power sub-project was not completed during the loan validity period, the expenditures beyond that period were covered by their own financial resources.

2.3 Effectiveness (Rating: b)

This project has somewhat achieved its objectives, therefore its effectiveness is fair.

2.3.1 Operational Effect and Indicator

(1) Facility Operating Conditions (power outage time, power supply volume, peak power supply.)

Although the effect indicator varies from one sub-project to another, in the state of Andhra Pradesh, power outage hours from FY2003 to FY2007 ranged from 100 to 300 hours during this period, or within 3% out of a total operating time of 8,760 hours. This indicates that the facility is working properly (see Table 1). However, power outage hours have increased recently because power supply has been unable to meet the increasing load demand. The supply volume from three substations in Haryana State has also increased (see Fig. 1).

Table 1 Power Outages According to Sub-projects in Andhra Pradesh State

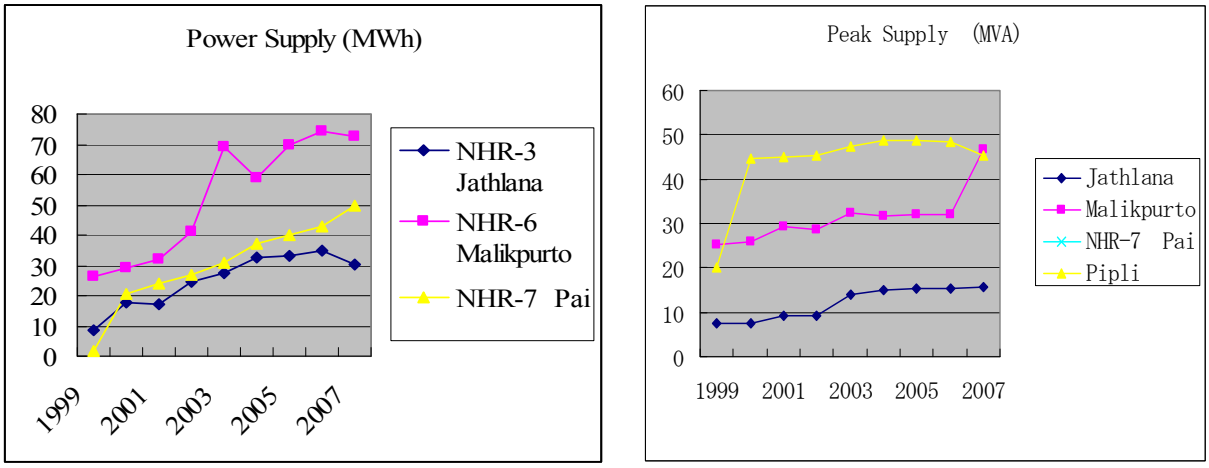
(Total annual operation hours 8,760)

Fiscal Year	Name of the 11kV feeders								
	11kV Gudadpally			11kV Goalveedy			11kV Kompally		
	No. of Cases	Outage Hours	%	No. of Cases	Outage Hours	%	No. of Cases	Outage Hours	%
1989	-	430.00	4.9	-	559.00	6.4	-	647.00	7.4
2002	115	124.00	1.4	110	150.75	1.7	250	170.50	1.9
2003	138	135.50	1.5	123	206.25	2.4	346	261.75	3.0
2004	125	230.25	2.6	135	185.15	2.1	310	250.00	2.9
2005	130	140.00	1.6	105	170.08	1.9	290	225.00	2.6
2006	281	254.33	2.9	158	161.41	1.8	205	208.00	2.4
2007	361	299.33	3.4	310	276.66	3.2	280	201.00	2.3

Note: Figures indicate the outage hours out of the total annual operation hours.

Source: Reply from APTRANSCO to Questionnaire

Fig. 1 Power Supply Volume and Peak Power Consumption of Haryana State Sub-projects



Source: Reply from HVPNL to Questionnaire

(2) Number of Irrigation Pumps

In the agricultural sector of India, irrigation is carried out primarily by pumping groundwater. As shown in Table 2, the achieved electric pump utilization rate in most of the states where the sub-projects have been implemented marks higher than one in nationwide, which is approximately 74%.

Table 2 Number of Electric Irrigation Pumps

State	Target (Planned)	March1985 Actual	March2005 Actual	March2008 (Reference)	Ratio (%)
All India	19,500,000	5,705,405	14,445,014	15,674,673	74
Andhra Pradesh	2,438,000	646,212	2,374,365	2,440,823	97
Haryana	406,000	271,902	462,635	515,869	114
Karnataka	975,000	440,758	1,434,060	1,723,224	147
Kerala	244,000	131,812	446,366	490,054	183
Maharashtra	1,463,000	935,256	2,572,815	2,897,155	176
Orissa	813,000	29,891	74,625	74,625	9
Tamil Nadu	1,625,000	1,033,147	1,854,471	1,955,114	114
West Bengal	813,000	39,492	113,563	115,462	14

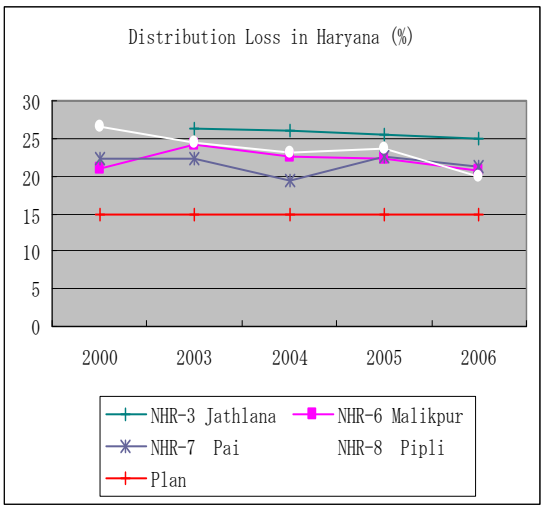
Source: REC, CEA Monthly Report "pumpset_energisation.pdf"

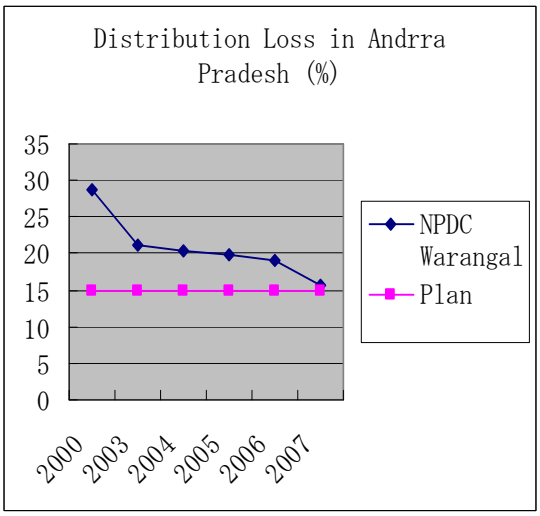
Note: 1) Target value is the estimated units taken from the Tenth Five-year Plan (2002-06).
2) Achievement ratio = March 2005 achieved value / number of electric pumps given in the Tenth Five-year Plan

(3) Power Distribution Loss Rate

In case examples of the power distribution region where new substation facilities were constructed by the sub-projects (Haryana and Andhra Pradesh states), a reduction in power transmission and distribution losses has been observed. However, the planned values at the time of appraisal have not been achieved in both states.

Fig. 2 Power Distribution Loss Rate in the Sub-projects





Source: Reply from HVPNL/APNPDCL to Questionnaire

(4) Operational Effect and Indicator of the Small Hydro Electric Sub-project

The operational effect indicator and the actual figures following the project's completion in the Amaravathy small hydroelectric sub-project additionally implemented through SAPI are as follows.

Table 3 Operational Effect and Indicator of the Amaravathy Small Hydroelectric Sub-project

Effect Indicators	Projected Value	Actual Value	Compared Value (%)
Net power volume	10.47 GWh/ year	7.5 GWh/year	71.6
Operation hours	6,570 Hr/year	4,188 Hr/year (174.5 Days/year)	63.7
Unplanned outage hours	-	2,178 Hr/year (90.75 Days/year)	-
Facility utilization rate (%)	75%	76%	101.3
Hydropower utilization rate (%)	75%	69.81% (Sep. to Dec., 2006)	93.1
Total annual inflow volume	378M m^3/year	365.41M m^3/year	96.7

The table 3 shows comparative data on lower power transmission volume, operating hours, hydroelectric utilization rate with the initial plan of Amaravathy small hydroelectric sub-project. Of the two power generators, one unit was out of order due to failure of the oil pressure system, and the amount of unplanned outage hours was 2,178 hours, which greatly exceeded the planned estimate. As a result, the facilities' operations and power production did not achieve the targets initially planned.

(5) Conclusion on Effectiveness

In a segment of the operational effect indicators, the actual value was lower than the planned value. However, the purpose of the project—to mitigate chronic power shortages and to efficiently provide electricity to rural areas—was judged to have been generally achieved.

Beneficiary Survey Findings in the States of Haryana, Andhra Pradesh and Tamil Nadu

A beneficiary survey was carried out targeting 25 respondents including large industrial consumers in each state for a total of 75 beneficiaries. The respondents such as factory owners were asked questions about power conditions before and after the project, voltage stability, income of neighboring residents, their living conditions, and the effect on access to social services and others.

Beneficiary Survey Findings		
Questions	Response (before and after project completion)	%
Power outage hours before and after implementation?	Average 6 hours (before) → 3 hours (after) (State of Haryana, Andhra Pradesh)	-
	Average 5 hours (before) → 1 hour (after) (State of Tamil Nadu)	-
Please mention direct benefits of the project (multiple choices).	Voltage stability	97.33%
	Increased opportunities to obtain information from the mass media	89.33%
	Increase of street lighting	84.00%
	Increased use of electricity within household	81.33%

Source: Beneficiary survey report

2.3.2 Economic and Financial Analysis (Internal Rate of Return: IRR)

For many states the IRR value was higher than the planned value at the time of

appraisal. In particular the underlying reasons for the high IRR value of sub-projects during the ex-post evaluation were reduced construction and maintenance costs and increased electricity sales.

Table 4 Average FIRR/EIRR Value of the Sub-projects to Improve the Power Distribution System

FIRR (Financial Internal Rate of Return)			EIRR (Economic Internal Rate of Return)	
	At appraisal	At ex-post evaluation	At appraisal	At ex-post evaluation
IRR	18.6%	31.9%	18.4%	33.3%
Cost	Construction costs and O/M expense (3% of construction costs)		Construction costs and O/M expense (3% of construction costs)	
Benefits	Electricity sales revenue		Amount of reduced power loss	

Source: SAPI and the re-calculation during evaluation

Table 5 Construction of Small Hydro Electric Facility (FIRR)

	Small hydroelectric construction project (average value)	SR-4-3 Amaravathy Dam SHPP	
	At appraisal	At appraisal	At ex-post evaluation
FIRR	6.6%	4.7%	9.8%
Cost	Construction costs and O/M expense (1% of construction costs)		
Benefits	Annual electricity sales		

Source: SAPI and the recalculation during evaluation
Note: Only one small hydroelectric sub-project, SR-4-3 Amaravathy Dam was implemented.

Table 6 Construction of Small Hydro Electric Facility (EIRR)

	Small hydroelectric construction project (average value)	SR-4-3 Amaravathy Dam SHPP	
	At the appraisal	At appraisal	At ex-post evaluation
EIRR	-	3.9%	8.2%
Cost	Construction costs and O/M expense (1% of construction costs) (economic price)		
Benefits	Annual electricity sales (economic price)		

Source: SAPI and the recalculation during evaluation

The IRR value for the small hydroelectric sub-project was an improvement over the planned value due to increased revenue from the sale of electricity based on a review of

electricity rates.

2.4 Impact

2.4.1 Rural Electrification and the Contribution to Increase of Food Production

The following impact was identified during the ex-post evaluation.

(1) Village Electrification Rate

The village electrification rate that averaged 64% nationwide at the time of appraisal rose to 74% at the end of March 2005. Excluding the states of Orissa and West Bengal, an electrification rate of nearly 100% was attained in all the other states where the project was implemented, even showing a higher electrification rate than all of India. This suggests that the project contributed to rural electrification in the targeted states.

Table 7 Numbers of Villages with Electricity

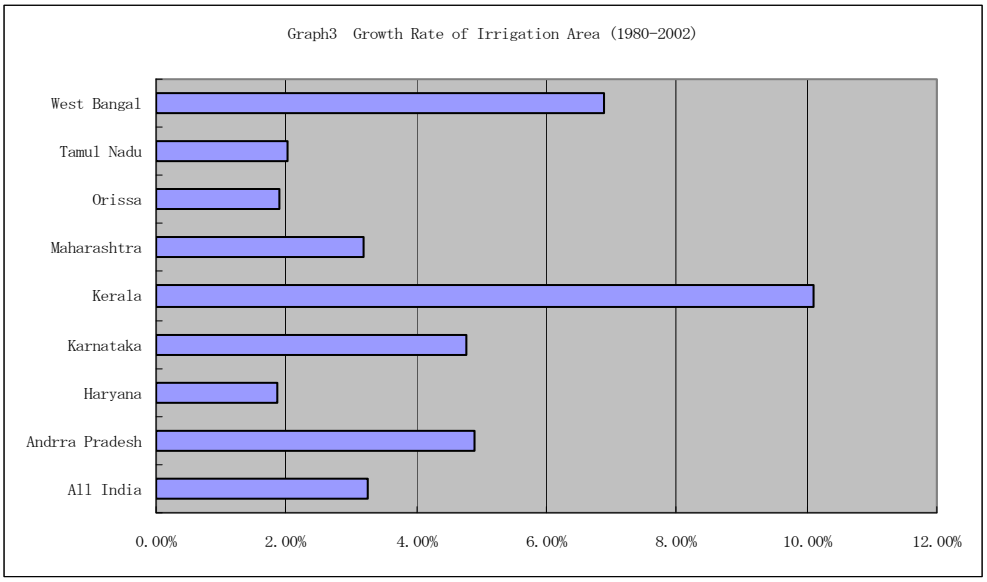
	1981 Census	Achieved Value as of Mar. 1985	Electrification Rate (A) (%)	7th Five-year Plan Value	2001 Census	Achieved Value as of Mar. 2005	Electrification Rate (B) (%)
All India	580,741	368,840	63.5	118,101	593,732	439,800	74.1%
Andhra Pradesh	27,379	22,851	83.5	4,370	26,613	26,613	100.0%
Haryana	6,745	6,731	99,8	-	6,764	6,764	100.0%
Karnataka	27,024	22,302	82.5	4,524	27,481	26,971	98.1%
Kerala	1,331	1,268	95.3	-	1,364	1,364	100.0%
Maharashtra	39,354	33,218	84.4	2,365	41,095	35,541	86.5%
Orissa	46,553	23,720	51.0	7,558	47,529	26,235	55.2%
Tamil Nadu	15,831	15,693	99.1	43	15,400	14,621	94.9%
West Bengal	38,024	12,201	32.1	14,918	37,945	32,190	84.8%

Source: Calculation from All India Electricity Statistics 2006, CEA, the 7th Five-year Plan, and "Village Electrification in India" (CEA Data) (Appraisal data, REC). Number of villages (1981 National Census), Data quoted from the Census of India 1981.

Note 1) Electrification rate (A) =Achieved value as of March 1985/1981 National Census on number of villages
Note 2) Electrification rate (B) = Achieved value as of March 2005/2001 National Census on number of villages

(2) Increased Power Consumption in Agriculture and Growth in Agricultural Crops

The year-to-year changes in the harvest rate of rice and other food grains and power consumption in agriculture are given below; and they show a rising trend (see Table 8 and Graph 4). In addition, the average growth rate of irrigated farmland reached an average of 4.5% during the period from 1980 to 2002 in the states where the sub-projects were implemented; and it exceeded the 3.3% growth rate achieved for all of India (see Graph 3). Further, it can be also observed that implementation of this project has contributed to rural electrification.



Source: Trends in Irrigated Area in India, Gokhale Institute of Politics and Economics, 2006

Table 8 Transitions in the Harvest Rate of Rice and Grains

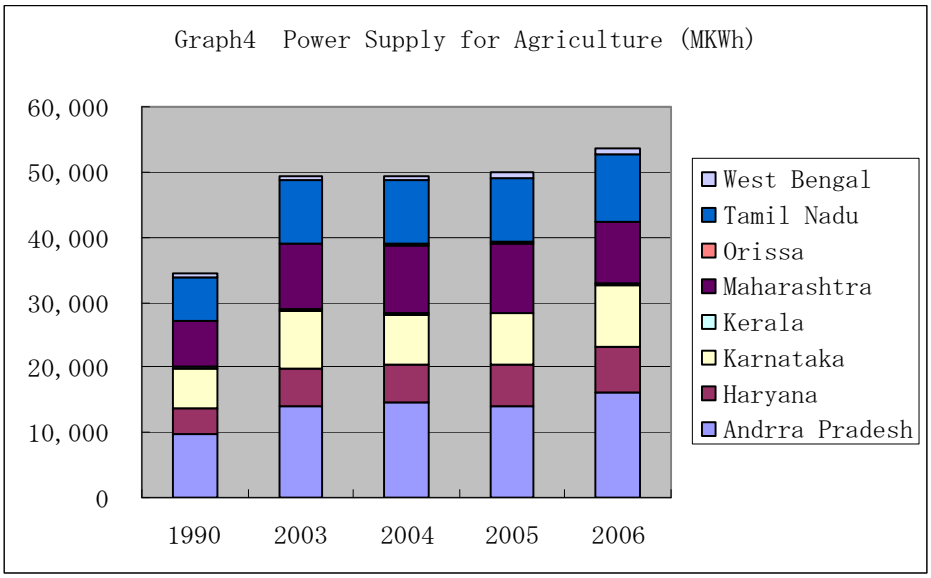
State Targeted in Sub-projects	Harvest Rate of Rice (kg/ha)			Harvest Rate of Grains (kg/ha)		
Year	2004	2005	2006	2004	2005	2006
Andhra Pradesh	3,111	2,939	2,984	2,138	2,365	2,231
Haryana	2,941	3,051	3,238	3,092	3,045	3,393
Karnataka	2,712	3,868	2,470	1,388	1,776	1,289
West Bengal	2,574	2,509	2,593	2,479	2,423	2,511
Orissa	1,446	1,531	1,534	1,300	1,349	1,359
Kerala	2,301	2,284	2,390	-	-	-
Maharashtra	1,425	1,779	1,680	836	948	940
Tamil Nadu	2,703	2,546	3,423	1,874	1,847	2,610
Average of targeted States	2,402	2,563	2,539	1,872	1,965	2,048
All India	1,984	2,102	2,131	1,652	1,715	1,756

Source: Statistics at a Glance 2008, 2006, Department of Agriculture & Cooperation, Ministry of Agriculture, GoI

Power consumption in the agricultural sector has substantially increased after these sub-projects were implemented, and the area of irrigated farmland for rice cultivation has also risen, leading to a stable growth of agricultural products and increased yield volume per unit area of land. The increase of power consumption in the agricultural sector is due to rural electrification and the spread of irrigated farming using groundwater through the dissemination of irrigation pumps that has increased the harvest rate of rice and grains. In

reviewing the year-to-year changes in harvest volume per hectare for rice and grains after the sub-projects were implemented, the average harvest rate of the states targeted in the projects exceeded all of India. In a comparison of the harvest rate for rice (1,740Kg/ha) and grains (1,380Kg/ha) for all of India at the time of appraisal, the increase after the projects were implemented is apparent.

Thus, agricultural production in the targeted states increased after project implementation, in conjunction with the rise in power consumption with the use of electric pumps in lieu of diesel pumps; and it can be said that the sub-projects also contributed to the improved productivity of cultivated land. The power supply volume in agriculture in the states targeted in the sub-projects is shown in Graph 4. Power consumption volume in the agricultural sector is increasing gradually; this indicates the rise in electric pumps used for irrigation. The increase is apparent in a comparison of figures after project implementation and ones at the time of appraisal.



Source: TERI Energy Data Directory and Yearbook 2007

(3) Transmission and Distribution Loss Rate

The transmission and distribution losses for India have continued to rise with the peak of 2002. This can be caused by countermeasures not being adaptable for controlling the increase in transmission and distribution losses due to the spread of rural electrification and irrigation pumps. Although having gradually declined since 2002, the loss rate was 30.4% nationwide in 2005 and remains high when compared to a 20% loss during the 1990s. However, particularly the transmission and distribution loss rate during the ex-post evaluation nearly all in the states where the sub-projects were implemented, was below the average nationwide value.

Table 9 Transitions in the Transmission and Distribution Loss Rate (%) in the Target States

State	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06
All India	24.8	26.7	30.9	32.9	34.0	38.3	32.5	31.3	30.4
Andhra Pradesh	32.3	33.6	37.7	36.6	26.8	30.1	27.7	24.0	20.1
Haryana	34.0	35.3	38.3	39.8	39.2	37.7	32.1	32.1	30.5
Karnataka	19.1	30.6	37.3	34.9	33.8	24.6	23.3	26.1	29.8
Kerala	19.1	17.7	17.8	18.4	32.2	27.5	21.6	22.5	23.5
Maharashtra	18.0	17.8	29.2	33.8	37.3	34.0	34.1	32.4	31.6
Orissa	49.8	43.2	44.3	44.9	47.3	45.4	57.1	44.0	45.6
Tamil Nadu	17.1	16.8	17.0	15.7	16.1	17.3	17.2	19.3	18.7
West Bengal	20.4	22.9	26.3	29.4	31.7	25.9	31.0	28.5	24.8

Source: TERI Energy Data Directory and Yearbook 2007

(4) Beneficiary Survey

Among the responses received from the beneficiary survey, the indirect benefits were "improved security due to streetlights", "improved living standards", and "improved water-purifying equipment".

Interview Findings of Farms

Since the construction of a power substation near the farmlands that has power stabilized power supply, farmers have replaced diesel pumps with electric pumps.

→ Due to a stabilized power supply, users have benefited by replacing diesel pumps to inexpensively operational electric pumps.

Beneficiary Survey Findings for Haryana, Andhra Pradesh, and Tamil Nadu States

The beneficiary survey was concluded on a total of 75 beneficiaries or 25 respondents in each state, including a large-scale industrial user. In Andhra Pradesh State, 72% of the beneficiaries or 25 subjects (including 18 farmers) responded that the project had “increased agricultural income".

Beneficiary Survey Findings		
Questionnaire	Response	%
Please mention the indirect impact the project has had (multiple selections).	Reduction of oil lamp use	90.66%
	Improved security due to streetlights	86.66%
	Improved living standards	80.00%
	Improved water purifying equipment	74.66%

	Improved the quality of educational service	69.33%
	Reduced working hours	53.33%
	Increased income	48.00%

The above information suggests that the improved power supply facilities, which build the social foundations in local villages, have elevated local electrification rate, and an increase in the number of electric pumps used in villages have facilitated well-balanced rural development. However, due to the factors such as small project scale, it cannot be concluded that the development effects are derived only from the implementation of these projects.

2.4.2 Impact on the Natural Environment

The negative impact of the small hydroelectric power sub-project on water use downstream the power plant was investigated at the time of appraisal, however it was concluded that implementing the sub-project would not create any problems as the power plant would be operating using the irrigation drainage water from the existing irrigation dam and irrigation ditch.

For the system improvement sub-projects (EOR-6 Paralakhemundi, EOR-7 Rairhole&Barkote, and EOR-8 Patnagarh) in Orissa State, forest clearance was obtained to implement the projects; the project cost included its acquisition cost and compensation fee for forest clearance. This process delayed the term of works, but it did not have any seriously negative impact on the natural environment. Transmission and distribution lines that are in contact with trees are regularly inspected several times a year

2.4.3 Land Acquisition and Resettlement

Some land acquisition was planned during the appraisal stage; and the relevant acquisition and compensation expense estimated (Rs 1,700,000 for the small hydroelectric sub-project and Rs 7 million for the system improvement sub-projects) were included in the project cost. The land acquisition cost was also included in the estimated cost of each sub-project. Interviews with the local authorities and project implementing agencies regarding compensation expenses indicate no resettlement of residents related to the projects and appropriate compensation payments related to the acquisitions. There were no reports of disputes related to resettlements or land acquisitions during the ex-post evaluation stage.

2.5 Sustainability (Rating: b)

Though some problems have been observed in terms financial aspect in the power transmission and distribution companies in each state, sustainability of the project is fair.

2.5.1 Executing Agency

2.5.1.1 Structural Aspects of Operation and Maintenance

Rural Electrification Corporation Limited (REC), the executing agency of the project, presently has a total of 699 personnel (consisting of 364 management, 335 general administration, and 63 electrical engineers, many of whom are from each State Electricity Board (SEB)). REC also has six regional offices, 17 project offices in each state capital and two training centers; and it has obtained ISO 9001:2000. No substantial re-organization within REC at the time of appraisal was observed at the evaluation.

As mentioned earlier, each SEB is responsible for the operation and maintenance of the project; and REC assisted the technical evaluation on equipment procurement when the sub-projects were implemented. A case example is given below, which shows the engineers employed by power transmission and distribution companies in Andhra Pradesh State.

Table 10 Engineers Employed by Transmission and Distribution Companies in Andhra Pradesh

APTRANSCO (transmission company)		APNPDCL (distribution company)	
Chief Engineers	18	Superintending Engineers	924
Regional Engineers	143	Administrations	1,587
Assistant Engineers	313	Planners	49
Assistant Regional Engineers	588	Operation and Maintenance	4,622
Superintendents	46	-	-
Total	1,108	Total	7,182

Source: Reply from APTRANSCO/APNPDCL to Questionnaire

Table 11 Restructuring According to State

State	Generation Co.	Transmission Co.	Distribution Co.
Andhra Pradesh	1	1	4
Haryana	1	1	3
Karnataka	2	1	5
Orissa	2	1	4
Maharashtra	1	1	1

Source: Report on the Performance of The State Power Utilities for the Years 2004-05 to 2006-07, Power Finance Corporation Limited

In the operation and maintenance system that was reviewed in the appraisal, the facilities of each State Electricity Board were to be transferred to each SEB, but during the implementation of the sub-projects, company split-ups occurred in the power sector as shown below. The purpose of the split up was to promote further development in the power sector, to enable the supply of electricity to all parts of the country, and to rectify electricity charges. As a result, the transmission and distribution companies that are in charge of maintenance have strengthened their measures against losses.

The structure of the power sector companies in the State of Andhra Pradesh is as follows.

Generation: Power Generation Company of Andhra Pradesh (APGENCO)
Transmission: Power Transmission Corporation of Andhra Pradesh (APTRANSCO)
Distribution: Northern Power Distribution Company Ltd of Andhra Pradesh (APNPDCL) and 3 others

The structure of the power sector companies in other State of Haryana is as follows.

Generation: Haryana Power Generation Company Ltd. (HPGCL)
Power transmission: Haryana Vidyut Prasaran Nigam Ltd. (HVPNL)
Power distribution: Uttar Haryana Bijli Vitran Nigam Ltd. (UHBVNL) and two others

Due to restructuring, the role for facility improvement and operation/maintenance works have been clearly divided; and it has become easier to secure a maintenance system for the facilities after project completion and to sustain the project's effect.

2.5.1.2 Technical Aspects of Operation and Maintenance

The technical aspects of operation and maintenance is mainly carried out by each SEB (the overall number of engineers is about 80,000) and supervised by REC (reviewing specification forms of tender documents and preparing standard specification documents). There were 280 REC employees who participated in various local and overseas training programs in 2007. In addition, 14 different types of training programs were held, including methods to reduce transmission and distribution losses and reviews on electricity charges, and 293 employees participated in these programs.

In the states where restructuring took place, public corporations overseeing the power transmission and distribution sector also take responsibility for technical aspects. Although size varies, in Andhra Pradesh State, for instance, APTRANSCO is in charge of the transmission sector and has 1,108 electricians. Its training center conducted 93 technical sessions from June 2007 for a one-year period on Auto CAD, ORACLE, MS OFFICE; within that, computers were used 63 times.

APNPDCL, in charge of distribution in the northern area, conducted training on safety

countermeasures related to maintenance using their own training facilities as well at outside institutions. Similar training programs are surmised to have been conducted at other SEBs or public corporations formed after restructuring that are in charge of technical maintenance.

Thus, trainings on operation and maintenance are appropriately carried out and the relevant parties possess the adequate experience and skills needed to implement and maintain the projects.

2.5.1.3 Financial Aspects of Operation and Maintenance

Regarding the profitability of the implementing institution, REC, has improved from 1.57% at the time of appraisal to 3.24% at the time of the evaluation. However, its capital-adequacy ratio decreased slightly from 16.3% (at the end of FY1987) to 13.26% (at the end of FY2007), even though, it is not serious in terms of management. The state power utilities in India are expected to continue to be foremost customers. In India's power sector, the financial conditions of the transmission and distribution sector of each state is in deficit. This is because pricing in the upstream sector is based on cost plus fee in contrast to the downstream sector where technical and commercial losses—mainly due to rate restrictions, electric leakage, and pilfering of power–are higher than 30%. Thus, there is an urgent need to strengthen the financial conditions of the end-user organizations in the power sector.

Table 12 Annual Profit and Loss and Subsidies for
Power Transmission and Distribution Public Corporations (unit: million Rs

Year	2001		2002		2003		2004	
	Profit / Loss	With Subsidy	Profit / Loss	With Subsidy	Profit / Loss	With Subsidy	Profit / Loss	With Subsidy
Andhra Pradesh	- 29,480	- 4,910	-12,320	2,770	-15,790	-650	-11,940	1,090
Karnataka	- 18,700	3,440	-15,990	3,400	-13,150	3,100	-11,070	4,620
Haryana	- 9,480	- 1,840	- 8,030	260	-7,850	2,410	-14,490	-3,470
Maharashtra	- 5,400	-5,390	- 2,550	-2,550	-5,490	-9,040	- 8,040	- 8,040
West Bengal	- 17,060	-14,670	- 9,140	-9,140	- 2,960	- 2,960	- 2,750	-2,750
Orissa	-2,610	- 2,610	- 9,440	-9,440	1,930	1,930	3,030	3,030
Kerala	- 12,540	630	- 9,350	810	- 9,160	920	-2,390	1,040
Tamil Nadu	- 51,740	- 48,520	- 21,000	1,130	-13,600	-11,000	-20,300	-11,060

Source: Teri Energy Data & Yearbook 2007

At the appraisal and SAPI study stage, 3% of the facility investment cost was established as the indicator to measure the sufficiency level of operation and maintenance expense.

Even though, the amount allocated for maintenance at APTRANSCO (Andhra Pradesh

State) was not necessarily adequate from 2002 to 2003, it increased during the three-year period from 2003 to 2005, and after 2005, more than 3% has been secured. In the case of APNPDC, the ratio was high in 2002, but decreased towards 3% with each subsequent year and it has maintained an appropriate budget through financial review.

Both the power transmission company (HVPNL) and the power distribution company (UHBVNL) in Haryana State have secured about 4% to 5%, and it can be said that the operation and maintenance budget has been adequately secured.

Table 13 APTRANSCO O/M cost (million rupees)

Year	2002	2003	2004	2005	2006
O/M cost	330	387	585	1,057	1,061
Fixed-assets	25,085	24,392	24,935	27,499	29,379
Ratio (%)	1.32%	1.59%	2.35%	3.85%	3.61%

Source: Annual Report 2006, 2005, 2004, and 2003 APTRANSCO

Table 14 APNPDC O/M cost (million rupees)

Year	2002	2003	2004	2005	2006
O/M cost	314	233	242	293	293
Fixed-assets	5,293	6,731	7,740	9,148	9,361
Ratio (%)	5.94%	3.46%	3.13%	3.21%	3.13%

Source: Annual Report 2006, 2005, 2004, and 2003 APNPDC

Table 15 HVPNL O/M cost (million rupees)

Year	2004	2005	2006	2007	2008
O/M cost	490	512	532	705	843
Fixed-assets	9,816	12,147	12,806	14,130	16,137
Ratio (%)	4.99%	4.22%	4.16%	4.99%	5.22%

Source: Annual Report 2008, 2007, 2006, 2005, and 2004, HVPNL

Table 16 UHBVNL O/M cost (million rupees)

Year	2003	2004	2005	2006
O/M cost	230.2	396.6	397.9	926.8
Fixed-assets	7,452	7,561	7,677	8,433
Ratio (%)	3.09%	5.25%	5.18%	10.99%

Source: Annual Report 2007, 2006, 2005, and 2004, UHBVNL

With some variation of the amount spent in each state, operation and maintenance costs have tended to increase in conjunction with the expansion of the power-distribution network, and the figure, 3%, which was set during the appraisal and the SAPI study has been nearly met. Therefore, it can be said that operation and maintenance costs are sufficient. The power transmission and distribution companies are supplemented by subsidies as shown in Table 12 when there is a shortage of funds due to losses.

2.5.2 Current Status of Operation and Maintenance

At the appraisal stage, the shortage of materials and spare parts during operation and maintenance was originally to be supplemented independently by each SEB. However, following the restructure of the power sector, the power transmission and distribution companies in most of the states are now responsible for the operation and maintenance of the substations within the limited scope of their projects. The employees take training at a seminar house or are taught by experienced technical professionals. When spare parts are short during a malfunction, the nearest transmission and distribution company would supply them in order to reduce the outage hours.

3. Conclusion, Lessons Learned and Recommendations

3.1 Conclusion

Although the project implementation period far exceeded the original plan, it contributed to the national policies and measures to reduce power transmission and distribution losses, to disseminate electric pumps, and to achieve rural electrification. However, the fragile financial foundations of the public power transmission and distribution corporations in each state that are in charge of operation and maintenance are slightly problematic in terms of sustainability.

In light of the above, this project is evaluated to be fairly satisfactory.

3.2 Lessons Learned

None

3.3 Recommendations

None

Comparison of Main Plan and Actual Performance

Item	Plan	Performance
(1) Project Outputs	(1) Formulate project implementation system, and establish operation approach. (2) Standardize the formulation and implementation of the sub-projects, and implement a basic study the medium to long-term implementation of the sub-projects. (3) Implement sub-projects to improve the power transmission and distribution system, and newly construct or reinforce substations in 96 sub-projects in 10 states. (4) Implement small hydroelectric power sub-project, newly construct run-off river type substations in 8 sub-projects in five states.	(1) As planned (2) As planned The following document was prepared in order to achieve standardization. (Operational Guidelines for System Improvement) (3) The number of sub-projects reduced to 45 in 7 States, and their output was achieved as planned. (4) Reduced to only 1 sub-project; the output was achieved as planned.
(2) Project Period	January 1991 to December 1993	January 1991to February 2007
(3) Project cost Foreign currency Local currency Total Japanese ODA loan portion Exchange rate	 26,078 million yen 14,994 million yen (1,764 million rupees) 41,072 million yen 24,379 million yen 1 rupee = 8.5 yen (September 1989)	 12,018 million yen 5,512 million yen (1,837 million rupees) 17,530 million yen 13,718 million yen 1 rupee = 2.89 yen (at SAPI study completion in July, 1995) 1 rupee = 2.75 yen (at loan disbursement completion in February, 2002)

Details of the Project Implementation Period

Plan	Performance
(1) Sub-projects selected at the time of appraisal. - Improvements to the power transmission and distribution system: - Jan. 1991 to Dec. 1993 (36 months) - Small Hydroelectric power plant: - Jan. 1991 to Apr. 1993 (28 months) (2) Selected sub-projects by SAPI - Improvements to the power transmission and distribution system: - Jul. 1995 to Jan. 1999 (43 months) - Small hydroelectric power plant: - Nov. 1999 to Nov. 2001 (25 months) (3) Last addition of sub-projects (WMH-35, 36, 37, 38) - Improvements to the power transmission and distribution system: - Nov. 1999 to May 2001 (19 months)	(1) Sub-projects selected at the time of appraisal. - Improvements to the power transmission and distribution system: - Jan. 1991 to Jun. 1999 (102 months) - Small Hydroelectric power plant (N/A) (2) Selected sub-projects by SAPI - Improvements to the power transmission and distribution system: - Jul. 1995 to Mar. 2002 (81 months) - Small hydroelectric power plant - Nov. 1999 to Feb. 2007 (88 months) (3) Last addition of sub-projects (WMH-35, 36, 37, 38) - Improvements to the power transmission and distribution system: - Nov. 1999 to Mar. 2004 (53 months)